

Series 2600A System SourceMeter®

Reference Manual

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Series 2600A System SourceMeter[®] Instruments Reference Manual

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Cleveland, Ohio, U.S.A.

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Table of Contents

1	Getting Started	1-1
	Introduction	1-2
	Capabilities and features	1-2
	Organization of manual sections	1-3
	General information	1-3
	Warranty information	1-3
	Contact information	1-3
	Unpacking and inspection	1-3
	Options and accessories	1-4
	User's and Reference manuals	1-5
	Front and rear panel familiarization	1-6
	Front panel summaries	1-6
	Rear panel summaries	1-9
	Cooling vents	1-13
	Power-up	1-14
	Line power connection	1-14
	Power-up sequence	1-15
	Beeper	1-15
	Display modes	1-16
	Editing controls	1-17
	Source and compliance editing	1-17
	Menu navigation	1-18
	Menu types	1-19
	Interface configuration	1-21
	USB storage overview	1-21
	Connecting the USB flash drive	1-21
	Using the file system	1-22
	File system navigation	1-22
	Error and status messages	1-23
2	DUT Test Connections	2-1
	Input/output connectors	2-2
	Input/output LO and chassis ground	2-4
	Sensing methods	2-6
	2-wire local sensing	2-6
	4-wire remote sensing	2-8
	Sense mode selection	2-9
	Contact check connections	2-9
	Multiple SMU connections	2-10
	Guarding and shielding	2-12
	Guarding	2-13
	Noise shield	2-14
	Safety shield	2-16
	Using shielding and guarding together	2-18
	Test fixture	2-20
	Floating an SMU	2-20
	Output-off states	2-23
	Selecting the output-off state	2-23
3	Basic Operation	3-1
	Overview	3-3

Operation overview	3-3
Source-measure capabilities	3-3
Compliance limit	3-4
Setting the compliance limit	3-5
Basic circuit configurations	3-6
Operation considerations	3-6
Warm-up	3-6
Auto zero	3-7
NPLC caching	3-8
Basic source-measure procedure	3-8
Front panel source-measure procedure	3-8
Remote source-measure procedure	3-10
Triggering in local mode	3-11
Configuring trigger attributes in local mode	3-12
Measure only	3-13
Sink operation and interface	3-14
Ohms measurements	3-14
Ohms calculations	3-14
Ohms ranging	3-14
Basic ohms measurement procedure	3-14
Ohms sensing	3-15
Sense selection	3-16
Remote ohms programming	3-17
Power measurements	3-18
Power calculations	3-18
Basic power measurement procedure	3-18
Remote power programming	3-18
Contact check measurements	3-19
Overview	3-19
Contact check commands	3-20
Contact check programming example	3-21
User setup	3-21
Saving user setups	3-21
Recalling a saved setup	3-22
To select power-on setup	3-22
Saving user setups from a command interface	3-22
4 Source-Measure Concepts	4-1
Overview	4-2
Compliance limit	4-2
Maximum compliance	4-2
Compliance principles	4-2
Overheating protection	4-3
Power equations to avoid overheating	4-3
Operating boundaries	4-6
Source or sink	4-6
Continuous power operating boundaries	4-6
I-Source operating boundaries	4-7
V-Source operating boundaries	4-11
Source I measure I, source V measure V	4-14
Basic circuit configurations	4-15
Source I	4-15
Source V	4-15
Measure only (V or I)	4-16
Contact check	4-17
Guard	4-18
Guard overview	4-18
Guard connections	4-19
Settling time considerations	4-20
Measurement settling time considerations	4-20
Reduction in gain-bandwidth	4-22

5	High-Capacitance Mode	5-1
	Overview	5-2
	Understanding high-capacitance mode	5-2
	Understanding source settling times.....	5-2
	Adjusting the voltage source.....	5-3
	Enabling high-capacitance mode	5-4
	Front panel.....	5-4
	Command interface	5-5
6	Range, Digits, Speed, Rel, and Filters	6-1
	Overview	6-2
	Range.....	6-2
	Available ranges	6-2
	Maximum source values and readings	6-3
	Ranging limitations	6-3
	Manual ranging.....	6-3
	Auto ranging	6-3
	Low range limits.....	6-3
	Range considerations.....	6-4
	Range programming.....	6-4
	Digits	6-6
	Setting display resolution.....	6-6
	Remote digits programming.....	6-6
	Speed.....	6-6
	Setting speed.....	6-7
	Remote speed programming	6-7
	Rel.....	6-8
	Front panel rel.....	6-8
	Remote rel programming	6-9
	Filters	6-9
	Filter types	6-9
	Front panel filter control.....	6-10
	Remote filter programming.....	6-12
7	Reading Buffers	7-1
	Reading buffer overview	7-2
	Working with reading buffers in the local state.....	7-2
	Reading buffer options.....	7-2
	Configuring reading buffers	7-3
	Appending or overwriting existing reading buffers	7-3
	Storage operation	7-4
	Saving reading buffers.....	7-4
	Recalling readings.....	7-5
	Working with reading buffers in the remote state	7-5
	Reading buffer commands.....	7-7
	Buffer status.....	7-9
	Dynamic reading buffers	7-10
	Buffer examples.....	7-10
8	Digital I/O	8-1
	Digital I/O port	8-2
	Port configuration.....	8-2
	Digital I/O configuration	8-3
	Controlling digital I/O lines	8-4
	Output enable (Models 2601A/2602A).....	8-5
	Overview.....	8-5
	Operation.....	8-6
	Front panel control of output enable.....	8-6
	Remote control of output enable.....	8-7
	Legacy mode.....	8-7
	Overview.....	8-7
	Features of legacy mode	8-7
	Enable or disable legacy mode.....	8-8
	Interlock (Models 2612A/2612A/2635A/2636A)	8-8

	Overview	8-8
	Operation	8-8
	TSP-Link synchronization lines	8-9
	Connecting to TSP-Link	8-9
	Using TSP-Link synchronization lines for digital I/O	8-9
	Remote TSP-Link synchronization line commands	8-10
9	Sweep Operation	9-1
	Overview	9-2
	Section overview	9-2
	Sweep overview	9-2
	Sweep characteristics	9-3
	Linear staircase sweeps	9-3
	Logarithmic staircase sweeps	9-5
	List sweeps	9-8
	Pulse mode sweeps	9-9
	Configuring and running sweeps	9-10
	Configuring other sweep attributes	9-10
	Configuring measurements during a sweep	9-11
	Source and measurement delays	9-11
	Initiating and running sweeps	9-11
	Aborting a sweep	9-11
	Sweeping using factory scripts	9-12
	Front panel	9-12
	Sweep programming examples	9-12
	List sweep example	9-13
10	Triggering	10-1
	Remote triggering overview	10-3
	Using the remote trigger model	10-4
	Configuring source and measure actions	10-6
	Enabling pulse mode sweeps (end pulse action)	10-6
	SMU event detectors	10-6
	Clearing SMU event detectors	10-7
	Using the TRIG key to trigger a sweep	10-7
	Using trigger events to start actions on trigger objects	10-8
	Action overruns	10-9
	Digital I/O Port and TSP-Link synchronization lines	10-9
	Common attributes	10-9
	Trigger configuration on hardware lines	10-10
	Action overruns on hardware lines	10-11
	Timers	10-11
	Timer attributes	10-11
	Triggering a timer	10-12
	Using timers to perform pulse mode sweeps	10-13
	Timer action overruns	10-17
	Event blenders	10-17
	Event blender modes	10-17
	Assigning input trigger events	10-18
	Action overruns	10-18
	LAN triggering overview	10-18
	Understanding hardware value and pseudo line state	10-18
	Understanding LXI trigger event designations	10-19
	Generating LXI trigger packets	10-19
	Logging LAN trigger events in the event log	10-20
	Accessing the event log from the command interface	10-22
	Command interface triggering	10-22
	Manual triggering	10-23
	Interactive triggering	10-23
	Detecting trigger events using the wait() function	10-23
	Using the assert() function to generate trigger events	10-24
	Using the release() function of the hardware lines	10-24
	Using the set() function to bypass SMU event detectors	10-24

	Event detector overruns.....	10-25
	Examples using interactive triggering	10-25
	Hardware trigger modes for synchronization lines	10-27
	Falling edge trigger mode	10-27
	Rising edge master trigger mode.....	10-29
	Rising edge acceptor trigger mode.....	10-30
	Either edge trigger mode	10-31
	Understanding synchronous triggering modes.....	10-32
	Synchronous master trigger mode (SynchronousM)	10-32
	Synchronous acceptor trigger mode (SynchronousA)	10-34
	Synchronous trigger mode.....	10-35
11	Display Operations	11-1
	Display functions and attributes	11-2
	Display features	11-2
	Display screen	11-2
	Measurement functions	11-3
	Display resolution	11-3
	Display messages.....	11-4
	Clearing the display	11-4
	Cursor position.....	11-4
	Displaying text messages.....	11-5
	Input prompting	11-7
	Menu.....	11-7
	Parameter value prompting	11-8
	Indicators.....	11-9
	LOCAL lockout.....	11-10
	Load test menu	11-10
	Loading and saving a user script.....	11-11
	Adding USER TESTS menu entries	11-11
	Deleting USER TESTS menu entries	11-12
	Running a test from the front panel	11-12
	Key-press codes	11-12
	Sending key codes	11-12
	Capturing key-press codes.....	11-13
12	TSP Fundamentals and Script Management	12-1
	Introduction	12-2
	Test Script Processor (TSP)	12-2
	Run-time environment	12-2
	Queries.....	12-3
	Scripts.....	12-3
	Naming scripts	12-3
	Renaming Scripts	12-4
	Functions	12-4
	Scripts that create functions	12-4
	Programming overview	12-5
	What is a chunk?	12-5
	What is a script?	12-5
	Run-time environment	12-6
	Nonvolatile memory	12-6
	TSP script types.....	12-7
	Programming model for scripts.....	12-7
	User scripts	12-8
	Creating a user script.....	12-8
	Script examples	12-9
	Saving a user script	12-11
	Loading scripts from the USB flash drive.....	12-13
	Running a user script.....	12-14
	Modifying a user script.....	12-15
	Script management.....	12-16
	Memory considerations for the run-time environment	12-18

13	Test Script Builder (TSB)	13-1
	Installing the Test Script Builder software	13-2
	System connections	13-2
	Using Test Script Builder	13-2
	Project Navigator	13-2
	Script Editor	13-2
	Programming Interaction	13-2
	Starting Test Script Builder.....	13-3
	Opening communications	13-4
	Creating and modifying a script	13-6
	Script launch configuration	13-10
	Launching a script	13-14
	Running a TSP file	13-15
	Retrieving scripts from the Series 2600A	13-15
	Instrument console	13-16
	File management tasks.....	13-22
	Displaying custom messages	13-25
14	System Expansion (TSP-Link)	14-1
	Overview	14-2
	Master and slaves	14-2
	System configurations	14-2
	Connections	14-2
	Initialization	14-3
	Assigning node numbers	14-3
	Resetting the TSP-Link.....	14-3
	Using the expanded system.....	14-4
	Accessing nodes	14-4
	System behavior.....	14-5
	Triggering with TSP-Link	14-5
	TSP advanced features.....	14-5
	Using groups to manage nodes on the TSP-Link network	14-7
	Running parallel test scripts.....	14-8
	Using the data queue for real-time communication	14-10
	Copying test scripts across the TSP-Link network	14-10
	Removing stale values from the reading buffer	14-10
15	Communications Interfaces	15-1
	Overview	15-2
	Selecting an interface.....	15-2
	Output queue	15-2
	GPIB operation.....	15-3
	GPIB standards	15-3
	GPIB connections	15-3
	Primary address	15-4
	Terminator.....	15-5
	General bus commands	15-5
	REN (remote enable).....	15-6
	IFC (interface clear)	15-6
	LLO (local lockout).....	15-6
	GTL (go to local).....	15-6
	DCL (device clear).....	15-6
	SDC (selective device clear).....	15-6
	GET (group execute trigger).....	15-6
	SPE, SPD (serial polling).....	15-7
	Front panel GPIB operation	15-7
	Error and status messages.....	15-7
	GPIB status indicators	15-7
	LOCAL key	15-8
	RS-232 interface operation	15-8
	Setting RS-232 interface parameters	15-8
	Sending and receiving data	15-9
	Terminator.....	15-9
	Baud rate	15-9

	Data bits and parity	15-9
	Flow control (signal handshaking)	15-9
	RS-232 connections	15-10
	Error messages	15-11
	Ethernet communications.....	15-11
	Ethernet cable connection	15-11
	Using the LAN with remote operations	15-12
16	LAN Concepts and Settings	16-1
	Overview	16-2
	Establishing a point-to-point connection	16-2
	LAN troubleshooting suggestions	16-7
	Connecting to the LAN	16-8
	Setting the method.....	16-8
	Assigning the Method	16-9
	Setting the IP address	16-9
	Setting the subnet mask	16-9
	Understanding the domain name system	16-9
	Verify menu overview.....	16-10
	Understanding LAN speeds	16-10
	Configuring the LAN speed.....	16-10
	Duplex mode.....	16-11
	Configuring the duplex mode.....	16-11
	Configuring the network settings.....	16-11
	CONFIG/FAULT.....	16-11
	Viewing LAN status messages.....	16-11
	Viewing the network settings.....	16-12
	Confirming the active speed and duplex negotiation.....	16-12
	Confirming port numbers	16-12
	Selecting a remote command interface.....	16-13
	Configuring a telnet connection.....	16-13
17	Web Interface and TSB Embedded	17-1
	Working with the web interface	17-2
	Web browser requirements.....	17-2
	Accessing the web interface	17-2
	Configuring IP addressing	17-3
	Password management	17-6
	Password overview.....	17-6
	Accessing the virtual front panel.....	17-7
	Device identification indicator	17-8
	Working with TSB Embedded	17-9
	Using the Instrument Control Library (ICL).....	17-9
18	TSP-Net™	18-1
	Overview	18-2
	TSP-Net capabilities.....	18-2
	Using TSP-Net with any Ethernet-enabled device	18-2
	Example script	18-3
	Using TSP-Net vs. TSP-Link for communication	18-3
19	Remote Commands	19-1
	Test Script Language (TSL)	19-3
	Introduction	19-3
	Reserved words.....	19-3
	Variables and types	19-3
	Operators.....	19-4
	Functions	19-4
	Tables/arrays	19-5
	Precedence.....	19-6
	Logical operators	19-6
	Concatenation.....	19-7
	Branching.....	19-7
	Loop control.....	19-8

Command programming notes.....	19-9
Conventions.....	19-9
Functions and attributes.....	19-10
TSP-Link nodes.....	19-12
Logical instruments.....	19-12
Reading buffers.....	19-13
Time and date values.....	19-14
Remote versus local state.....	19-14
Standard libraries.....	19-15
String library functions.....	19-16
Math library functions.....	19-17
File I/O.....	19-18
Instrument Control Library.....	19-18
beeper.....	19-23
bit.....	19-23
data queue.....	19-29
delay.....	19-31
digio.....	19-31
display.....	19-38
errorqueue.....	19-54
event log.....	19-56
exit.....	19-58
file I/O.....	19-58
format.....	19-61
file system.....	19-62
gpib.....	19-65
io.....	19-65
LAN.....	19-69
localnode.....	19-85
makegetter and makesetter.....	19-93
meminfo.....	19-94
opc.....	19-94
printbuffer and printnumber.....	19-95
reset.....	19-96
script.....	19-97
serial.....	19-98
setup.....	19-101
smuX.....	19-103
Status.....	19-150
Status register sets.....	19-150
Status byte and SRQ.....	19-150
timer.....	19-203
trigger.....	19-205
tsplink.....	19-212
tspnet.....	19-221
userstring.....	19-234
waitcomplete.....	19-236
Standard libraries.....	19-236
String library functions.....	19-237
Math library functions.....	19-238
Factory scripts.....	19-238
Introduction.....	19-238
Running a factory script.....	19-239
Modifying a factory script.....	19-239
Factory script information.....	19-240
KISweep.....	19-240
KIPulse.....	19-248
KIHighC.....	19-271
KIParlib.....	19-273
KISavebuffer.....	19-274
20 Calibration.....	20-1
Introduction.....	20-2
Environmental conditions.....	20-2

	Temperature and relative humidity.....	20-2
	Warm-up period.....	20-2
	Line power.....	20-2
	Calibration considerations.....	20-2
	Calibration cycle.....	20-3
	Recommended calibration equipment.....	20-3
	Calibration errors.....	20-5
	Calibration.....	20-5
	Calibration steps.....	20-5
	Calibration commands.....	20-8
	Calibration procedure.....	20-9
21	Routine Maintenance	21-1
	Introduction.....	21-2
	Line fuse replacement.....	21-2
	Front panel tests.....	21-3
	Keys test.....	21-3
	Display Patterns test.....	21-3
	Upgrading the firmware.....	21-4
	Using TSB for flash firmware upgrade.....	21-4
22	Performance Verification	22-1
	Introduction.....	22-2
	Verification test requirements.....	22-2
	Environmental conditions.....	22-2
	Warm-up period.....	22-2
	Line power.....	22-3
	Recommended test equipment.....	22-3
	Verification limits.....	22-3
	Restoring factory defaults.....	22-4
	Performing the verification test procedures.....	22-5
	Test summary.....	22-5
	Test considerations.....	22-5
	Setting the source range and output value.....	22-5
	Setting the measurement range.....	22-6
	Output voltage accuracy.....	22-6
	Voltage measurement accuracy.....	22-8
	Output current accuracy.....	22-9
	Series 2600A output current accuracy 100nA and higher.....	22-9
	Model 2635A/2636A output current accuracy 1nA to 100nA ranges.....	22-11
	Current measurement accuracy.....	22-14
	Series 2600A current measurement accuracy 100nA and higher.....	22-14
	Model 2635A/2636A I-meas. accuracy 100pA to 100nA ranges.....	22-15
A	Error and Status Messages	A-1
	Introduction.....	A-2
	Error summary.....	A-2
	Error effects on scripts.....	A-2
	Reading errors.....	A-2
B	Common Commands	B-1
	Common commands.....	B-2
	Command summary.....	B-2
	Script command equivalents.....	B-3
	Command reference.....	B-3
C	Status Model	C-1
	Overview.....	C-2
	Status byte and SRQ.....	C-2
	Status register sets.....	C-2
	Queues.....	C-2
	Status function summary.....	C-11
	Clearing registers and queues.....	C-12
	Programming and reading registers.....	C-12

Programming enable and transition registers	C-12
Reading registers	C-13
Status byte and service request (SRQ)	C-13
Status byte register	C-13
Service request enable register	C-15
Serial polling and SRQ	C-15
SPE, SPD (serial polling)	C-15
Status byte and service request commands	C-15
Enable and transition registers	C-16
Controlling node and SRQ enable registers	C-16
Status register sets	C-17
System Summary Event Registers	C-17
Standard Event Register	C-18
Operation Event Registers	C-19
Measurement Event Registers	C-21
Register programming example	C-22
Queues	C-22
Output queue	C-22
Error queue	C-22
TSP-Link system status	C-23
Status model configuration example	C-23
D Display Character Codes	D-1
Display character codes	D-2
Display character dot patterns	D-5

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the user documentation for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product warranty may be impaired.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the user documentation. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, perform safe installations, and repair products. Only properly trained service personnel may perform installation and service procedures.

Keithley Instruments products are designed for use with electrical signals that are rated Measurement Category I and Measurement Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Measurement Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Measurement Category II connections require protection for high transient over-voltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the user documentation.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000V, no conductive part of the circuit may be exposed.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance-limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, ensure that the line cord is connected to a properly-grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.


The instrument and accessories must be used in accordance with its specifications and operating instructions, or the safety of the equipment may be impaired.


Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.


When fuses are used in a product, replace with the same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.


If a  screw is present, connect it to safety earth ground using the wire recommended in the user documentation.

The  symbol on an instrument means caution, risk of danger. The user should refer to the operating instructions located in the user documentation in all cases where the symbol is marked on the instrument.

The  symbol on an instrument means caution, risk of danger. Use standard safety precautions to avoid personal contact with these voltages.

The  symbol on an instrument shows that the surface may be hot. Avoid personal contact to prevent burns.

The  symbol indicates a connection terminal to the equipment frame.

If this  symbol is on a product, it indicates that mercury is present in the display lamp. Please note that the lamp must be properly disposed of according to federal, state, and local laws.

The **WARNING** heading in the user documentation explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in the user documentation explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits - including the power transformer, test leads, and input jacks - must be purchased from Keithley Instruments. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. Other components that are not safety-related may be purchased from other suppliers as long as they are equivalent to the original component (note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water-based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., a data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

Getting Started

In this section:

Topic	Page
Introduction	1-2
Capabilities and features	1-2
Organization of manual sections	1-3
General information	1-3
Warranty information	1-3
Contact information.....	1-3
Unpacking and inspection.....	1-3
Options and accessories	1-4
User's and Reference manuals.....	1-5
Front and rear panel familiarization	1-6
Front panel summaries	1-6
Rear panel summaries.....	1-9
Cooling vents	1-13
Power-up	1-14
Line power connection.....	1-14
Power-up sequence.....	1-15
Beeper	1-15
Display modes	1-16
Editing controls	1-17
Source and compliance editing	1-17
Menu navigation	1-18
Menu types	1-19
Interface configuration	1-21
USB storage overview	1-21
Connecting the USB flash drive.....	1-21
Using the file system	1-22
File system navigation	1-22
Error and status messages	1-23

Introduction

The Keithley Instruments Series 2600A System SourceMeter® instruments offer electronic component and semiconductor device manufacturers a scalable, high throughput, highly cost-effective solution for precision DC, pulse, and low frequency AC source-measure testing.

Capabilities and features

- Models 2601A/2602A System SourceMeter instruments:
 - Source \pm DC voltage from 1 μ V to 40.4 V
 - Source \pm DC current from 1 pA to 3.03 A
 - Source \pm pulse current up to 10 A
 - Measure \pm pulse current up to 10 A
 - Measure \pm DC voltage from 1 μ V to 40.8 V
 - Measure \pm DC current from 1 pA to 3.06 A
- Models 2611A/2612A System SourceMeter instruments:
 - Source \pm DC voltage from 1 μ V to 202 V
 - Source \pm DC current from 1 pA to 1.515 A
 - Source \pm pulse current up to 10 A
 - Measure \pm pulse current up to 10 A
 - Measure \pm DC voltage from 1 μ V to 204 V
 - Measure \pm DC current from 1 pA to 1.53 A
- Models 2635A/2636A System SourceMeter instruments:
 - Source +/- DC voltage from 1 μ V to 20 V
 - Source +/- DC current from 20 fA to 1.515 A
 - Source \pm pulse current up to 10 A
 - Measure \pm pulse current up to 10 A
 - Measure +/- DC voltage from 1 μ V to 204 V
 - Measure +/- DC current from 1 fA to 1.53 A
- Resistance and power measurement functions.
- LXI Class C.
- High Capacitance mode for load impedance up to 50 μ f.
- Contact check function.
- Two independent source-measure channels (Models 2602A, 2612A, and 2636A only).
- Four-quadrant sink or source operation.
- Embedded Test Script Processor (TSP™) accessible from any host interface; responds to high-speed test scripts comprised of instrument control commands.
- Linear, logarithmic, and custom sweeping and pulsing.
- Internally stores five user setup options.
- Two dedicated reading buffers per SMU that can each store and recall over 140,000 measurements. Additional dynamic reading buffers can be created.
- Filtering to reduce reading noise.
- Supports IEEE-488 (GPIB), RS-232, and Ethernet.
- TSP-Link: Allows TSP-enabled instruments to trigger and communicate with each other.
- Digital I/O port: Allows the Series 2600A to control other devices.
- Trigger model supports robust triggering and synchronization schemes at hardware speeds.
- Advanced TSP features enable parallel script execution across the TSP-Link network.
- USB flash drive access for saving data buffers, test scripts, and user setups.

- Web-based characterization tool that provides easy access to data gathering, sweeping, and pulsing features.

Organization of manual sections

The manual sections in the PDF version of this manual can be viewed by clicking the “Bookmarks” tab on the left side of this window. This tab also provides direct links to the various sections and section topics.

The manual sections are also listed in the Table of Contents located at the beginning of this manual.

General information

Warranty information

Warranty information is located at the back of this manual. Should your Series 2600A require warranty service, contact the Keithley Instruments representative or authorized repair facility in your area for further information. When returning the instrument for repair, be sure to complete and return the service form at the back of this manual to provide the repair facility with the relevant information.

Contact information

If you have any questions, please contact your local Keithley Instruments representative or call one of our Application Engineers at 1-888-KEITHLEY (1-888-534-8453), U.S. and Canada only. You can also contact us through our website at www.keithley.com.

Unpacking and inspection

Inspection for damage

The Series 2600A was carefully inspected electrically and mechanically before shipment. After unpacking all items from the shipping carton, check for any obvious signs of physical damage that may have occurred during transit (there may be a protective film over the display lens, which can be removed). Report any damage to the shipping agent immediately. Save the original packing carton for possible future shipment. Before removing the Series 2600A from the bag, observe the following handling precautions.

Handling precautions

- Always grasp the Series 2600A by the covers or by the handle.
- After removing the Series 2600A from its anti-static bag, inspect it for any obvious signs of physical damage. Report any such damage to the shipping agent immediately.
- When the Series 2600A is not installed and connected, keep the unit in its anti-static bag and store it in the original packing carton.

Package content

The following items are included with every Series 2600A order:

- Model 2601A, 2602A, 2611A, 2612A, 2635A, or 2636A SourceMeter instrument with line cord
- Two RJ-45 crossover cables

- Certificate of calibration
- Quick Start Guide
- CD-ROMs that contain:
 - PDFs of the User's and Reference Manuals
 - Test Script Builder script development software
- Accessories as ordered

The following items are included with Models 2601A, 2602A, 2611A, and 2612A only:

- 2600-KIT Screw terminal connector kit (two with Models 2602A and 2612A and one with Models 2601A and 2611A)

The following items are included with Models 2635A and 2636A only:

- 2600-IAC interlock connector
- CS-1423-3 inverted mini plug
- 2636-002 wire cutting
- 2600-ALG-2 low noise triax cable with alligator clips, UL approved for up to 42 V, 2m (6.6 ft) (two with Model 2636A and one with Model 2635A)
- Quick Start Guide

Options and accessories

GPIB cables, interfaces, and adaptors (connects Series 2600A to the GPIB bus)

Models 7006-1 and 7006-2: Single-shielded GPIB cables. Terminated with one straight connector (non-stacking) and one feed-through connector. Model 7006-1 is 1m long; Model 7006-2 is 2m long.

KPCI-488LP: IEEE-488 interface/controller for the PCI Bus.

KPXI-488: IEEE-488 interface board for the PXI Bus.

KUSB-488A: USB-to-GPIB interface adapter.

Models 7007-05, 7007-1, 7007-2, and 7007-4: Double-shielded premium GPIB cables. Each end is terminated with a feed-through metal housing for longest life and best performance. Model 7007-05 is 0.5m long; 7007-1 is 1m long; Model 7007-2 is 2m long; Model 7007-4 is 4m long.

Model 7010: Shielded GPIB-to-GPIB bus adapter. Provides additional clearance between the rear panel and GPIB cable connector. Allows easier access to cables and other connectors.

RS-232 cable (connects Series 2600A to the RS-232)

Model 7009-5 shielded RS-232 cable: This straight-through cable connects the RS-232 of the Series 2600A to the RS-232 interface of your PC. This cable is 5 ft long and uses shielded cable and connectors to reduce electromagnetic interference (EMI).

TSP-Link cable (connects Series 2600A to the TSP-Link or LAN)

CA-180-3A CAT 5 cable: Crossover CAT5 LAN cable that connects the TSP-Link of the Series 2600A to other instruments. It can also be used to connect the instrument to LAN equipment with Auto_MDIX or to connect the LAN port of the Series 2600A to a PC.

Digital I/O port cables (connects Digital I/O to other devices)

CA-126-1 DB-25 cable: DB-25 male to female DB-25 cable, 1.5 m (5 ft) long, used to connect the digital I/O port to other instruments.

2600-TLINK trigger cable: Cable used to connect the digital I/O port of Series 2600A instruments to other Keithley instruments equipped with Trigger Link (TLINK).

User's and Reference manuals

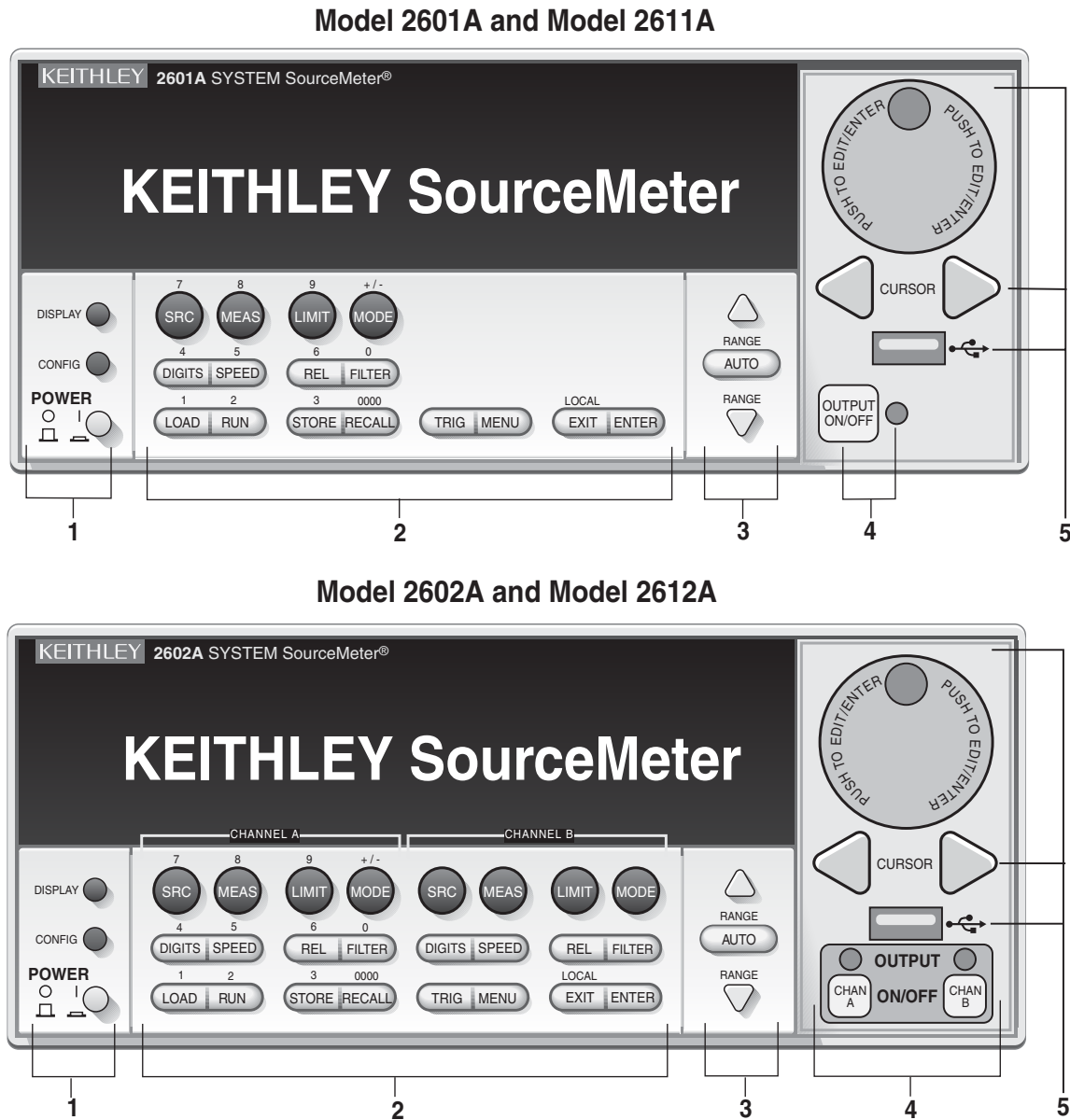
The Series 2600A's User and Reference Manuals are provided on the product information CD-ROM in PDF format. The User's Manual provides the fundamental operating information for the instrument. The Reference Manual provides additional information on the topics covered in the User's Manual. The Reference Manual also includes advanced operation topics and maintenance information.

Front and rear panel familiarization

Front panel summaries

The front panels of the Series 2600A are shown in [Figure 1-1](#). The descriptions of the front panel controls follow [Figure 1-1](#).

Figure 1-1
Front panel (see definitions below figure)



NOTE The Models 2601A, 2611A, and 2635A have one source measure channel (Channel A), and the Models 2602A, 2612A, and 2636A have two source measure channels (Channel A and Channel B).

1. Special keys and power switch:

DISPLAY	Toggles between the various source-measure displays and the user message mode. Selects Model 2602A, 2612A, 2636A single or dual-channel display.
CONFIG	Use to configure a function or operation.
POWER	Power switch: The in position turns SourceMeter instrument on (I); the out position turns it off (O).
Number	The number keys (0-9, +/-, 0000) allow direct numeric entry in the EDIT mode. Keys

2. Source-measure setup, performance control, and special operation:

Top row

Models 2601A, 2602A, 2611A, 2612A, 2635A, and 2636A:

SRC	Channel A selects the source function (V or A) and places cursor in the source field for editing.
MEAS	Channel A cycles through measure functions (V, A, Ω , or W).
LIMIT	Channel A places the cursor in the compliance limit field for editing.
MODE	Channel A directly chooses the measurement function (V, A, Ω , or W).

Models 2602A, 2612A, and 2636A only:

SRC	Channel B selects the source function (V or A) and places cursor in the source field.
MEAS	Channel B cycles through measure functions (V, A, Ω , or W).
LIMIT	Channel B places the cursor in the compliance limit field for editing.
MODE	Channel B directly chooses the measurement function (V, A, Ω , or W).

Middle row

Models 2601A, 2602A, 2611A, 2612A, 2635A, and 2636A:

DIGITS	Channel A changes display resolution to 4-1/2, 5-1/2, or 6-1/2 digits.
SPEED	Channel A sets the measurement speed by controlling the A/D converter measurement aperture.
REL	Channel A controls relative, which allows a baseline value to be subtracted from a reading.
FILTER	Channel A controls the digital filter, which can be used to reduce reading noise.

Models 2602A, 2612A, and 2636A only:

DIGITS	Channel B changes display resolution to 4-1/2, 5-1/2, or 6-1/2 digits.
SPEED	Channel B sets the measurement speed by controlling the A/D converter measurement aperture.
REL	Channel B controls relative, which allows a baseline value to be subtracted from a reading.
FILTER	Channel B controls the digital filter, which can be used to reduce reading noise.

Bottom row

LOAD	Loads factory or user-defined scripts for execution.
RUN	Runs the last selected factory or user-defined scripts.
STORE	Stores readings, source values, and timestamp values in one of two internal buffers per channel for later recall.
RECALL	Recalls stored readings, source values, and timestamp values from either of the two buffers.
TRIG	Triggers readings.
MENU	Accesses the main menu for saving and recalling setups, selecting a remote interface, line frequency, self-tests, serial number, and beeper control.
EXIT	Cancels selection and backs out of menu structure. Also used as a LOCAL key to take the unit out of remote.
ENTER	Accepts selection and moves to the next choice or exits the menu.

3. Range keys:

\triangle and ∇	Selects the next higher or lower source or measure range.
AUTO	Enables or disables source or measure auto range.

4. Output control and LED status indicator:

OUTPUT ON/OFF	Turns source output on or off.
LED indicator	Turns on when output is on.

5. Navigation Wheel, USB port, and cursor keys:

Use the **CURSOR** keys to move the cursor left or right. Once you select the desired source or compliance value, push the **navigation wheel** to edit the value. You can use the navigation wheel to enable or disable the edit mode.

Use the **CURSOR** keys or navigation wheel to navigate through menu items. To view a menu value, use the **CURSOR** keys for cursor control and then rotate the navigation wheel to change the value. Push the **navigation wheel** to open the submenu items or to select a menu option or a value.

Use the USB port to connect with a USB flash drive. The USB flash drive stores reading buffer data, scripts, and user setup options.

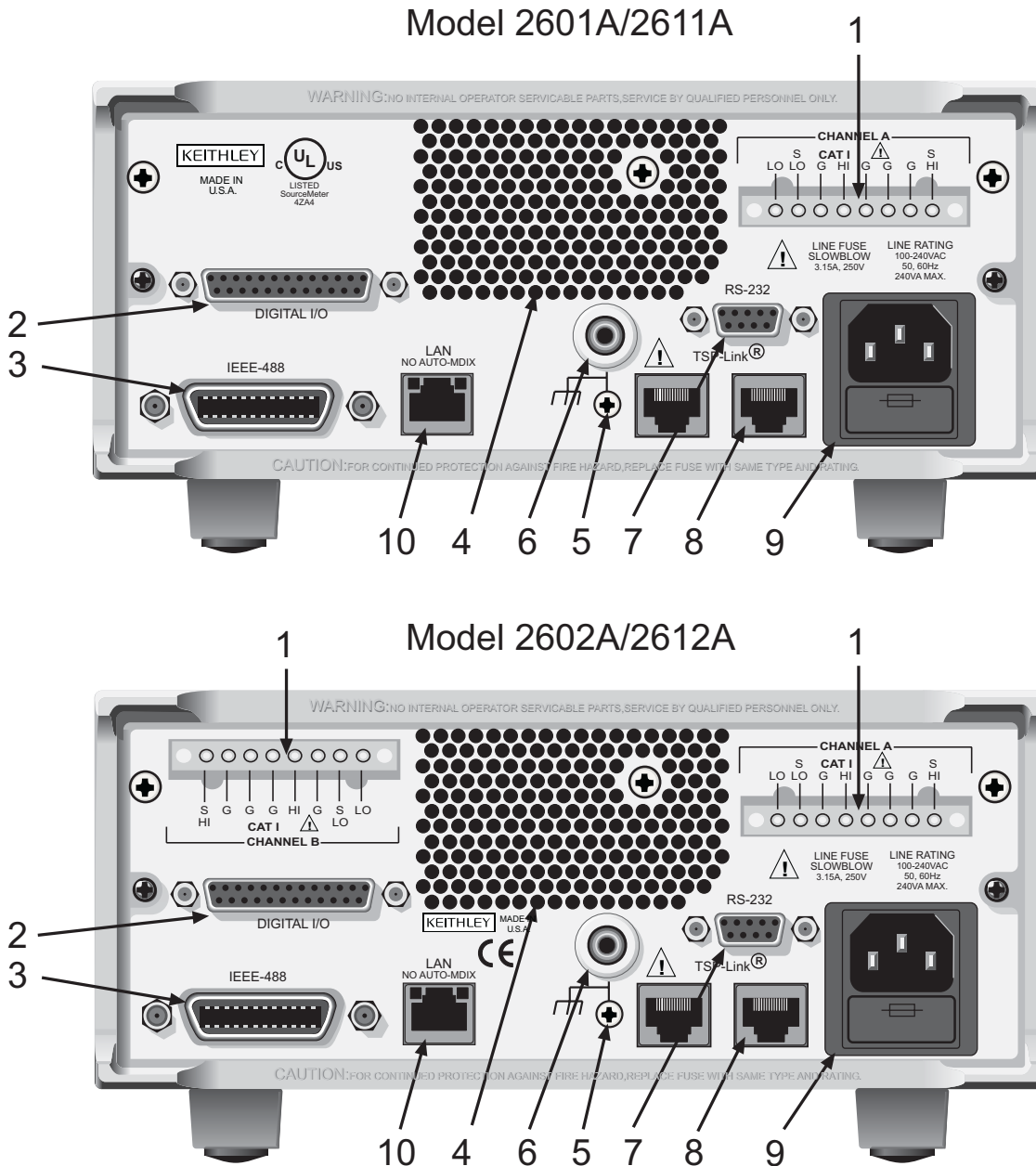
6. Display indicators (not shown):

EDIT	Unit is in the source editing mode
ERR	Questionable reading or invalid cal step
REM	Unit in remote mode
TALK	Unit is addressed to talk
LSTN	Unit is addressed to listen
SRQ	Service request
REL	Relative mode enabled
FILT	Digital filter is enabled
AUTO	Auto source or measure range is selected
ARM	Unit is armed and ready to run
* (asterisk)	Readings are being stored in the buffer

Rear panel summaries

The rear panels of Models 260A, 2611A and Models 2602A, 2612A are shown in *Figure 1-2*. The descriptions of the rear panel components follow *Figure 1-2*. The rear panels of Models 2625A and 2636A are shown in *Figure 1-3*. The descriptions of the rear panel components follow *Figure 1-3*.

Figure 1-2
Models 2601A/2611A and 2602A/2612A rear panels (see definitions below figure)



1. CHANNEL A and CHANNEL B (Channel B on 2602A/2612A only)

Input/output connections for source, sense, and guard.

2. DIGITAL I/O

Female DB-25 connector. Fourteen pins for digital input or output, one pin for output enable (2601A/2602A) or safety interlock (2611A/2612A); +5V and GND pins are also provided.

Use a cable equipped with a male DB-25 connector (Keithley Instruments part number CA-126-1CA).

3. IEEE-488

Connector for IEEE-488 (GPIB) operation. Use a shielded cable, such as the Model 7007-1 or Model 7007-2.

4. Cooling exhaust vent

Exhaust vent for the internal cooling fan. Keep the vent free of obstructions to prevent overheating.

5. Chassis ground

Ground screw for connections to chassis ground.

6. Low noise chassis ground

Ground jack for connecting Output HI or LO to chassis.

7. RS-232

Female DB-9 connector. For RS-232 operation, use a straight-through (not null modem) DB-9 shielded cable (Keithley Instruments Model 7009-5) for connection to the PC.

8. TSP-Link

Expansion interface that allows a Series 2600A and other TSP-enabled instruments to trigger and communicate with each other. Use a category 5e or higher LAN crossover cable (Keithley Instruments part number CA-180-3A).

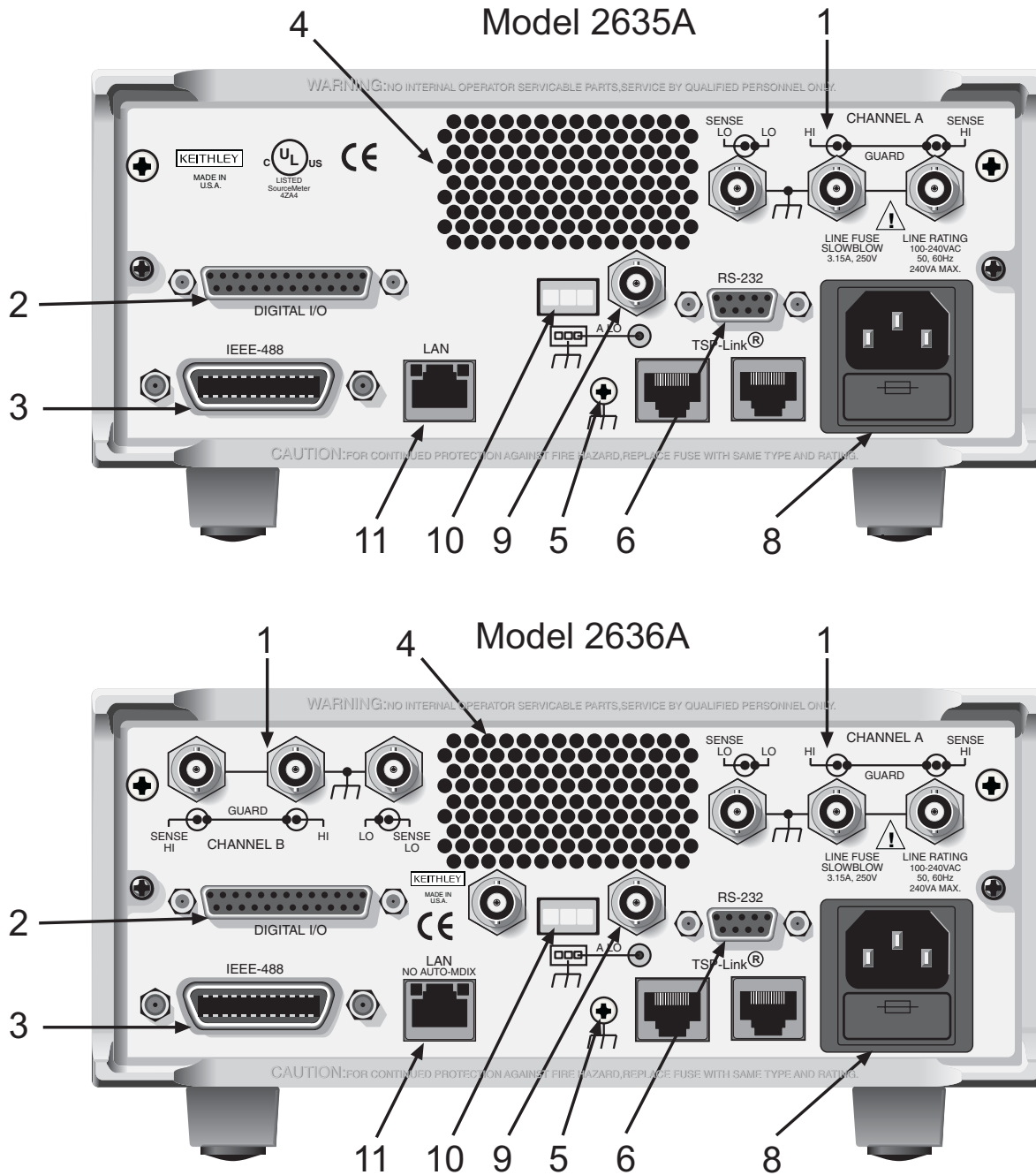
9. Power module

Contains the AC line receptacle and power line fuse. The instrument can operate on line voltages of 100V to 240V AC at line frequencies of 50Hz or 60Hz.

10. LAN

Use this RJ-45 connector to connect the instrument to the local area network. The RJ-45 connector connects a network card, a network switch, a router or a hub. When connecting directly to a PC, a crossover cable (included) must be used. When connecting to a network switch, router, or hub, a normal CAT-5 cable (not provided) should be used unless your equipment has Auto-MDIX capabilities. If it does have Auto-MDIX, the crossover cables may be used.

Figure 1-3
Models 2635A/2636A rear panels (see definitions below figure)



1. CHANNEL A and CHANNEL B (Channel B on Model 2636A only)

Triax connectors for input/output, guard, and sense connections. Use only low-noise triax cables such as the Keithley Instruments Model 7078-TRX (available in several lengths). Connector terminals and associated triax cable conductors are as follows:

Table 1-1
Connectors and triax cable conductors

Connector	Center conductor	Inner ring	Outer ring
LO	Sense LO	Input/Output LO	Chassis ground
HI	Input/Output HI	Guard	Chassis ground
SENSE HI	Sense HI	Guard	Chassis ground
Triax cable	Center conductor	Inner shield	Outer shield

WARNING *When connecting to the model 2611A, 2612A, 2635A and 2636A SMU outputs, with cables not rated for voltages above 42V, such as the 2600A-ALG-2, you must disable the high voltage output by using the INTERLOCK function as defined in section 10 of this manual. Leaving the high voltage enabled while not properly insulating the external connections to the unit poses a shock hazard which could cause serious injury to the user. It is also recommended that the LO connection terminal not be allowed to float by connecting it to signal ground or another known signal reference.*

2. DIGITAL I/O

Female DB-25 connector. Fourteen pins for digital input or output, one pin for safety interlock. Use a cable equipped with a male DB-25 connector (Keithley Instruments part number CA-126-1CA).

3. IEEE-488

Connector for IEEE-488 (GPIB) operation. Use a shielded cable, such as the Model 7007-1 or Model 7007-2.

4. Cooling exhaust vent

Exhaust vent for internal cooling fan. Keep vent free of obstructions to prevent overheating.

5. Chassis ground

Ground screw for connections to chassis ground.

6. RS-232

Female DB-9 connector. For RS-232 operation, use a straight-through (not null modem) DB-9 shielded cable for connection to the PC (Keithley Instruments Model 7009-5).

7. TSP-Link

Expansion interface that allows a Series 2600A and other TSP-enabled instruments to trigger and communicate with each other. Use a category 5e or higher LAN crossover cable (Keithley Instruments part number CA-180-3A).

8. Power module

Contains the AC line receptacle and power line fuse. The instrument can operate on line voltages of 100V to 240V AC at line frequencies of 50Hz or 60Hz. See [Section 21](#) of this manual for line fuse replacement instructions.

9. Triax connector on Ground Module

Channel A and Channel B low noise chassis ground triax connectors. Use only low-noise triax cables such as the Keithley Model 7078-TRX. Connector terminals and associated triax cable connectors are as follows:

Table 1-2

Triax connector on ground module

Connector	Center conductor	Inner ring	Outer ring
LO	Output Lo	Floating	Chassis Ground
Triax cable	Center conductor	Inner shield	Outer shield

10. Phoenix connector on Ground Module

Channel A and Channel B Low noise chassis ground Phoenix connector.

11. LAN

Use this RJ-45 connector to connect the instrument to the local area network. The RJ-45 connector connects a network card, a network switch, a router or a hub. When connecting directly to a PC, a crossover cable (included) must be used. When connecting to a network switch, router, or hub, a normal CAT-5 cable (not provided) should be used unless your equipment has Auto-MDIX capabilities. If it does have Auto-MDIX, the crossover cables may be used.

Cooling vents

The Series 2600A has side intake and rear exhaust vents. One side must be unobstructed when rack mounted to dissipate heat. Do not place a container of liquid (water or coffee for instance) on the top cover. If it spills, the liquid will enter the case through the vents and cause severe damage.

Excessive heat could damage the Series 2600A and degrade its performance. The Series 2600A must be operating in an environment where the ambient temperature does not exceed 50°C.

CAUTION To prevent damaging heat build-up and ensure specified performance, observe to the following precautions:

The rear exhaust vent and at least one side vent must be kept free of any obstructions. Even partial blockage could impair proper cooling.

DO NOT position any devices adjacent to the Series 2600A that force air (heated or unheated) into or onto its cooling vents or surfaces. This additional airflow could compromise accuracy performance.

When rack mounting the Series 2600A, make sure there is adequate airflow around at least one side to ensure proper cooling. Adequate airflow enables air temperatures within approximately one inch of the Series 2600A surfaces to remain within specified limits under all operating conditions.

Rack mounting high power dissipation equipment adjacent to the Series 2600A could cause excessive heating to occur. The specified ambient temperature must be maintained around the surfaces of the Series 2600A to specified accuracies. A good measure to ensure proper cooling in rack situations with convection cooling only is to place the hottest equipment (for instance, the power supply) at the top of the rack. Precision equipment (such as the Series 2600A) should be placed as low as possible in the rack where temperatures are coolest. Adding space panels below the Series 2600A will help ensure adequate air flow.

Power-up

Line power connection

Follow the procedure below to connect the Series 2600A to line power and turn on the instrument. The Series 2600A operates from a line voltage of 100V to 240V at a frequency of 50Hz or 60Hz. Line voltage is automatically sensed. There are no switches to set. Make sure the operating voltage in your area is compatible.

CAUTION Operating the instrument on an incorrect line voltage may cause damage to the instrument, possibly voiding the warranty.

1. Before plugging in the power cord, make sure that the front panel power switch is in the off (O) position.
2. Connect the female end of the supplied power cord to the AC receptacle on the rear panel.
3. Connect the other end of the power cord to a grounded AC outlet.

WARNING *The power cord supplied with the Series 2600A contains a separate ground wire for use with grounded outlets. When proper connections are made, the instrument chassis is connected to power line ground through the ground wire in the power cord. Failure to use a grounded outlet may result in personal injury or death due to electric shock.*

4. Turn the instrument on by pressing the front panel power switch to the on (I) position.

Line frequency

The Series 2600A will operate at line frequencies of either 50Hz or 60Hz. For best measurement noise performance, the unit should be configured to match the actual line frequency used, as follows:

1. Press the **MENU > LINE-FREQ** and then press **ENTER**.
2. Select the appropriate frequency and then press **ENTER**.
Note: Select **AUTO** to automatically detected the line frequency.
3. Press **EXIT** to back out of the menu structure.

Via remote, use the `localnode.linefreq` command to set the line frequency. For example, the following command sets the line frequency to 60Hz:

```
localnode.linefreq = 60
```

To set automatic line frequency detection from a remote interface use:

```
localnode.autolinefreq = true
```

Fuse replacement

A rear panel fuse drawer is located below the AC receptacle (refer to [Figure 1-2](#) for Models 2601A/2602A/2611A/2612A and [Figure 1-3](#) for Models 2635A/2636A). This fuse protects the power line input of the instrument. If the line voltage fuse needs to be replaced, refer to [Line fuse replacement](#) in [Section 21](#).

Power-up sequence

On power-up, the Series 2600A performs self-tests and momentarily lights all segments and indicators. If a failure is detected, the instrument rotates through any error messages detected at start-up (error messages are listed in [Appendix A](#)).

NOTE If a problem develops while the instrument is under warranty, return it to Keithley Instruments, Inc., for repair.

Assuming no errors occur, the Series 2600A will power-up as follows:

1. The OUTPUT indicators and display pixels flash briefly.
2. The following items are shown in sequence:
 - The firmware revision number.
 - The line frequency.
 - The TSP-Link node.
 - The enabled command interface(s) and address (GPIB/LAN/RS-232).

System identification

Serial number, firmware revision, and calibration dates can be displayed by selecting **SYSTEM-INFO** from the main menu.

Complete the following steps to view the system information.

1. Press **MENU > SYSTEM-INFO**.
2. Choose one of the following:
 - **FIRMWARE**
 - **SERIAL#**
 - **CAL**

For remote programming, use the `*IDN?` query to read system information.

Beeper

With the beeper enabled, a beep will be issued to acknowledge the following actions:

- A short beep, emulating a key click, is issued when a front panel key is pressed.
- A short beep is also issued when the navigation wheel is turned or pressed.
- A longer beep is issued when the source output is turned on.

Complete the following steps to turn the beeper on or off.

1. select **MENU > BEEPER**.
2. Choose one of the following:
 - **ENABLE**
 - **DISABLE**

Via remote, use the `beeper.enable` command to control the beeper. For example, the following enables the beeper:

```
beeper.enable = 1
```

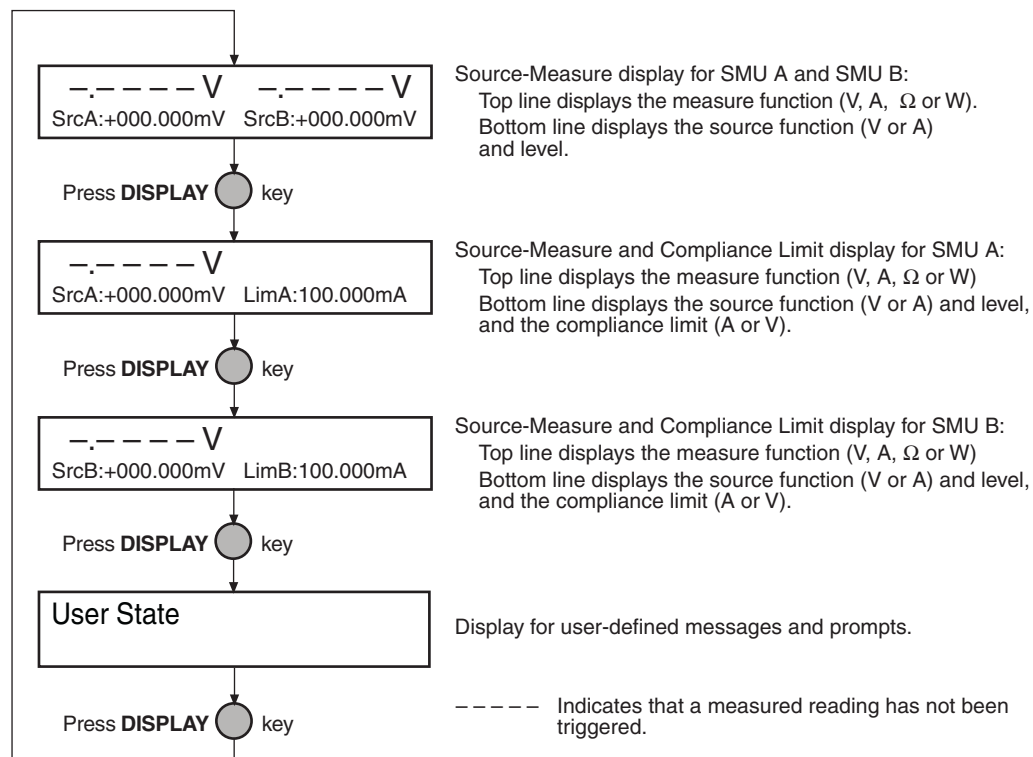
Display modes

Use the **DISPLAY** key to cycle through the various display modes shown in [Figure 1-4](#).

(Models 2602A, 2612A, and 2636A only) Press the **DISPLAY** key more than once to cycle through the dual channel and single channel display modes. This applies to CHANNEL A (SMU A) and CHANNEL B (SMU B).

The Models 2601A, 2611A, and 2635A are a single channel (SMU A). Refer to [Section 11](#) for more information on display messaging.

Figure 1-4
Display modes



Editing controls

Source and compliance editing

When the Series 2600A is in the edit mode (EDIT indicator on), the editing controls are used to set source and compliance values. Note that source auto ranging will turn off when editing the source value.

Editing source values

Complete the following steps to edit the source.

1. Press the **SRC** key. The cursor flashes in the source value field.
2. Use the **CURSOR** arrow keys or the **navigation wheel** to move the cursor to the desired digit.
3. Push the **navigation wheel** or **ENTER** to edit the source value. The EDIT indicator is illuminated.
4. Do one of the following to change the source value:
 - Rotate the **navigation wheel** to adjust the digit.
Note: The digit automatically overflows or underflows to the next digit when wrapping from 9 to 0 or from 0 to 9.
 - If the keypad feature is enabled, use the numeric keys (0-9, +/-, 0000) to enter the source value.
Note: The +/- toggles the polarity, and 0000 sets the value to 0.
5. Once the desired value displays, press **ENTER**.
Note: The EDIT indicator is *not* illuminated.
6. (Optional) Press the **EXIT** key to cancel source editing.

Editing compliance values

Complete the following steps to edit the compliance value.

1. Do one of the following:
 - (Model 2601A/2611A/2635A and 2602A/2612A/2636A in single-channel display mode only) Press the **LIMIT** key.
 - (Model 2602A/2612A/2636A dual-channel display mode only) Press **LIMIT** or **CONFIG > LIMIT** to edit the compliance limit.
2. Choose one of the following:
 - **VOLTAGE**
 - **CURRENT**
3. Use the **CURSOR** arrow keys to move the cursor to the desired value.
4. Press the **navigation wheel** or **ENTER** to enter edit mode. The EDIT indicator is illuminated.
5. Do one of the following to modify the compliance limit value:
 - Rotate the **navigation wheel** to adjust the value.
Note: The digit automatically overflows or underflows to the next digit when wrapping from 9 to 0 or from 0 to 9.
 - If the keypad feature is enabled, use the numeric keys (0-9) to enter the value.
6. Press **ENTER** to complete editing.
Note: The EDIT indicator is *not* illuminated.
7. (Optional) Press the **EXIT** key cancel changes.

Menu navigation

When the Series 2600A is not in the edit mode (the EDIT indicator is not illuminated), the editing controls are used to navigate the Main and Configuration menus to make selections and/or set values (see [Menu navigation](#) for more information). After entering a menu structure, use the editing keys as follows:

Selecting menu items

- Use the **CURSOR** arrow keys to select a menu or an option.
- Press the **ENTER** key to select an item or menu option.
- Rotate the **navigation wheel** (clockwise or counter-clockwise) to select a value.
- Use the **EXIT** key to cancel changes or to return to the main menu.

NOTE You can use the **navigation wheel** to select items from the menu or a submenu.

Setting a value

There are two ways to adjust a value: Value adjust or numeric entry. To use the keypad, the keypad feature must be enabled. Both methods use the following editing techniques:

- To set a value to zero, press the **0000** numeric entry key.
- To toggle the polarity of a value, press the **+/-** numeric entry key.

Value adjust method

1. Use the **CURSOR** arrow keys to move the cursor to the value that you want to edit.
2. Push the **navigation wheel** or **ENTER** to enter edit mode. The EDIT indicator is illuminated.
3. Rotate the **navigation wheel** to set the appropriate value.
4. Press **ENTER** to select the value. Press **EXIT** to cancel the change.

Numeric entry method

1. Use the **CURSOR** arrow keys to move the cursor to the value that you want to edit.
2. Press the number entry key (**0** to **9**). The cursor moves to the next value on the right.
3. Repeat [Step 2.](#) as required to set the desired values.
4. Press **ENTER** to select the value.
5. (Optional) Press **EXIT** the cancel change and to return to the main menu.

NOTE The numeric entry method may only be used if the numeric keypad is enabled.

Menu types

Many aspects of operation are configured through menus. There are two types of menus. Refer to [Menu navigation](#) for more details on using menus.

Main menu

The main menu is summarized in [Table 1-3](#), along with the reference for each main selection. To access the menu items shown in [Table 1-3](#), press the **MENU** key, and then make your selection.

Table 1-3
Main menu

Menu selection	Description	Reference
SCRIPT LOAD SAVE	Recalls users scripts saved. Loads scripts into nonvolatile memory. Saves scripts.	Section 12
SETUP SAVE RECALL POWERON	Saves and recalls user and factory setup options. Saves user setup options. Recalls user setup options. Sets the default configuration.	Section 1
GPIB ADDRESS ENABLE	Configure the GPIB interface options. Configure the address for the GPIB interface. Enables and disables the GPIB interface.	Section 15 Section 15 Section 8
LAN STATUS CONFIG APPLY_SETTINGS RESET ENABLE	Use to configure the local area network (LAN) Displays connection status. Use to configure the IP address and gateway. Applies the configurations selected from the CONFIG menu. Restores the default settings. Enables and disables the LAN.	Section 16
RS232 BAUD BITS PARITY FLOW-CTRL ENABLE	Controls the options for the RS-232 interface Sets the baud rate Configures the number of bits Sets the parity Configures the flow control Use to enable and disable the RS-232 interface	Section 15
TSPINK NODE RESET	An alternate way to configure the instrument for TSP-Link Selects the instrument node identifier Use to reset the TSP-Link network	Section 14
UPGRADE	Used to upgrade the firmware from a USB memory stick	Section 21
DISPLAY TEST NUMPAD	Use to perform the display tests Runs the display test Enables and disables the numeric keypad	Section 21
DIGOUT DIG-IO-OUTPUT WRITE-PROTECT LEGACY-MODE	Controls digital outputs Selects the digital I/O values. Write protects specific digital I/O lines Enable or disable legacy mode	Section 8

Menu selection	Description	Reference
BEEPER ENABLE DISABLE	Controls the key beeps. Enables the key beeps. Disables key beeps.	Section 1
LINE-FREQ AUTO 50Hz 60Hz	Configure the line frequency. Automatically selects the line frequency.	Section 1
SYSTEM-INFO FIRMWARE SERIAL# CAL	Displays the system information. Displays the version of firmware installed. Displays the serial number of the unit. Displays the last calibration date.	Section 1
RESET-PASSWORD	Reset the system password.	

Configuration menus

The configuration menus are summarized in [Table 1-4](#), along with the reference for each main selection. There are two ways to make selections:

- Press **CONFIG**, then navigate to the desired submenu.
- Press **CONFIG**, then press the associated key. For example, pressing **CONFIG** followed by **REL** takes you directly to the Relative menu.

Table 1-4
Configuration menus

Menu selections	Shortcut	Description	Reference
CHANNEL-A SRC MEAS LIMIT SPEED REL FILT OUTPUT	SRC MEAS LIMIT SPEED REL FILTER OUTPUT	Configure Channel A: V-source sense, low range; I-source low range, and HighC-mode. V and I-Measure sense, low range; auto zero. V-source and I-source compliance limits. Measurement speed (NPLC). Set relative values. Control digital filter. Set off-state, control digital I/O.	Section 6 Section 6 Section 6 Section 6 Section 6 Section 3 Section 19
CHANNEL-B SRC MEAS LIMIT SPEED REL FILT OUTPUT	SRC MEAS LIMIT SPEED REL FILTER OUTPUT	Configure Channel B: V-source sense, low range; I-source low range, and HighC-mode. V and I-Measure sense, low range; auto zero. V-source and I-source compliance limits. Measurement speed (NPLC). Set relative values. Control digital filter. Set off-state, control digital I/O.	Section 6 Section 6 Section 6 Section 6 Section 6 Section 3 Section 19
COMMON TRIG STORE	TRIG STORE	Configure common functions: Set trigger in, count, interval, and delay. Set buffer count and destination.	Section 10 Section 4

Interface configuration

The following summarizes basic interface configuration for the Series 2600A. Details on the interfaces, including configuration, are provided in [Section 15](#). Use the editing controls for [Menu navigation](#) described earlier in this section to select and configure the interface.

Complete the following steps to select the GPIB interface:

1. Press **MENU > GPIB** and then press **ENTER**.
2. Choose **ADDRESS**, then press **ENTER**.
3. Set the **GPIB** address (0 to 30) and press **ENTER**.
4. Press **EXIT** to return to the main menu.

Complete the following steps to select the RS-232 interface

1. Press **MENU > RS232**, then press **ENTER**.
2. Do the following:
 - Set the **BAUD** rate: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200.
 - Set **BITS**: 7 or 8.
 - Set **PARITY**: NONE, ODD, or EVEN.
 - Set the **FLOW-CTRL**: NONE or HARDWARE.
3. Press **EXIT** to return to the main menu.

See [Section 15](#) for more information about communications interfaces and how to select the LAN interface.

USB storage overview

The Keithley Instruments Series 2600A System SourceMeter® instrument includes a USB port on the front panel. To store scripts and to transfer files from the instrument to the host PC, insert a USB flash drive into the USB port.

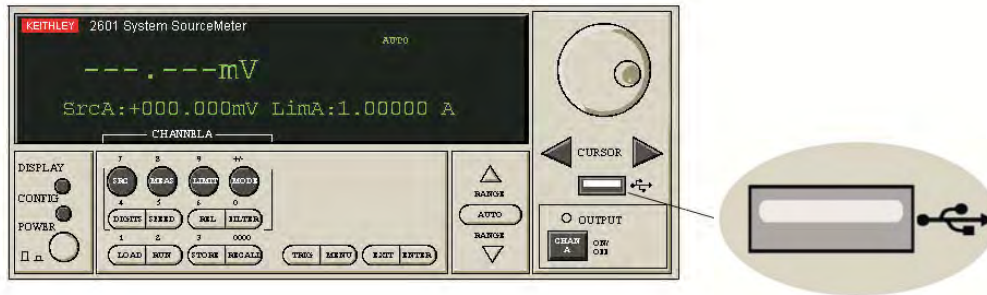
- For additional information on saving reading buffers to the USB flash drive, see [Reading Buffers](#) in [Section 7](#).
- For additional information on storing and loading scripts to and from the USB flash drive, see [Saving a user script](#) in [Section 12](#).
- For additional information on file I/O, see [File I/O](#) in [Section 19](#).
- For additional information on saving user setups, see [User setup](#) in [Section 3](#).

Connecting the USB flash drive

The Series 2600A supports flash drives that comply with USB 1.0 and 2.0 standards. You can save data to the USB flash drive from the front panel or you can create a script to save data to the USB flash drive.

To connect the USB flash drive, insert the USB flash drive into the USB port, located on the front panel of the instrument (see [Figure 1-5](#)).

Figure 1-5
USB port



Using the file system

File system navigation

The Lua `fs` library provides the command set necessary to navigate the file system and list the available files on a flash drive. The instrument encapsulates this command set as an `fs` logical instrument, so that the file system of any given node is available to the entire TSP-Link system. For example, the command `node[5].fs.readdir(". ")` can be used to read the contents of the current working directory on Node 5.

To allow for future enhancements, the root folder of the USB flash drive has the absolute path `"/usb1/"`.

NOTE Both slash (/) and backslash (\) are supported as directory separators.

The following Lua `fs` commands, which support basic navigation and directory listing, are included for your reference:

```
fs.chdir
fs.cwd
fs.is_dir
fs.is_file
fs.mkdir
fs.readdir
fs.rmdir
```

The following Lua `fs` commands are not supported at this time:

```
fs.chmod
fs.chown
fs.stat
```

Error and status messages

Error and status messages briefly displayed. During operation and programming, you will encounter a number of front panel messages. Typical messages are either status or error notifications, as listed in [Appendix A](#).

Messages, both status and error, are held in queues. For information on retrieving error messages from queues, refer to [Appendix A](#).

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In this section:

Topic	Page
Input/output connectors	2-2
Input/output LO and chassis ground	2-4
Sensing methods	2-6
2-wire local sensing	2-6
4-wire remote sensing	2-8
Sense mode selection	2-9
Contact check connections	2-9
Multiple SMU connections	2-10
Guarding and shielding	2-12
Guarding	2-13
Noise shield	2-14
Safety shield	2-16
Using shielding and guarding together	2-18
Test fixture	2-20
Floating an SMU	2-20
Output-off states	2-23
Selecting the output-off state	2-23

Input/output connectors

The Keithley Instruments Series 2600A System SourceMeter® Models 2601A, 2602A, 2611A, and 2612A use screw connectors for input and output connections to devices under test (DUTs). The Model 2602A/2612A uses two connectors as shown in [Figure 2-1](#) (one for each source-measure unit (SMU) channel). The Model 2601A/2611A has only one connector for a single SMU. Models 2635A and 2636A use triax connectors as shown in [Figure 2-2](#).

A connector can be removed from the rear panel by loosening the two captive retaining screws and pulling it off the rear panel. Each screw can accommodate from 24 AWG (0.2mm²) to 12 AWG (2.5mm²) conductors.

After making the wire connections from a connector to a DUT, reinstall the connector onto the rear panel and tighten the two captive screws.

WARNING *Hazardous voltages may be present on the output and guard terminals. To prevent electrical shock that could cause injury or death, NEVER make or break connections to the Series 2600A while the output is on. Power off the equipment from the front panel or disconnect the main power cord from the rear of the SourceMeter instrument before handling cables connected to the outputs. Putting the equipment into standby does not guarantee the outputs are not powered if a hardware or software fault occurs.*

Maximum floating (common mode) voltage for a SMU is 250V. Exceeding this level could damage the instrument and create a shock hazard. See [Floating an SMU](#) later in this section for details on floating the SMUs.

The input/output connectors of the SourceMeter instruments are rated for connection to circuits rated Installation Category I only, with transients rated less than 1500V peak. Do not connect the Series 2600A terminals to CAT II, CAT III, or CAT IV circuits. Connections of the input/output connectors to circuits higher than CAT I can cause damage to the equipment or expose the operator to hazardous voltages.

To prevent electric shock and/or damage to the SourceMeter instrument, when connecting to a source with a greater current capability than the Series 2600A, a fuse should be provided in-line with the Series 2600A input/output connectors rated no more than 3A.

Figure 2-1
2602A/2612A input/output connectors

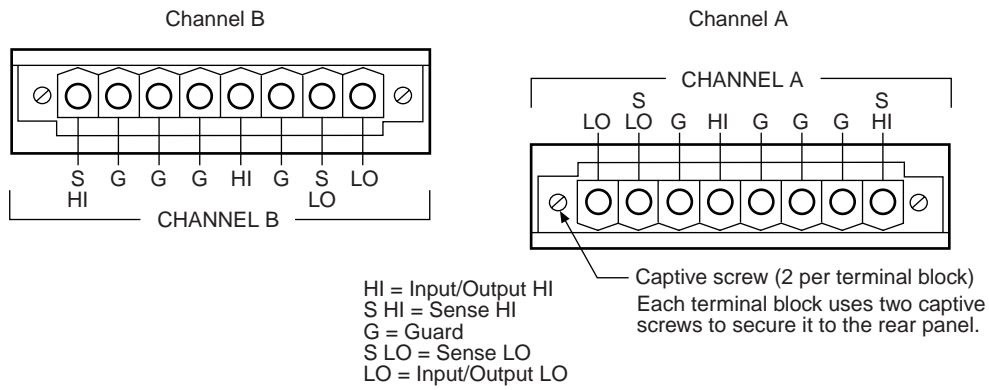
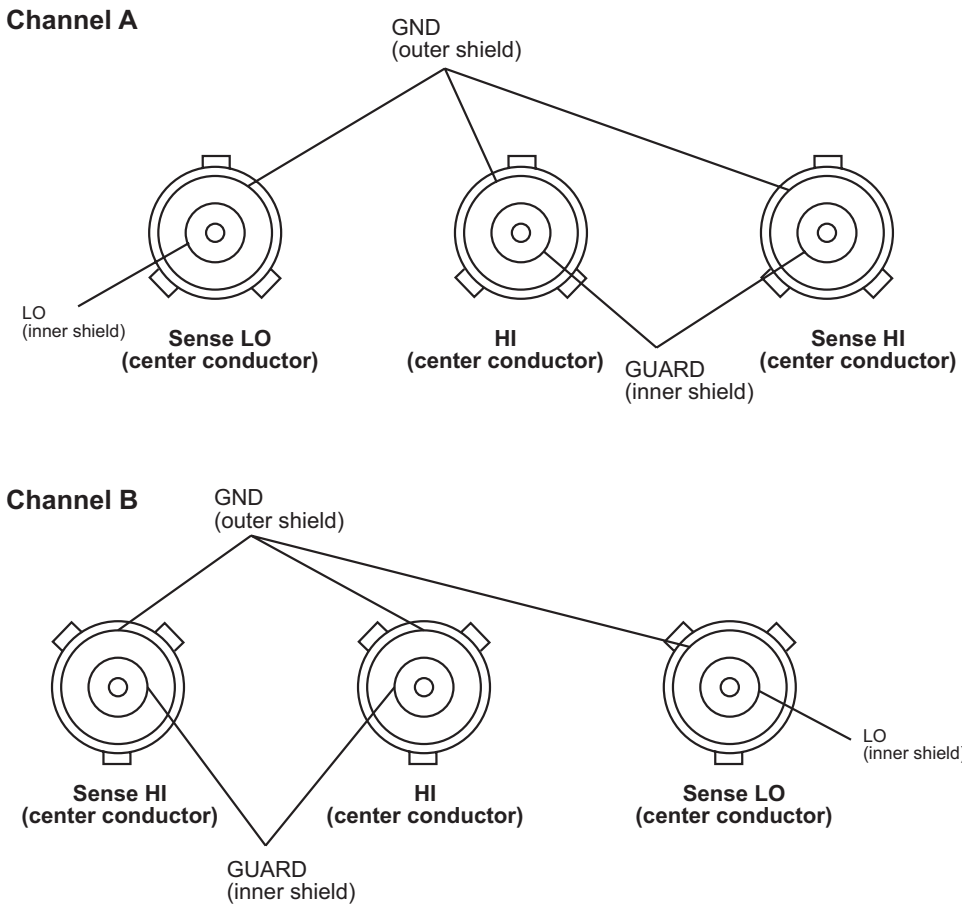


Figure 2-2
Model 2636A input/output connectors



Input/output LO and chassis ground

As shown in [Figure 2-3](#), SMU input/output LOs are available at the rear panel terminal blocks. Input/output LOs are not connected between channels and are electrically isolated from chassis ground.

As shown, there is a low-noise chassis ground banana jack that can be used as a common signal ground point for Input/Output LOs. This low-noise signal ground banana jack is connected to the chassis through a Frequency Variable Resistor (FVR).

The FVR (see [Figure 2-4](#)) is used to isolate the SMUs from high frequencies that may be present on the chassis of the Series 2600A. As frequencies on the chassis increase, the resistance of the FVR increases to dampen its effects.

NOTE Keep in mind that the chassis should never be used as a ground point for signal connections. High frequencies present on the chassis of the Series 2600A may result in higher noise. The chassis should only be used as a safety shield. Use the chassis screw for connections to the chassis of the Series 2600A. For Model 2636A, connect to ground on the ground module not to the chassis screw.

Figure 2-3
Model 2602A/2612A input/output LO and chassis ground terminals

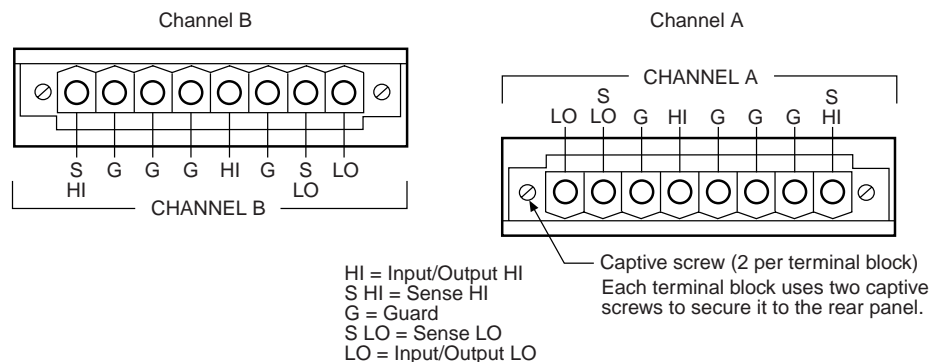


Figure 2-4
Model 2636A input/output and chassis ground

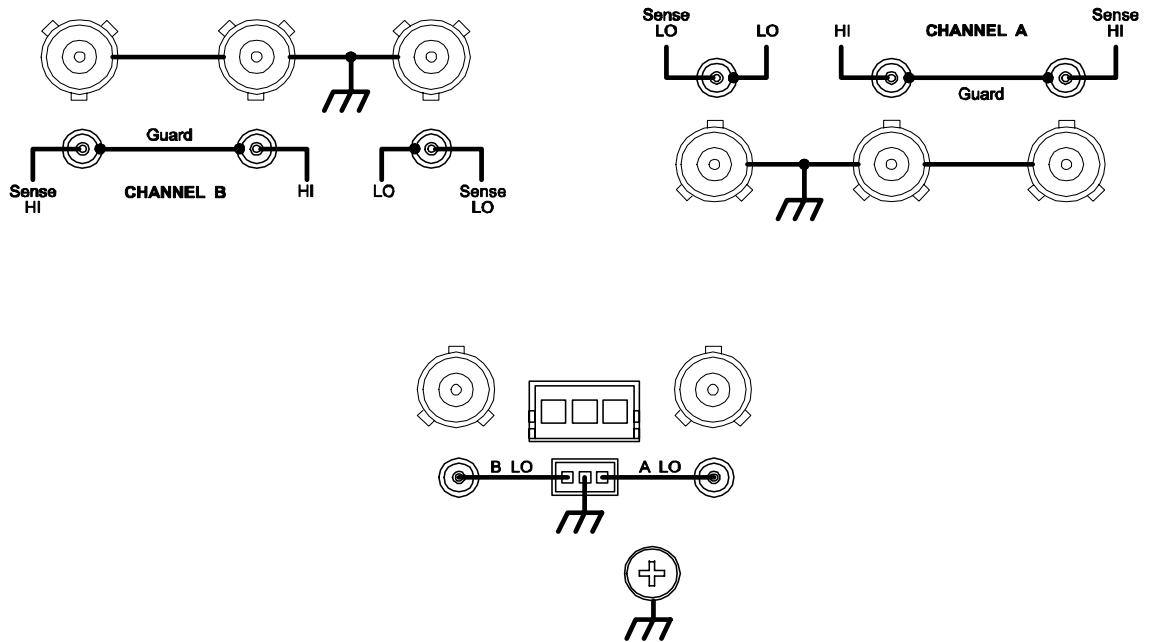


Figure 2-5
Model 2602A/2612A Low-Noise Chassis Ground Banana Jack and Chassis Screw

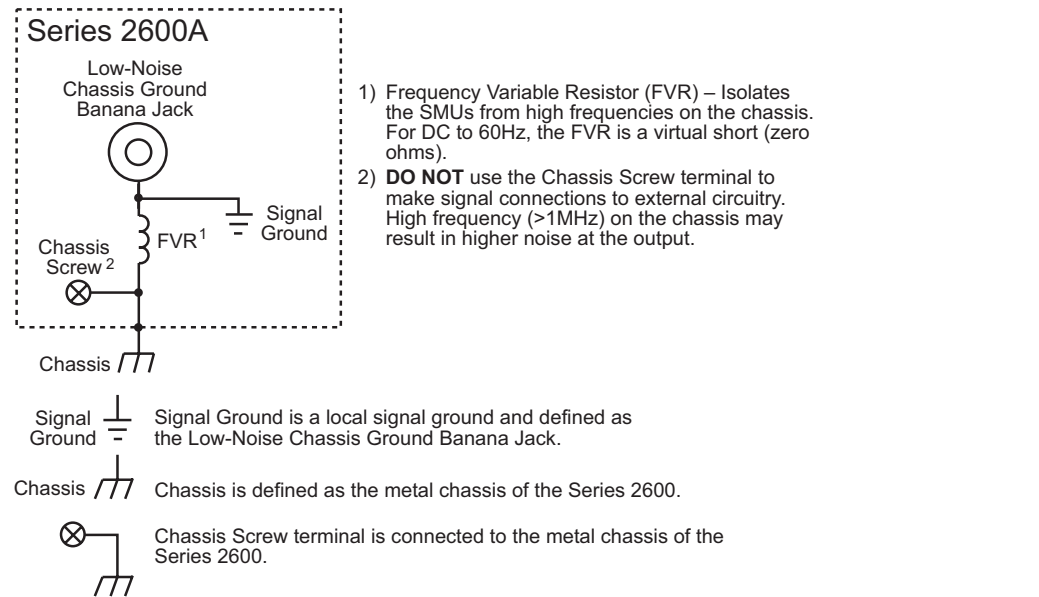
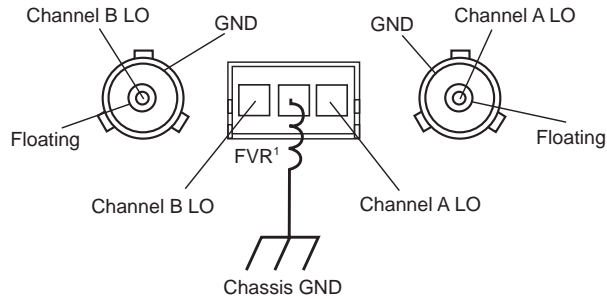


Figure 2-6
Model 2636A



WARNING When connecting to the model 2611A, 2612A, 2635A, and 2636A SMU outputs, with cables not rated for voltages above 42V, such as the 2600A-ALG-2, you must disable the high voltage output by using the INTERLOCK function as defined in [Section 8](#) of this manual. Leaving the high voltage enabled while not properly insulating the external connections to the unit poses a shock hazard which could cause serious injury to the user. It is also recommended that the LO connection terminal not be allowed to float by connecting it to signal ground or another known signal reference.

Sensing methods

Source-measure operations are performed using either 2-wire local sense connections or 4-wire remote sense connections.

NOTE The default sense setting is 2-wire local. See [Sense mode selection](#) later in this section to check and or change the sense mode.

2-wire local sensing

Two-wire local sensing (as shown in [Figure 2-7](#)) can be used for the following source-measure conditions:

- Sourcing and measuring current.
- Sourcing and/or measuring voltage in high impedance (>1kΩ) test circuits.

Figure 2-7
Model 2602A/2612A two-wire connections (local sensing)

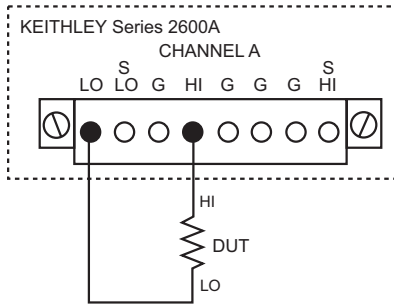


Figure 2-8
Model 2636A two-wire connections (local sensing, non-floating)

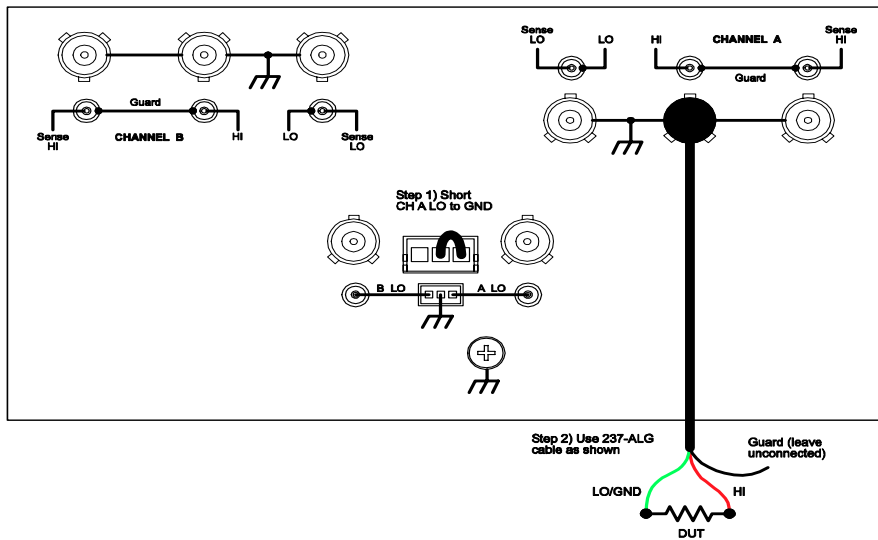
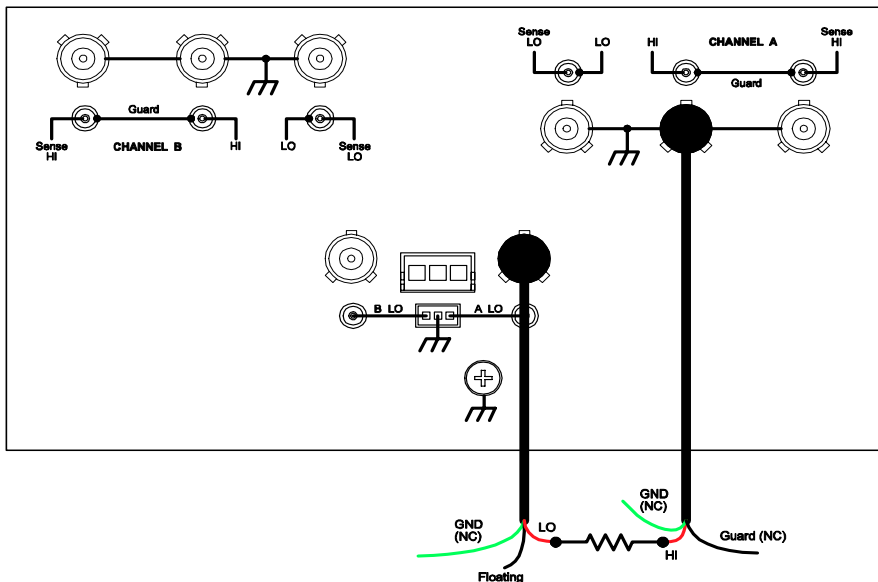


Figure 2-9
Model 2636A two-wire connections (local sensing, floating)



4-wire remote sensing

When sourcing and/or measuring voltage in a low-impedance test circuit (see [Figure 2-10](#)), there can be errors associated with IR drops in the test leads. Voltage source and measure accuracy are optimized by using 4-wire remote sense connections. When sourcing voltage, 4-wire remote sensing ensures that the programmed voltage is delivered to the DUT. When measuring voltage, only the voltage drop across the DUT is measured.

Use 4-wire remote sensing for the following source-measure conditions:

- Sourcing and/or measuring voltage in low impedance (<1kΩ) test circuits.
- Enforce voltage compliance limit directly at the DUT.

Figure 2-10

Model 2602A/2612A four-wire connections (remote sensing)

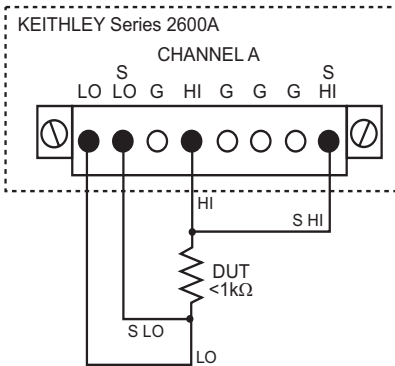
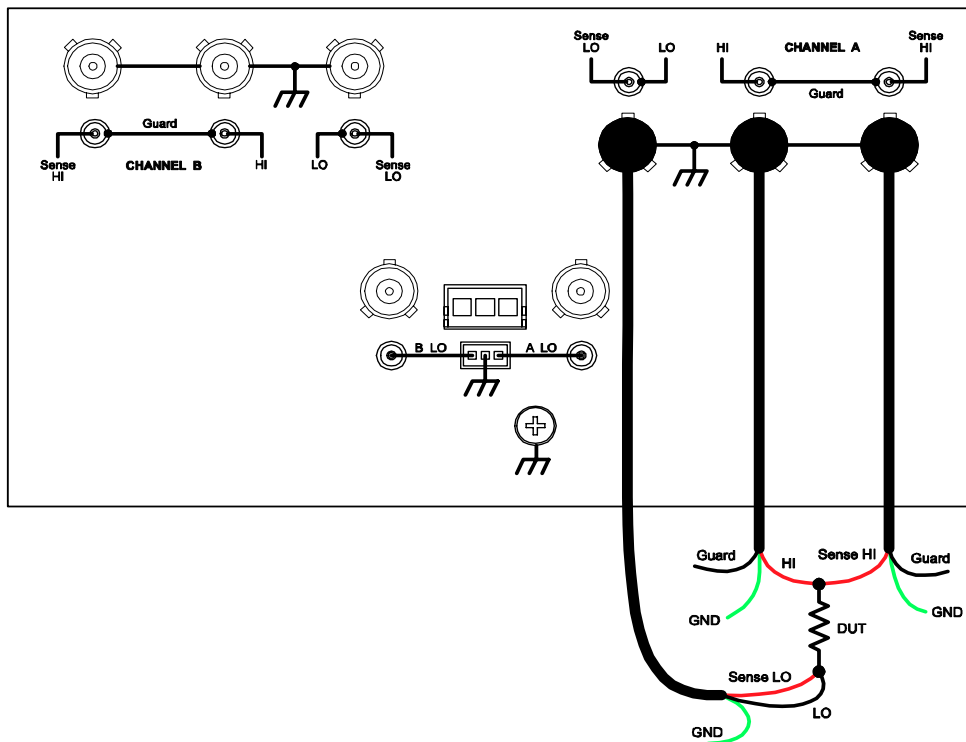


Figure 2-11

Model 2636A four-wire connections (remote sensing)



Sense mode selection

The sense mode can be set for 2-wire local or 4-wire remote connections.

Front panel sense selection

[Table 2-1](#) summarizes the steps to check and/or change the sense mode front panel. When in the menu structure, use the navigation wheel (or **CURSOR** keys) to position the blinking cursor on the desired menu item, and press **ENTER** to select it. Use the **EXIT** key to back out of the menu structure.

Table 2-1

Selecting the sense mode from the front panel

Model 2601A/2611A/2635A	Model 2602A/2612A/2636A
1) Press CONFIG key	1) Press CONFIG key
2) Select SRC or MEAS menu*	2) Select CHANNEL-A or CHANNEL-B
3) Select V-SOURCE menu	3) Select SRC or MEAS menu*
4) Select SENSE-MODE menu	4) Select V-SOURCE menu
5) Select 2-WIRE or 4-WIRE	5) Select SENSE-MODE menu
	6) Select 2-WIRE or 4-WIRE

* The sense mode can be set from either the **SRC** or **MEAS** menu.

Remote programming sense selection

[Table 2-2](#) summarizes the commands to select the sense mode. See [Section 19](#) for details on using these commands.

Table 2-2

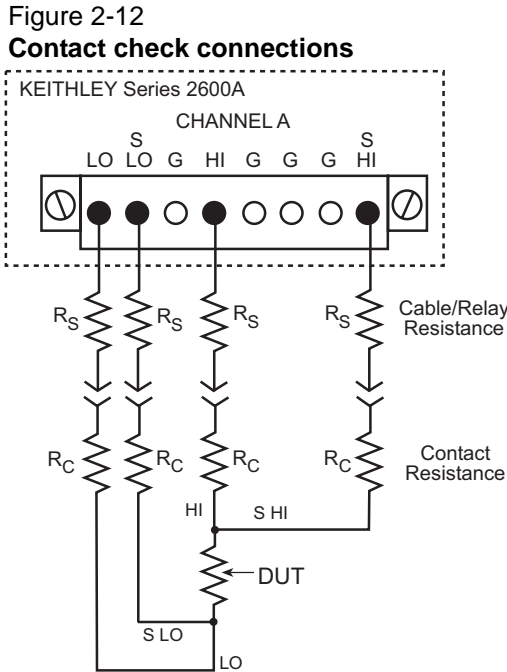
Commands to select sense mode

Command*	Description
<code>smuX.source.output = smuX.OUTPUT_OFF</code>	Turns off the SMU output.
<code>smuX.sense = smuX.SENSE_LOCAL</code>	Selects local (2-wire) sense.
<code>smuX.sense = smuX.SENSE_REMOTE</code>	Selects remote (4-wire) sense.

* Model 2601A/2611A/2635A: smuX = smua. Model 2602A/2612A/2636A: smuX = smua (Channel A) or smub (Channel B).

Contact check connections

The contact check function prevents measurement errors due to excessive resistance in the force or sense leads. Connections for contact check measurements are shown in [Figure 2-12](#). See [Section 3](#) for operation and [Section 19](#) for details on contact check commands.



Multiple SMU connections

Figure 2-13 shows how to use two SMUs to test a 3-terminal device, such as an N-channel JFET. A typical application is for SMU B to source a range of gate voltages, while SMU A sources voltage to power the device and measures current at each gate voltage.

Figure 2-13
Model 2602A/2612A two SMUs connected to a 3-terminal device (local sensing)

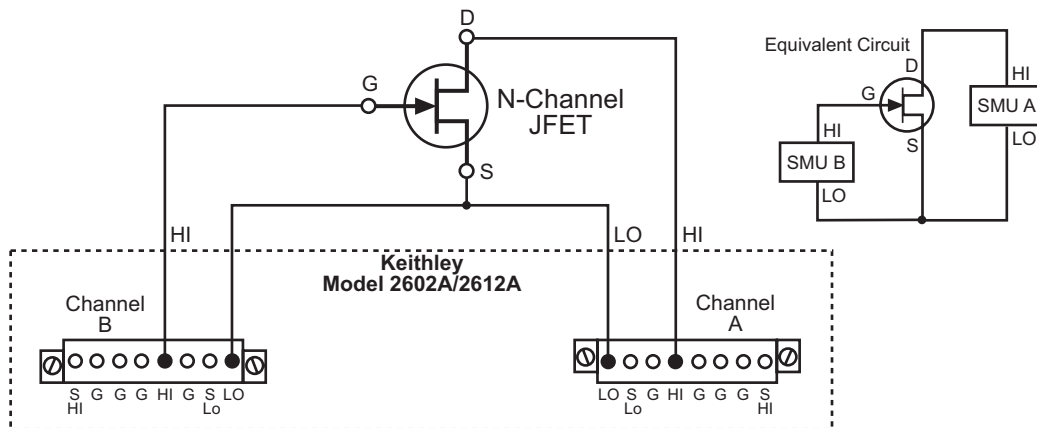


Figure 2-14
Model 2636A, two SMUs connected to a 3-terminal device (local sensing, floating)

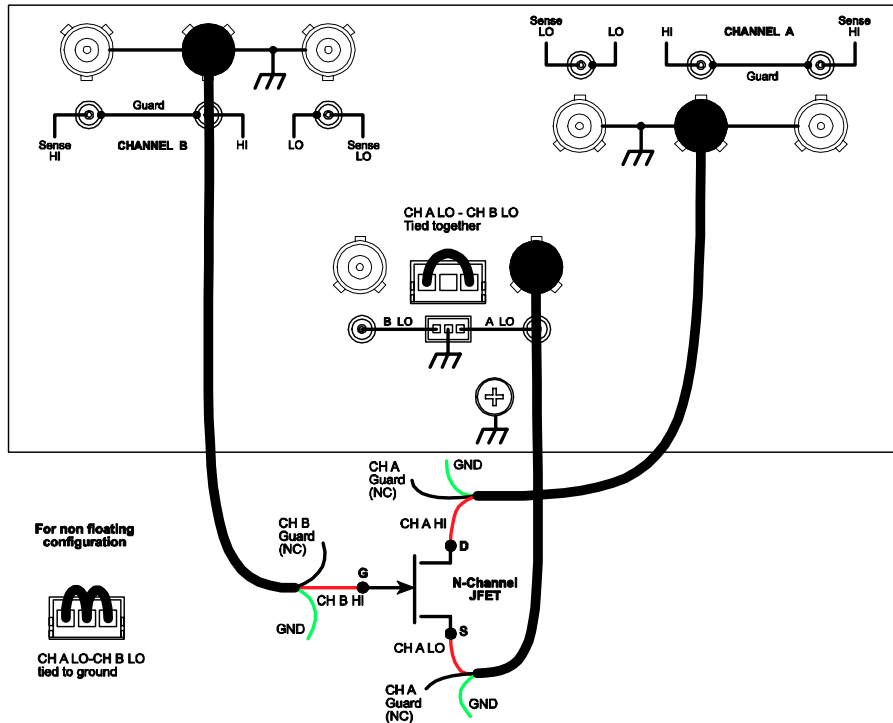


Figure 2-15 shows how to use three SMUs to test the same 3-terminal device. The third SMU is connected to the source (S) terminal of the JFET. This allows the source terminal to be biased above signal low. Setting this SMU to output 0V effectively connects the source terminal of the JFET to signal low.

Figure 2-15
Three SMUs connected to a 3-terminal device

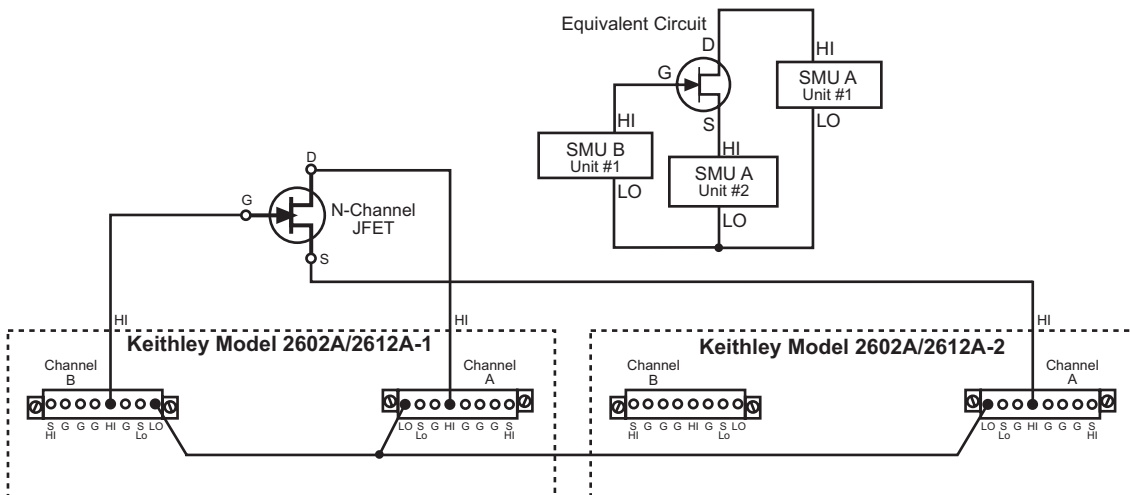
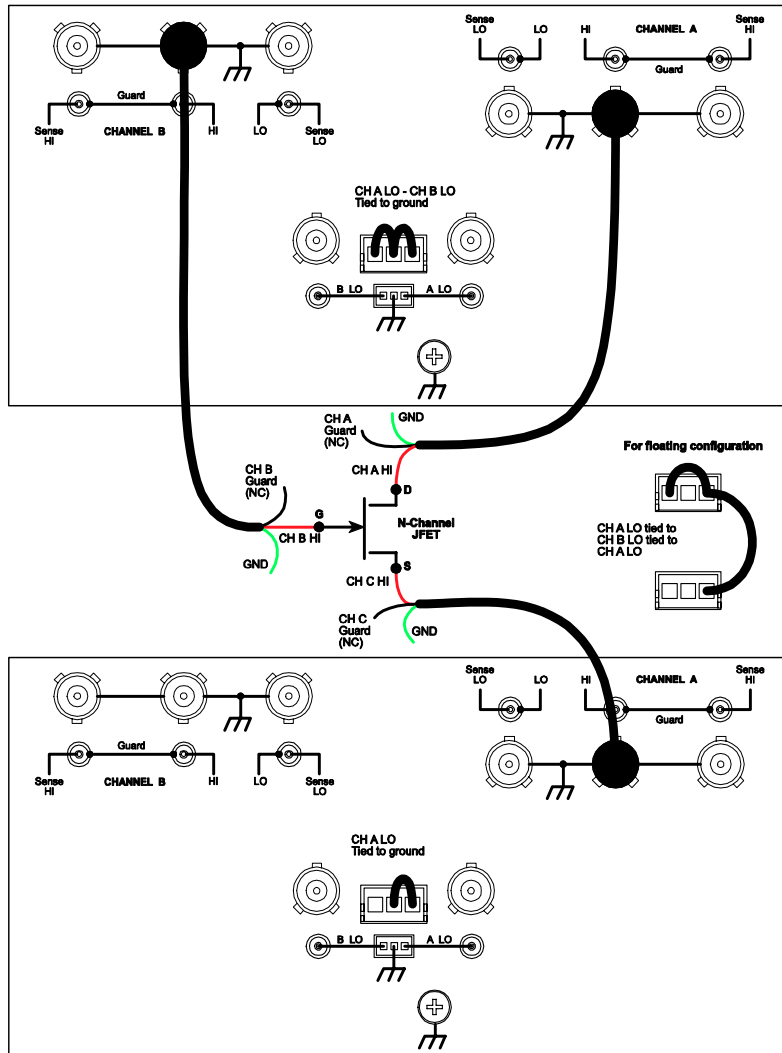


Figure 2-16
Model 2636A, three SMUs connected to a 3-terminal device (local sensing, non-floating)



Guarding and shielding

Source-measure performance and safety are optimized with the effective use of guarding and shielding (noise and safety shields).

Guarding

A driven guard is always enabled and provides a buffered voltage that is at the same level as the input/output HI voltage. The purpose of guarding is to eliminate the effects of leakage current (and capacitance) that can exist between input/output high and low. Without guarding, leakage and capacitance in the external high-impedance test circuit could be high enough to adversely affect the performance of the SourceMeter instrument.

Guarding (shown in [Figure 2-16](#)) should be used for the following source-measure condition:

- Test circuit impedance is $>1G\Omega$.

NOTE See [Guarding and shielding](#) for details on the principles of guarding.

Figure 2-17
Models 2602A and 2612A high-impedance guarding

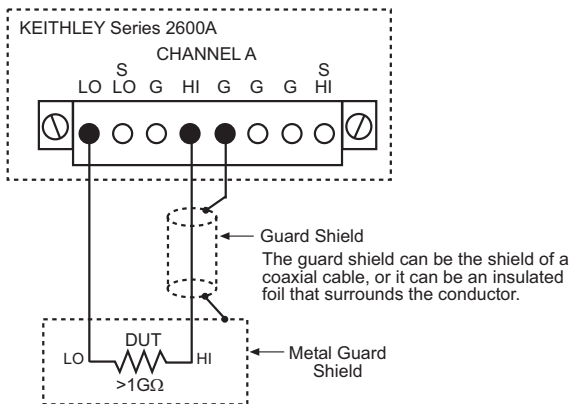


Figure 2-18
Model 2636A high-impedance guarding (floating)

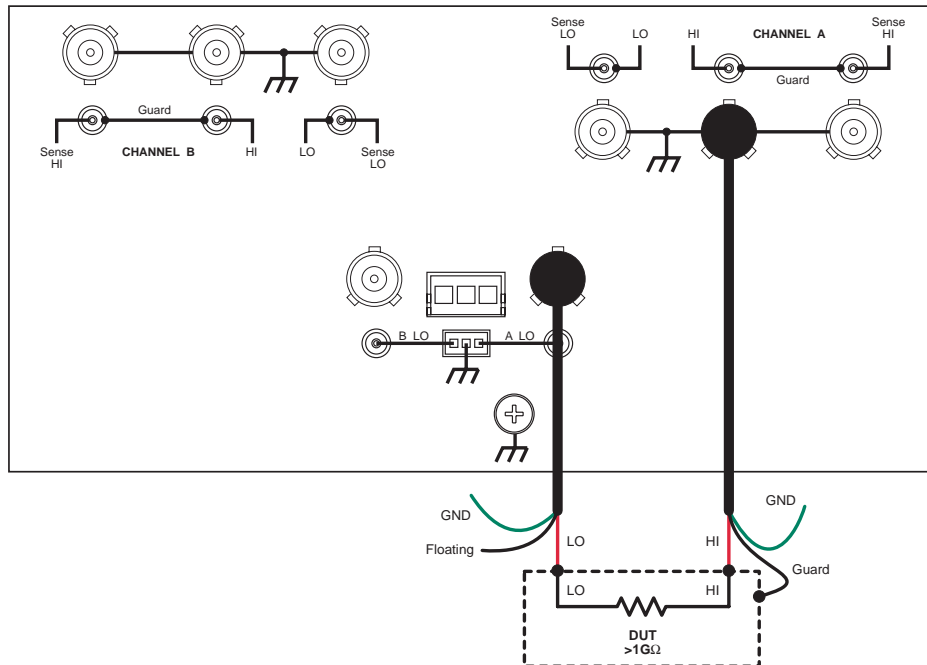
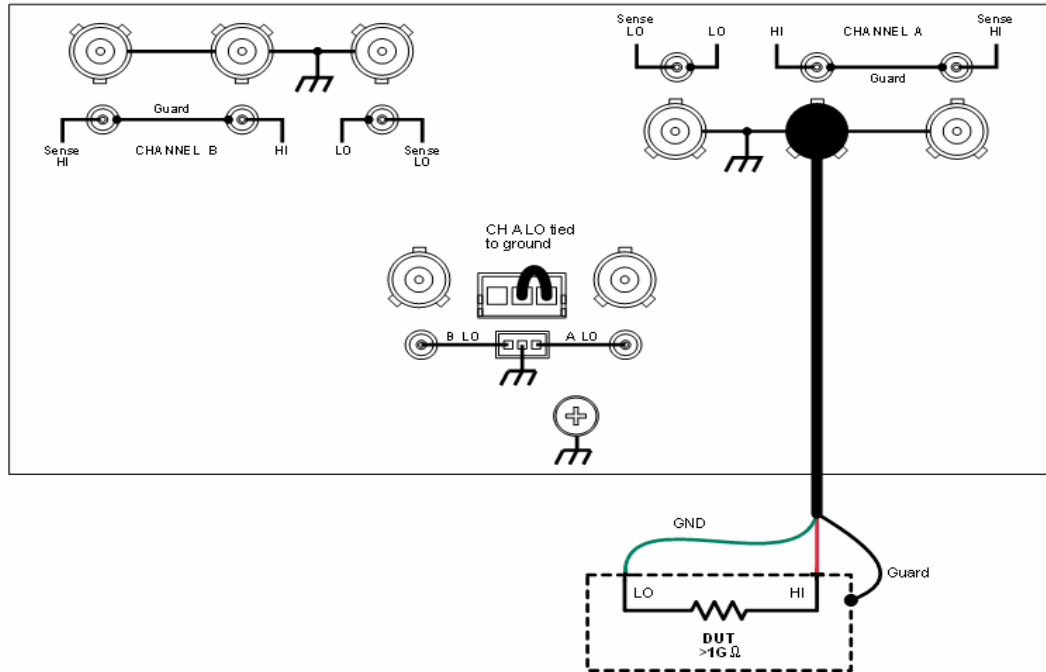


Figure 2-19
Model 2636A High-impedance guarding (non-floating)



Noise shield

A noise shield (see [Figure 2-20](#)) is used to prevent unwanted signals from being induced into the test circuit. Low-level signals may benefit from effective shielding. The metal noise shield surrounds the test circuit and should be connected to SMU LO as shown in [Figure 2-20](#).

Figure 2-20
Models 2602A and 2612A noise shield

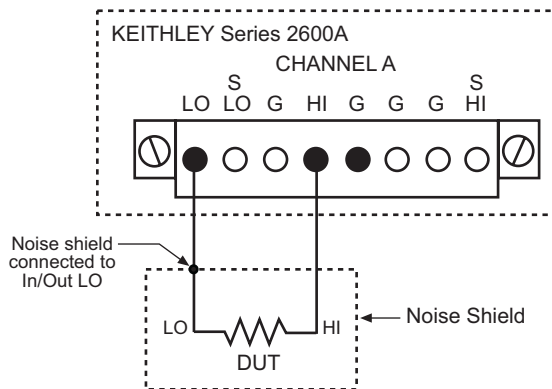


Figure 2-21
Model 2636A noise shield (non-floating)

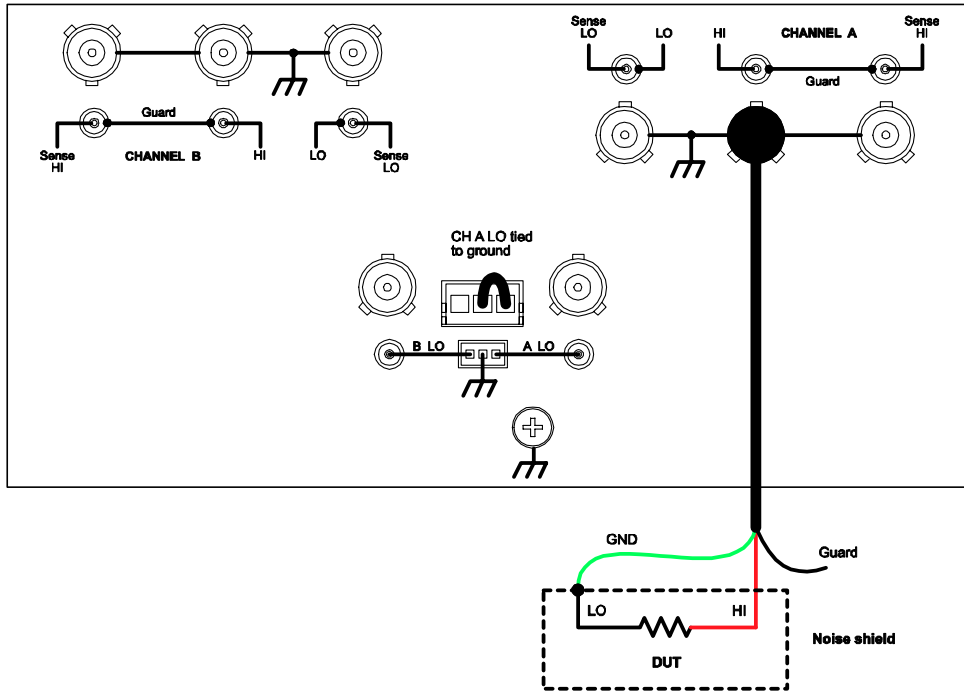


Figure 2-22
Model 2636A noise shield (non-floating)

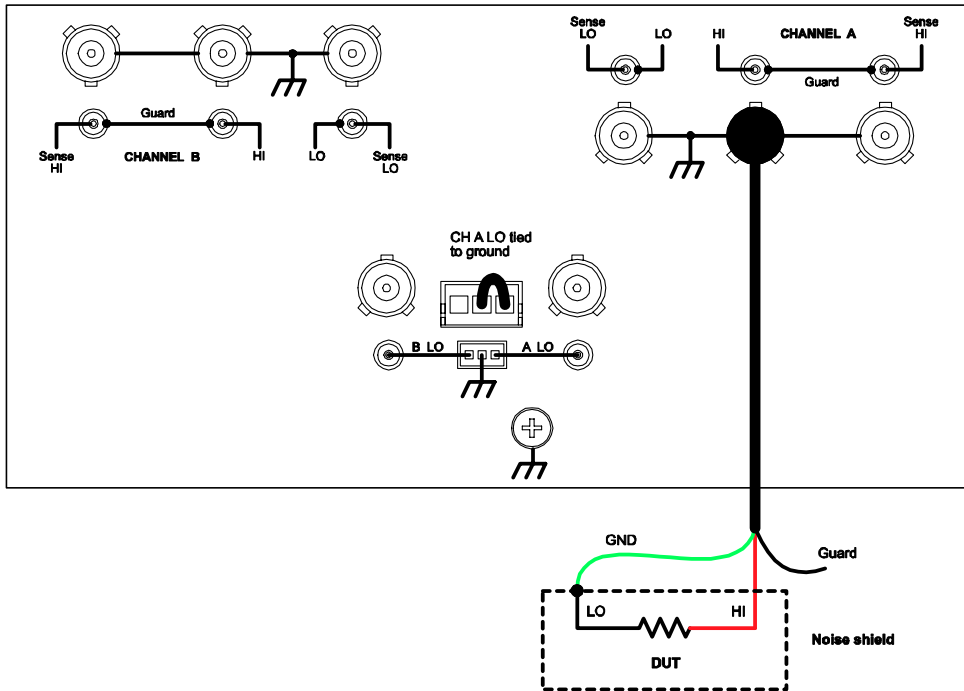
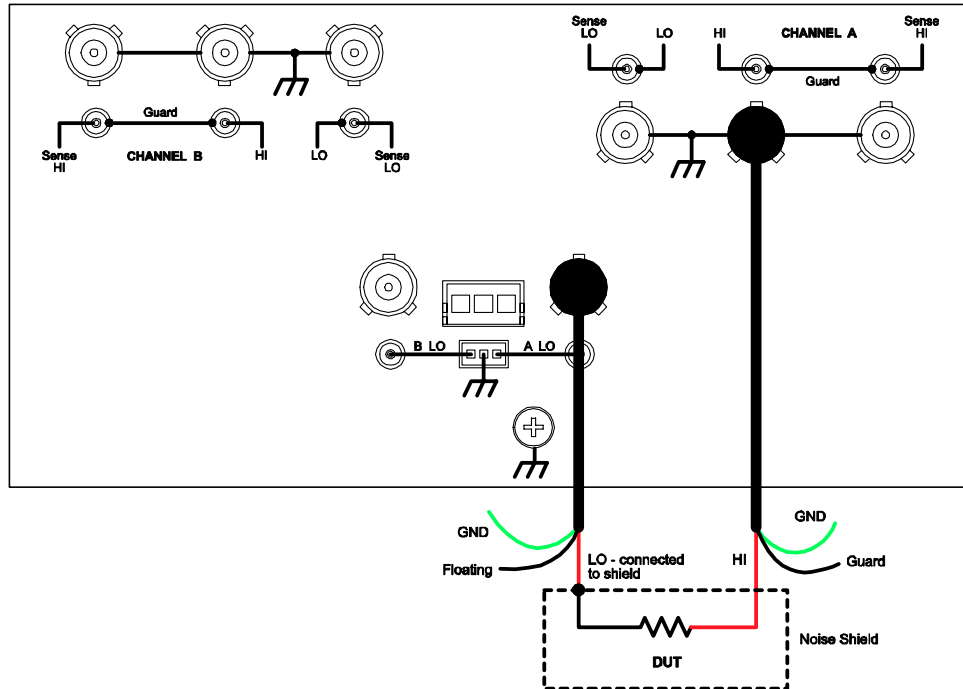


Figure 2-23
Model 2636A noise shield (floating)



Safety shield

A safety shield must be used whenever hazardous voltages ($>30 V_{\text{rms}}$, $42 V_{\text{peak}}$) will be present in the test circuit. The safety shield can be metallic or nonmetallic, and must completely surround the DUT test circuit. A metal safety shield must be connected to a known safety earth ground and chassis ground. See [Test fixture](#) later in this section for important safety information on the use of a metal or nonmetallic enclosure.

Model 2601A/2602A safety shield

The maximum output voltage for a Model 2601A/2602A channel is 40V, which is considered a non-hazardous level. However, using two or more Model 2601A/2602A voltage sources in a series configuration can cause test circuit voltage to exceed 42V. For example, the SMUs of two Model 2601A/2602A instruments can be connected in series to apply 80V to a DUT (see [Figure 2-24](#)).

The connections for the test configuration in [Figure 2-24](#) are shown in [Figure 2-25](#). Use #18 AWG wire or larger for connections to safety earth ground and chassis.

NOTE Floating an SMU may also cause test circuit voltage to exceed 42V (see [Floating an SMU](#) for more information).

Figure 2-24
Safety shield for hazardous voltage using two 2601A/2602A channels (>42V)

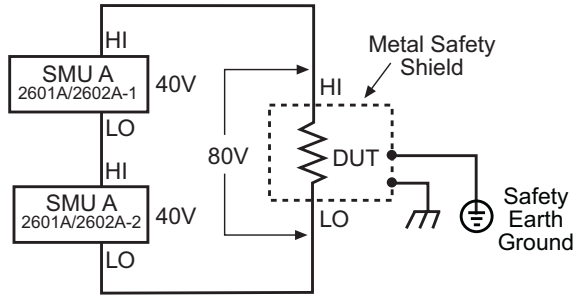
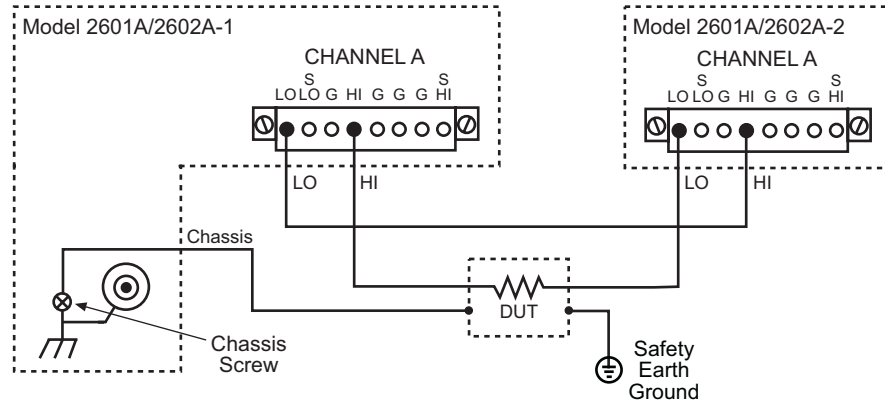


Figure 2-25
Model 2601A/2602A-1 connections for test circuit shown in Figure 2-24



Model 2611A/2612A/2635A/2636A safety shield

The maximum output voltage for a Model 2611A/2612A/2635A/2636A channel is 200V, which is considered hazardous and requires a safety shield (Figure 2-26). The connections for the test configuration in Figure 2-26 are shown in Figure 2-28. Use # 18 AWG wire or larger for connections to safety earth ground and chassis.

Figure 2-26
Safety shield for Models 2611A/2612A/2635A/2636A hazardous voltage (200V maximum)

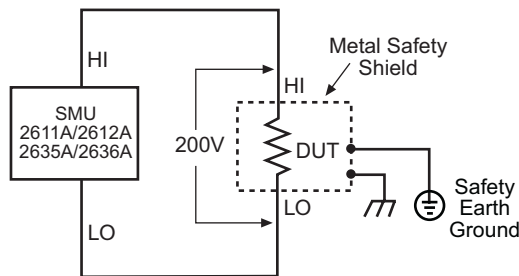


Figure 2-27
Model 2601A/2602A-1 connections for test circuit shown in Figure 2-26

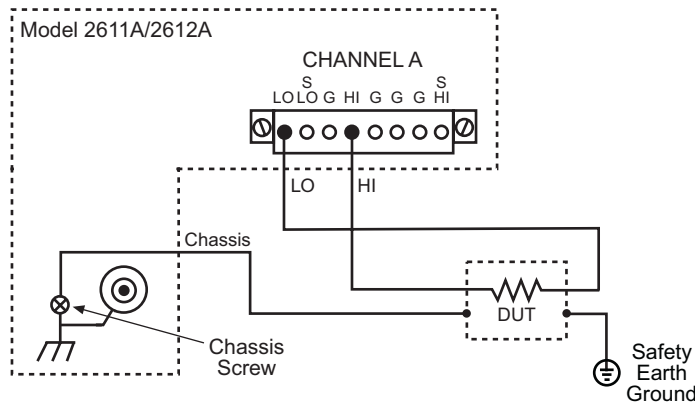
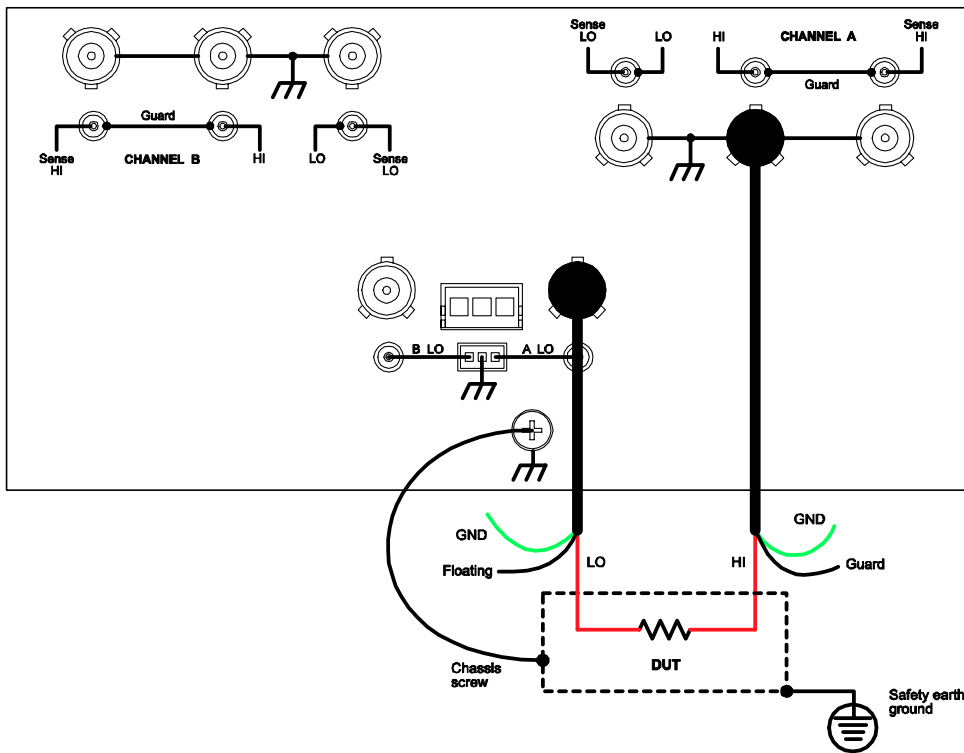


Figure 2-28
Model 2636A connections for test circuit shown in Figure 2-26



Using shielding and guarding together

Figure 2-29 shows connections for a test system that uses a noise shield, a safety shield, and guarding. The guard shields are connected to the driven guard (G) of the SMU. The noise shield is connected to SMU LO. The safety shield is connected to the chassis and to a safety earth ground.

Figure 2-29
Model 2601A/2602A-1 connections for noise shield, safety shield, and guarding

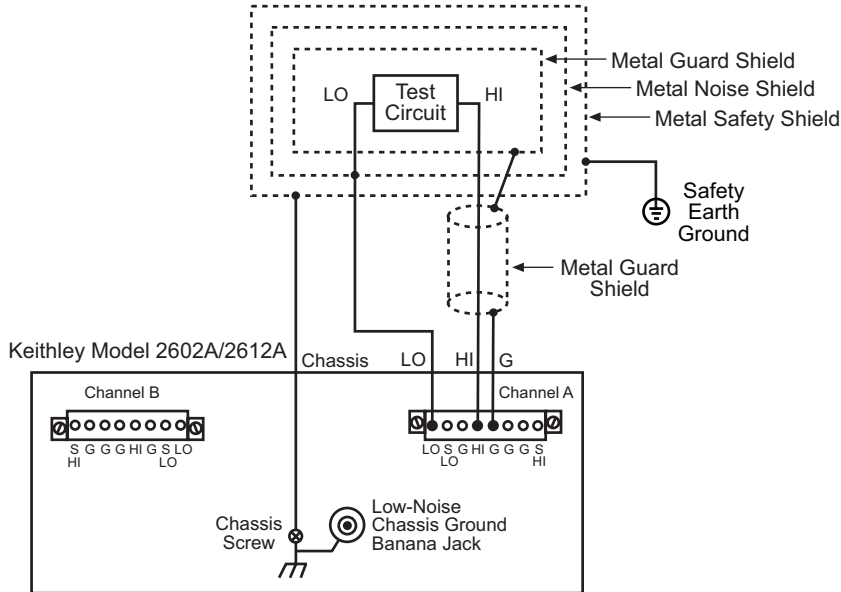
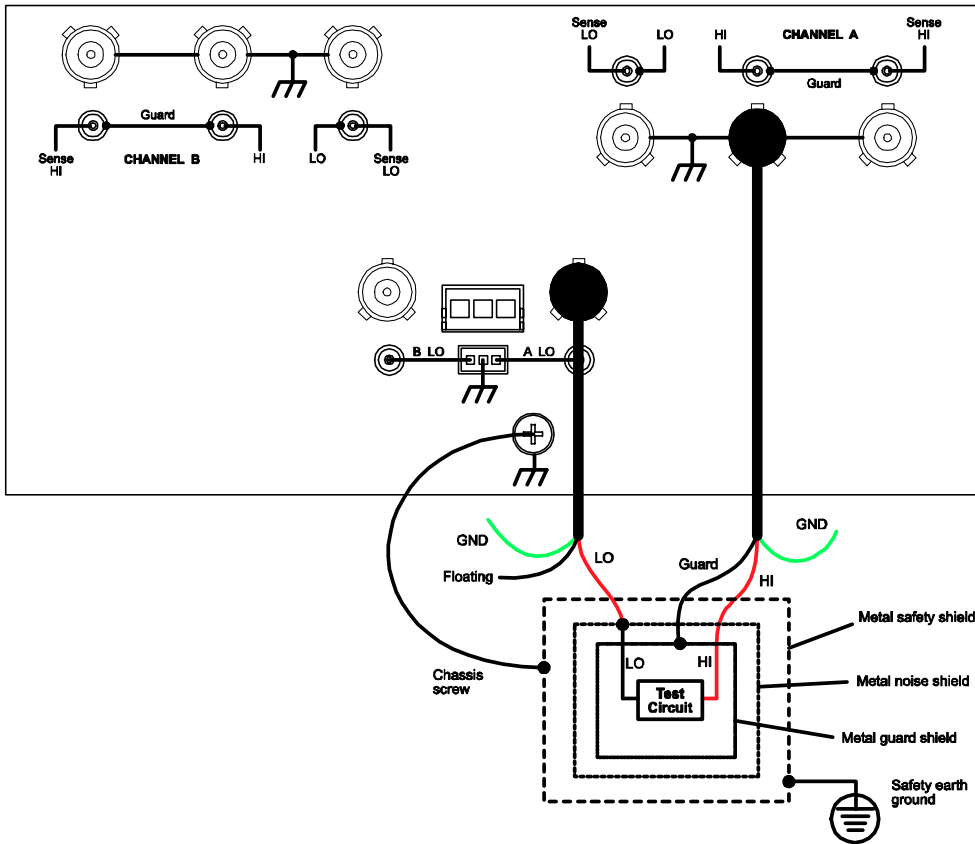


Figure 2-30
Model 2636A connections for noise shield, safety shield, and guarding



Test fixture

A test fixture can be used for an external test circuit. The test fixture can be a metal or nonmetallic enclosure, and is typically equipped with a lid. The test circuit is mounted inside the test fixture. When hazardous voltages (>30 Vrms, 42 Vpeak) will be present, the test fixture must have the following safety requirements:

WARNING To provide protection from shock hazards, an enclosure should be provided which surrounds all live parts.

Nonmetallic enclosures must be constructed of materials suitably rated for flammability and the voltage and temperature requirements of the test circuit.

For metallic enclosures, the test fixture chassis must be properly connected to safety earth ground. A grounding wire (#18 AWG or larger) must be attached securely to the test fixture at a screw terminal designed for safety grounding. The other end of the ground wire must be attached to a known safety earth ground.

Construction material: A metal test fixture must be connected to a known safety Earth Ground as described in the above **WARNING**. A nonmetallic test fixture must be constructed of materials that are suitable for flammability, voltage, and temperature conditions that may exist in the test circuit. The construction requirements for a nonmetallic enclosure are also described in the **WARNING** above.

Test circuit isolation: With the lid closed, the test fixture must completely surround the test circuit. A metal test fixture must be electrically isolated from the test circuit. Input/output connectors mounted on a metal test fixture must also be isolated from the test fixture. Internally, Teflon standoffs are typically used to insulate the internal pc-board or guard plate for the test circuit from a metal test fixture.

Interlock switch: The test fixture must have a normally-open interlock switch. The interlock switch must be installed so that when the lid of the test fixture is opened, the switch will open, and when the lid is closed, the switch will close.

WARNING *When an interlock is required for safety, a separate circuit should be provided that meets the requirements of the application to reliably protect the operator from exposed voltages.*

*The output enable pin on the **digital I/O port** on the Models 2601A and 2602A are not suitable for control of safety circuits and should not be used to control a safety interlock. The Interlock pin on the **digital I/O port** for the Models 2611A, 2612A, 2635A, and 2636A can be used to control a safety interlock.*

Floating an SMU

Using an external source in the test system may require that a Series 2600A SMU float off chassis earth ground. An example of such a test system is shown in [Figure 2-31](#), which includes an

external voltage source. Notice that output low of the voltage source is connected to chassis earth ground.

For the test circuit shown in [Figure 2-31](#), the Series 2600A must float off chassis earth ground. As shown, SMU LO of the Series 2600A is floating +10V above chassis earth ground. If SMU LO of the Series 2600A was instead connected to chassis ground, the external voltage source would be shorted through chassis ground.

The Series 2600A connections for the floating configuration ([Figure 2-31](#)) are shown in [Figure 2-32](#). In order to float the SMU, input/output LO must be isolated from chassis ground. This is accomplished by NOT connecting input/output LO to chassis ground.

The external voltage source in [Figure 2-31](#) and [Figure 2-32](#) can instead be a SMU of a second Series 2600A instrument. Keep in mind that if the combined outputs of the sources exceeds 42V, then a safety shield will be required for the DUT (see the following WARNINGS).

WARNING *The maximum floating (common mode) voltage for a SMU is $\pm 250V$. Exceeding this level may cause damage to the instrument and create a shock hazard.*

Using an external source to float a SMU could create a shock hazard in the test circuit. A shock hazard exists whenever $>42V$ peak is present in the test circuit. Appropriately rated cables or insulators must be provided for all connections to prevent access to live parts

When $>42V$ is present, the test circuit must be insulated for the voltage used or surrounded by a metal safety shield that is connected to a known safety earth ground and chassis ground (see [Safety shield](#)).

Figure 2-31
Floating the Series 2600A

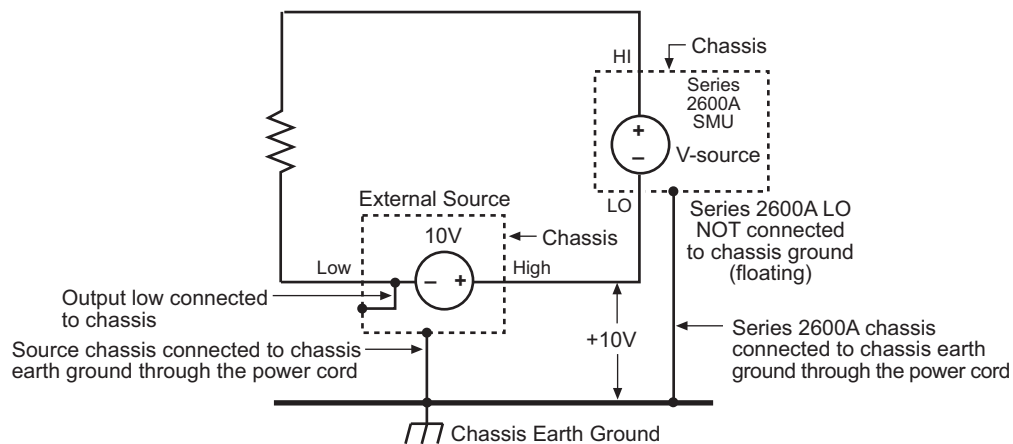


Figure 2-32
Model 2601A/2602A-1 SMU connections

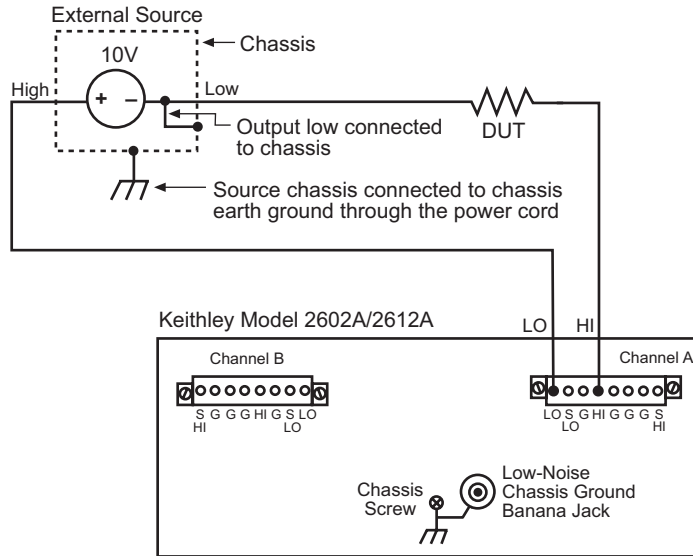
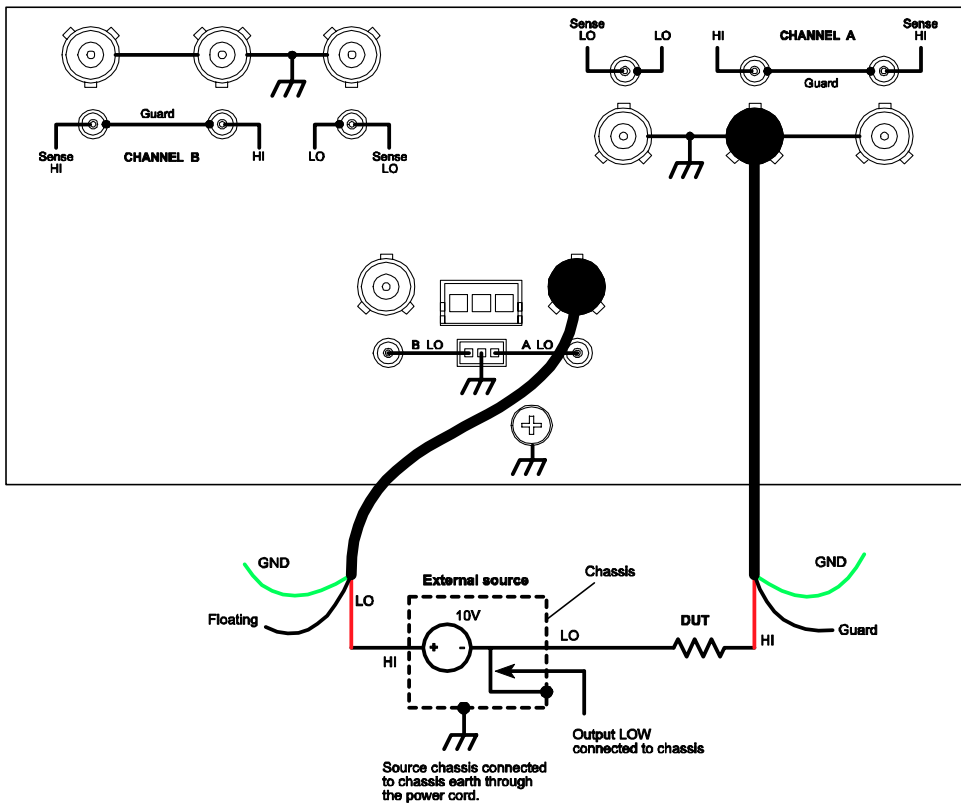


Figure 2-33
Model 2636A SMU connections for the floating configuration shown in [Figure 2-31](#)



Output-off states

When a SMU is turned off, it may not be completely isolated from the external circuit that it is connected to. There are three output-off states for a Series 2600A SMU: Normal, High Impedance or zero. For the Models 2602A, 2612A, and 2636A, each SMU channel can have its own unique output-off state.

Normal output-off state

For the normal output-off state (which is the default setting), the SMU will source 0V. The current compliance determined by the `smuX.source.offlimiti` command (default 1mA) is used. Therefore, the SMU may source or sink a very small amount of power. In most cases, this source or sink power level is not significant.

High-impedance output-off state

For the high-impedance output-off state, the output relay opens when the output is turned off. This disconnects external circuitry from the input/output of the SMU. To prevent excessive wear on the output relay, do not use this output off state for tests that turn the output off and on frequently.

Zero output-off state

When in this output-off state, the Series 2600A is configured as follows:

When the V-Source is the selected source:

- The programmed V-Source value remains on the display.
- Internally, the V-Source is set to 0V.
- The current compliance setting remains the same as the output-on value. Real compliance detection remains active.
- Measurements are performed and displayed.

When the I-Source is the selected source:

- The programmed I-Source value remains on the display.
- Internally, the V-Source is selected and set to 0V.
- Current compliance is set to the programmed Source I value or to 10% full-scale of the present current range, whichever is greater.
- Measurements are performed and displayed.

While in the zero output-off state, the Series 2600A can be used as an I-Meter since it will output 0V, but measure current.

Selecting the output-off state

Output-off state menu

To access the OUTPUT configuration menu:

1. Press the **CONFIG** key.
2. Select the appropriate **OUTPUT ON/OFF** key.
3. In the configuration menu, select **OFF STATE** to display the OUTPUT OFF STATE menu.

NOTE The OUTPUT OFF STATE menu can also be accessed by navigating the configuration menu that is displayed by pressing the **CONFIG** key.

With the OUTPUT OFF STATE menu displayed, select the desired output-off state: **HI-Z** (high-impedance), **NORMAL**, or **ZERO**.

Remote programming

[Table 2-3](#) lists the commands to select the output-off state.

Table 2-3

Commands to select the output-off state

Command*	Description
<code>smuX.source.offlimiti = ivalue</code>	Sets current limit in normal output-off state.
<code>smuX.source.offmode = smuX.OUTPUT_NORMAL</code>	Selects normal output-off state.
<code>smuX.source.offmode = smuX.OUTPUT_HIGH_Z</code>	Selects high-impedance output-off state.
<code>smuX.source.offmode = smuX.OUTPUT_ZERO</code>	Selects zero output-off state.

* Model 2601A/2611A/2635A: smuX = smua, Model 2602A/2612A/2636A: smuX = smua (Channel A) or smub (Channel B).

In this section:

Topic	Page
Overview	3-3
Operation overview	3-3
Source-measure capabilities	3-3
Compliance limit	3-4
Setting the compliance limit	3-5
Basic circuit configurations	3-6
Operation considerations	3-6
Warm-up	3-6
Auto zero	3-7
NPLC caching	3-8
Basic source-measure procedure	3-8
Front panel source-measure procedure	3-8
Remote source-measure procedure	3-10
Triggering in local mode	3-11
Configuring trigger attributes in local mode	3-12
Measure only	3-13
Sink operation and interface	3-14
Ohms measurements	3-14
Ohms calculations	3-14
Ohms ranging	3-14
Basic ohms measurement procedure	3-14
Ohms sensing	3-15
Sense selection	3-16
Remote ohms programming	3-17
Power measurements	3-18
Power calculations	3-18
Basic power measurement procedure	3-18
Remote power programming	3-18
Contact check measurements	3-19
Overview	3-19
Contact check commands	3-20
Contact check programming example	3-21

- User setup** **3-21**
- Saving user setups 3-21
- Recalling a saved setup 3-22
- To select power-on setup..... 3-22
- Saving user setups from a command interface 3-22

Overview

The documentation in this section provides basic operating instructions for the Keithley Instruments Series 2600A System SourceMeter® instrument and includes the following:

- [Operation overview](#)
- [Operation considerations](#)
- [Measure only](#)
- [Sink operation and interface](#)
- [Ohms measurements](#)
- [Power measurements](#)
- [Contact check measurements](#)

Operation overview

Source-measure capabilities

From the front panel, the instrument can be configured to perform the following operations:

- **Source voltage:** Display current and/or voltage measurement.
- **Source current:** Display voltage and/or current measurement.
- **Measure resistance:** Display resistance calculated from voltage and current components of measurement.
- **Measure power:** Display power calculated from voltage and current components of measurement.
- **Measure only (V or I):** Display voltage or current measurement.

Voltage and current

[Table 3-1](#) lists the source and measure limits for the voltage and current functions.

The full range of operation is explained in [Operating boundaries](#) in [Section 4](#).

Table 3-1
Source-measure capabilities

Model 2601A/2602A			Model 2611A/2612A			Model 2635A/2636A		
Range	Source	Measure	Range	Source	Measure	Range	Source	Measure
100mV	±101mV	±102mV	200mV	±202mV	±204mV	200mV	+/-202mV	+/-204mV
1V	±1.01V	±1.02V	2V	±2.02V	±2.04V	2V	+/-2.02V	+/-2.04V
6V	±6.06V	±6.12V	20V	±20.2V	±20.4V	20V	+/-20.2V	+/-20.4V
40V	±40.4V	±40.8V	200V ¹	±202V	±204V	200V ³	+/-202V	+/-204V
100nA	±101nA	±102nA	100nA	±101nA	±102nA	100pA	N/A	+/-102pA
1µA	±1.01µA	±1.02µA	1µA	±1.01µA	±1.02µA	1nA	+/-1.01nA	+/-1.02nA
10µA	±10.1µA	±10.2µA	10µA	±10.1µA	±10.2µA	10nA	+/-10.1nA	+/-10.2nA
100µA	±101µA	±102µA	100µA	±101µA	±102µA	100nA	+/-101nA	+/-102nA
1mA	±1.01mA	±1.02mA	1mA	±1.01mA	±1.02mA	1µA	±1.01µA	±1.02µA
10mA	±10.1mA	±10.2mA	10mA	±10.1mA	±10.2mA	10µA	±10.1µA	±10.2µA
100mA	±101mA	±102mA	100mA	±101mA	±102mA	100µA	±101µA	±102µA
1A	±1.01A	±1.02A	1A	±1.01A	±1.02A	1mA	±1.01mA	±1.02mA
3A	±3.03A	±3.06A	1.5A	±1.515A	±1.53A	10mA	±10.1mA	±10.2mA
			10A ²	±10.1A	±10.2A	100mA	±101mA	±102mA
						1A	±1.01A	±1.02A
						1.5A	±1.515A	±1.53A
Max Power = 40.4W per channel			Max Power = 30.603W per channel 1. 200V source range available only when interlock is enabled. See Section 8 . 2. 10A range available only in pulse mode.			Max Power = 30.603W per channel 3. 200V source range available only when interlock is enabled. See Section 8 .		

Compliance limit

When sourcing voltage, the Series 2600A can be set to limit current. Conversely, when sourcing current, the Series 2600A can be set to limit voltage. The Series 2600A output will not exceed the compliance limit. The maximum compliance limit is the same as the maximum values listed in [Table 3-2](#). Note that the compliance value will take the same sign as the source value, and the maximum compliance limits are based on source range. See [Compliance limit](#) for more information.

NOTE The only exception to the compliance limit not being exceeded is the VLIMIT when operating as an ISOURCE. To avoid excessive (and potentially destructive) currents from flowing, the VLIMIT will source or sink up to 102mA for ISOURCE ranges on or below 100mA. For the ranges 1A and above, the maximum current allowed is the current source setting.

Table 3-2
Maximum compliance values

Model 2601A/2602A		Model 2611A/2612A		Model 2635A/2636A	
Source range	Maximum compliance value	Source range	Maximum compliance value	Source range	Maximum compliance value
100mV	3A	200mV	1.5A	200mV	1.5A
1V	3A	2V	1.5A	2V	1.5A
6V	3A	20V	1.5A	20V	1.5A
40V	1A	200V	100mA	200V	100mA
100nA	40V	100nA	200V	1nA	200V
1µA	40V	1µA	200V	10nA	200V
10µA	40V	10µA	200V	100nA	200V
100µA	40V	100µA	200V	1µA	200V
1mA	40V	1mA	200V	10µA	200V
10mA	40V	10mA	200V	100µA	200V
100mA	40V	100mA	200V	1mA	200V
1A	40V	1A	20V	10mA	200V
3A	6V	1.5A	20V	100mA	200V
				1A	20V
				1.5A	20V

Setting the compliance limit

Front panel compliance limit

Set the compliance limit from the front panel as follows:

1. For the Model 2601A/2611A/2635A or the Model 2602A/2612A/2636A single-channel display mode, press the **LIMIT** key to directly access compliance editing.
2. For the Model 2602A/2612A/2636A dual-channel display mode, press the **LIMIT** key, then select **CURRENT** or **VOLTAGE** as desired. Press **ENTER** or the **navigation wheel**.
3. Press the **navigation wheel**, set the compliance limit to the desired value, and then press **ENTER** or the **navigation wheel** to complete editing.
4. Press **EXIT** to return to the normal display.

Remote compliance limit

[Table 3-3](#) summarizes basic commands to program the compliance limit. See [Section 19](#) for more details on these commands. To program the compliance, simply send the command using the desired parameter. For example, the following commands set the current and voltage compliance to 50mA and 4V respectively:

```
smua.source.limiti = 50e-3
smua.source.limitv = 4
```

The following command prints the compliance state:

```
print(smua.source.compliance)
```

A returned value of 1 indicates that the voltage limit has been reached if the unit is configured as a current source, or that the current limit has been reached if the unit is configured as a voltage source.

Table 3-3
Compliance commands

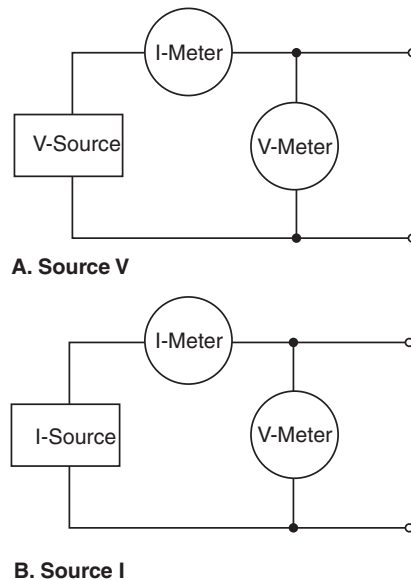
Command*	Description
<code>smuX.source.limiti = limit</code>	Set current compliance limit.
<code>smuX.source.limitv = limit</code>	Set voltage compliance limit.
<code>compliance = smuX.source.compliance</code>	Test if in compliance (1 = in compliance; 0 = not in compliance).

*smuX = smua for the Model 2601A/2611A/2635A; smuX = smua (Channel A) or smub (Channel B) for the Model 2602A/2612A/2636A.

Basic circuit configurations

The fundamental source-measure configurations for the Series 2600A are shown in [Figure 3-1](#). When sourcing voltage, you can measure current or voltage (configuration A). When sourcing current, you can measure voltage or current (configuration B). See [Basic circuit configurations](#) in [Section 4](#) for more detailed information on these circuit configurations.

Figure 3-1
Fundamental source measure configuration



Operation considerations

The following paragraphs discuss the warm-up period and auto zero.

Warm-up

The Series 2600A must be turned on and allowed to warm up for at least two hours to achieve rated accuracies.

Auto zero

The Series 2600A uses a ratiometric A/D conversion technique. To ensure accuracy of readings, the instrument must periodically obtain fresh measurements of its internal ground and voltage reference. The time interval between needing to update these reference measurements is determined by the integration aperture being used for measurements. Separate reference and zero measurements are used for each aperture.

There are three different settings for auto zero as summarized in [Table 3-4](#). By default, the instrument automatically checks these reference measurements whenever a signal measurement is made (AUTO). If the reference measurements are out of date when a signal measurement is made, the instrument will automatically take two more A/D conversions, one for the reference and one for the zero, before returning the result. Thus, occasionally, a measurement takes longer than normal.

This extra time can cause problems in sweeps and other test sequences in which measurement timing is critical. To avoid the extra time for the reference measurements in these situations, the OFF selection can be used to disable the automatic reference measurements. Keep in mind that with automatic reference measurements disabled, the instrument may gradually drift out of specification.

To minimize the drift, a reference and zero measurement should be made just prior to the critical test sequence. The ONCE setting can be used to force a refresh of the reference and zero measurements used for the current aperture setting.

Table 3-4

Auto zero settings

Auto zero setting	Description
OFF	Turns automatic reference measurements off.
ONCE	Turns automatic reference measurements off, but immediately taking one reference and one zero measurement.
AUTO	Automatically takes new acquisitions when processor determines reference and zero values are out-of-date.

Front panel auto zero

Set the auto zero from the front panel as follows:

1. Press the **CONFIG** key, and select **MEAS** from the menu.
2. Select **AUTO-ZERO**, then press **ENTER** or the **navigation wheel**.
3. Select the desired mode (**OFF**, **ONCE**, or **AUTO**), and then press **ENTER** or the **navigation wheel**.
4. Press **EXIT** as necessary to return to the normal display.

Remote command auto zero

Use the auto zero command with the appropriate option shown in [Table 3-5](#) to set auto zero via remote (see [Section 6](#) for more details). For example, send the following command to activate Channel A automatic reference measurements:

```
smua.measure.autozero = smua.AUTOZERO_AUTO
```

Table 3-5
Auto zero command and options

Command*	Description
smuX.measure.autozero = smuX.AUTOZERO_OFF	Disable auto zero**
smuX.measure.autozero = smuX.AUTOZERO_ONCE	Force one ref and zero
smuX.measure.autozero = smuX.AUTOZERO_AUTO	Force ref and zero with each measurement

*smuX = smua for the Model 2601A/2611A/2635A; smuX = smua (Channel A) or smub (Channel B) for the Model 2602A/2612A/2636A.

**Old NPLC cache values will be used when auto zero is disabled (see [To minimize the drift, a reference and zero measurement should be made just prior to the critical test sequence. The ONCE setting can be used to force a refresh of the reference and zero measurements used for the current aperture setting.](#)).

NPLC caching

NPLC caching speeds up operation by caching A/D reference and zero values for up to the ten most recent measurement aperture settings. Whenever the integration rate is changed via the **SPEED** key, or a user setup is recalled, the NPLC cache is checked. If the integration rate is already stored in the cache, the stored reference and zero values are recalled and used. Otherwise, a reference and zero value are acquired and stored in the cache. If there are already ten NPLC values stored, the oldest one will be overwritten by the newest one. When auto zero is off, NPLC values stored in the cache will be used regardless of how old they are. If there are no entries in the cache for the aperture being used, the unit will acquire them when the first measurement is made

Basic source-measure procedure

Front panel source-measure procedure

Use the following procedure to perform the basic source-measure operations of the Series 2600A. The following procedure assumes that the Series 2600A is already connected to the DUT as explained in Section 3.

WARNING *Hazardous voltages may be present on the output and guard terminals. To prevent electrical shock that could cause injury or death, NEVER make or break connections to the Series 2600A while the output is on. Power off the equipment from the front panel or disconnect the main power cord from the rear of the Series 2600A before handling cables connected to the outputs. Putting the equipment into standby does not guarantee the outputs are not powered if a hardware or software fault occurs.*

Step 1: Select and set source level.

Perform the following steps to select the source and edit the source value:

1. Press **SRC** as needed to select the **V-Source** or **I-Source** as indicated by the units in the source field on the display. The flashing digit (cursor) indicates which value is presently selected for editing.

2. Move the cursor to the digit to change, then press the **navigation wheel** to enter the EDIT mode, as indicated by the EDIT indicator.
3. Use the **RANGE** keys to select a range that will accommodate the value you want to set. (See [Section 6](#) for range information.) For best accuracy, use the lowest possible source range.
4. Enter the desired source value, then press **ENTER** or the **navigation wheel** to complete editing.

Step 2: Set compliance limit.

Perform the following steps to edit the compliance limit value:

1. For the Model 2601A/2611A/2635A or the Model 2602A/2612A/2636A single-channel display mode, press the **LIMIT** key.
2. For the Model 2602A/2612A/2636A dual-channel display mode, press **CONFIG** then **LIMIT**, then select **CURRENT** or **VOLTAGE**. Press **ENTER** or the **navigation wheel**.
3. Move the cursor to the digit to change, then press the **navigation wheel** to enter the EDIT mode, as indicated by the EDIT indicator.
4. Enter the desired limit value, then press **ENTER** or the **navigation wheel** to complete editing.

Step 3: Select measurement function and range.

Select measurement function and range as follows:

1. Put the Model 2602A/2612A/2636A in the single-channel display mode, then select the desired measurement function by pressing **MEAS** or **MODE**.
2. Select the desired measurement range with the **RANGE** keys, or enable **AUTO RANGE**, keeping the following points in mind:
 - When measuring the source (such as Source V Measure V), you cannot select the measurement range using the **RANGE** keys. The selected source range determines the measurement range.
 - When not measuring the source (such as Source V Measure I), measurement range selection can be done manually or automatically. When using manual ranging, use the lowest possible range for best accuracy. In auto range, the Series 2600A automatically goes to the most sensitive range to make the measurement.

Step 4: Turn output on.

Turn the output on by pressing the **ON/OFF OUTPUT** key. The OUTPUT indicator light will turn on.

Step 5: Observe readings on the display.

Observe the readings on the display. Press **TRIG** if necessary to trigger the unit to begin taking readings. For the single-channel display mode, the readings will appear on the top line, while source and limit values are on the bottom line.

Step 6: Turn output off.

When finished, turn the output off by pressing the **ON/OFF OUTPUT** key. The OUTPUT indicator light will turn off.

Remote source-measure procedure

Basic source-measurement procedures can also be performed via remote by sending appropriate commands in the right sequence. [Table 3-6](#) summarizes basic source-measure commands. See [Section 19](#) for more information on using these commands.

Table 3-6

Basic source-measure commands

Command*	Description
<pre>smuX.measure.autorangei = smuX.AUTORANGE_ON smuX.measure.autorangev = smuX.AUTORANGE_ON smuX.measure.autorangei = smuX.AUTORANGE_OFF smuX.measure.autorangev = smuX.AUTORANGE_OFF smuX.measure.rangei = rangeval smuX.measure.rangev = rangeval reading = smuX.measure.i() reading = smuX.measure.v() reading = smuX.measure.iv() reading = smuX.measure.r() reading = smuX.measure.p()</pre>	<p>Enable current measure auto range. Enable voltage measure auto range. Disable current measure auto range. Disable voltage measure auto range. Set current measure range. Set voltage measure range. Request a current reading. Request a voltage reading. Request a current and voltage reading. Request a resistance reading. Request a power reading.</p>
<pre>smuX.source.autorangei = smuX.AUTORANGE_ON smuX.source.autorangev = smuX.AUTORANGE_ON smuX.source.autorangei = smuX.AUTORANGE_OFF smuX.source.autorangev = smuX.AUTORANGE_OFF smuX.source.func = smuX.OUTPUT_DCVOLTS smuX.source.func = smuX.OUTPUT_DCAMPS smuX.source.leveli = sourceval smuX.source.levelv = sourceval smuX.source.limiti = level smuX.source.limitv = level smuX.source.output = smuX.OUTPUT_ON smuX.source.output = smuX.OUTPUT_OFF smuX.source.rangei = rangeval smuX.source.rangev = rangeval smuX.sense = smuX.SENSE_LOCAL smuX.sense = smuX.SENSE_REMOTE</pre>	<p>Enable current source auto range. Enable voltage source auto range. Disable current source auto range. Disable voltage source auto range. Select voltage source function. Select current source function. Set current source value. Set voltage source value. Set current limit. Set voltage limit. Turn on source output. Turn off source output. Set current source range. Set voltage source range. Local sense (2-wire). Remote sense (4-wire).</p>
<p>* smuX = smua for the Model 2601A/2611A/2635A; smuX = smua (Channel A) or smub (Channel B) for the Model 2602A/2612A/2636A.</p>	

Requesting readings

You can request readings by including the appropriate measurement command as the argument for the `print` command. For example, the following will request a Channel A current reading:

```
print(smua.measure.i())
```

Source-measure programming example

The set-up and command sequence for a basic source-measure procedure is shown below:

- Source function and range: volts, auto range
- Source output level: 5V
- Current compliance: 10mA
- Measure function and range: current, 10mA

```
smua.reset()                -- Restore Series 2600A defaults.
smua.source.func = smua.OUTPUT_DCVOLTS  -- Select voltage source function.
smua.source.autorangev = smua.AUTORANGE_ON  -- Set source range to auto.
smua.source.levelv = 5                -- Set voltage source to 5V.
smua.source.limiti = 10e-3            -- Set current limit to 10mA.
smua.measure.rangei = 10e-3          -- Set current range to 10mA.
smua.source.output =smua.OUTPUT_ON      -- Turn on output.
print(smua.measure.i())              -- Request current reading.
smua.source.output =smua.OUTPUT_OFF     -- Turn off output.
```

Triggering in local mode

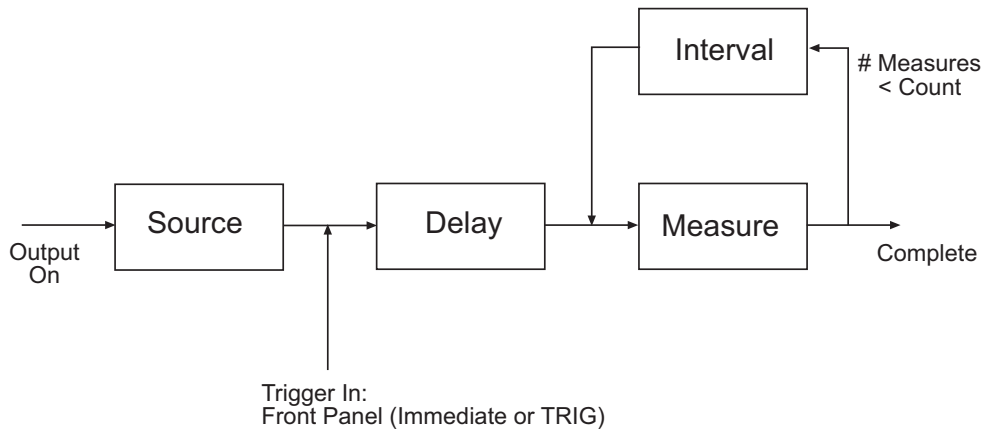
It is not necessary to change any trigger settings to use the basic source and measurement procedures covered in this section, however it is important to reset the instrument before triggering in local mode.

Use **MENU > SETUP > RECALL > INTERNAL > FACTORY** to reset the factory default conditions.

Figure 3-2 shows the general sequence for measurement triggering. The basic sequence is as follows:

- When the output is turned on, the programmed source value is immediately applied to the device under test (DUT).
- (Front panel operation only) If the immediate trigger source is selected, a measurement will be triggered immediately. However, if the manual trigger source is selected, the front panel **TRIG** key must be pressed.
- The unit waits for the programmed delay period (if any).
- The instrument takes one measurement.
- If the number of measurements is less than the programmed trigger count, it cycles back to take another measurement (the measurement cycle will be repeated indefinitely if the infinite trigger count is selected).
- For multiple measurements, the unit waits for the programmed trigger interval (if any) before taking the next measurement.

Figure 3-2
Local triggering



Configuring trigger attributes in local mode

- From the front panel, press **CONFIG > TRIG**. The following menu items are shown:

TRIGGER-IN: Use these options to select the trigger-in source:

- IMMEDIATE:** Triggering occurs immediately and the unit starts once it is ready to take measurements (for example, after the source output is turned on).
- MANUAL:** The front panel **TRIG** key must be pressed to trigger the instrument to take readings.

COUNT: Sets the trigger count (number of measurements) as follows:

- FINITE:** The unit will cycle through measurement cycles for the programmed trigger count (1 to 99999).
- INFINITE:** The unit will cycle through measurement cycles indefinitely until halted.

INTERVAL: Sets the time interval between measurements (0s to 999.999s) when the **COUNT** is greater than 1.

DELAY: Sets the delay period between the trigger and the start of measurement (0s to 999.999s).

Front panel triggering example

This example configures the trigger parameters to meet the following requirements:

- Manual triggering (**TRIG** key)
- Infinite trigger count (cycle indefinitely through measurement cycles)
- Interval (time between measurements): 1s
- Delay (time from trigger to measurement): 2s

Configure the trigger parameters as follows:

- Press **CONFIG** then **TRIG**.
- Select **TRIGGER-IN**, then press the **ENTER** key or the **navigation wheel**.
- Select **MANUAL**, then press the **ENTER** key or the **navigation wheel**.
- Choose **COUNT**, then select **INFINITE**, and press the **ENTER** key or the **navigation wheel**.
- Select **INTERVAL**, set the interval to 1s, then press the **ENTER** key or the **navigation wheel**.
- Choose **DELAY**, set the delay to 2s, then press the **ENTER** key.

7. Press **EXIT** to return to normal display.
8. Push **OUTPUT** to turn the output on and then press **TRIG**. A 2-second delay occurs before the first measurement. The unit cycles through measurements indefinitely with a 1s interval between measurements.
9. Turn off the **OUTPUT** to stop taking readings.

Measure only

In addition to being used for conventional source-measure operations, the Series 2600A can also be used to measure only voltage or current. Perform the following steps to use the Series 2600A to measure voltage or current:

1. Select source-measure functions.
Measure voltage only (voltmeter): Press **SRC** to select the I-Source, and press **MEAS** to select the voltage measurement function.
Measure current only (ammeter): Press **SRC** to select the V-Source, and press **MEAS** to select the current measurement function.
2. Set source and compliance levels.
Use the editing procedure provided in steps 1 and 2 of the [Front panel source-measure procedure](#) to edit the source and compliance levels:
 - a. Select the lowest source range and set the source level to zero (000.000nA or 000.000mV, 0.00000nA for Models 2635A/2636A).
 - b. Set compliance to a level that is higher than the expected measurement.

CAUTION When using the Series 2600A as a voltmeter, V-Compliance must be set higher than the voltage that is being measured. Failure to do this could result in excessive current flow into the Series 2600A (<150mA) and incorrect measurements.

3. Select range:
Use the **RANGE** keys to select a fixed measurement range that will accommodate the expected reading. Use the lowest possible range for best accuracy.
When measuring the function opposite from the source function, AUTO range can be used instead. The Series 2600A automatically goes to the most sensitive range.
4. Connect voltage or current to be measured. Connect the DUT to the SourceMeter instrument using 2-wire connections (see [Section 3](#)).
5. Turn output on. Press the **ON/OFF** key to turn the output on.
6. Take reading from display (press **TRIG** if necessary). When finished, turn output off.

Sink operation and interface

When operating as a sink (V and I have opposite polarity), the SourceMeter instrument is dissipating power rather than sourcing it. An external source (for example, a battery) or an energy storage device (i.e., capacitor) can force operation into the sink region.

For example, if a 12V battery is connected to the V-Source (In/Out HI to battery high) that is programmed for +10V, sink operation will occur in the second quadrant (Source +V and measure - I).

CAUTION When using the I-Source as a sink, ALWAYS set V-Compliance to a level that is higher than the external voltage level. Failure to do so could result in excessive current flow into the SourceMeter instrument (<102mA) and incorrect measurements. See [Compliance limit](#) for details.

NOTE The only exception to the compliance limit not being exceeded is the VLIMIT when operating as an ISOURCE. To avoid excessive (and potentially destructive) currents from flowing, the VLIMIT will source or sink up to 102mA for ISOURCE ranges on or below 100mA. For the ranges 1A and above, the maximum current allowed is the current source setting.

The sink operating limits are shown in [General SourceMeter instrument power equation](#) in [Section 4](#).

Ohms measurements

Ohms calculations

Resistance readings are calculated from the measured current and measured voltage as follows:

$$R = V/I$$

Where: R is the calculated resistance

V is the measured voltage

I is the sourced current

Ohms ranging

The front panel ohms function does not use ranging. The unit formats a calculated V/I reading to best fit the display. There may be leading zeros if the ohms reading is very small (<1mΩ).

Basic ohms measurement procedure

Perform the following steps to perform ohms measurements. The following procedure assumes that the SourceMeter instrument is already connected to the DUT as explained in [Section 3](#).

WARNING *Hazardous voltages may be present on the output and guard terminals. To prevent electrical shock that could cause injury or death, NEVER make or break connections to the Series 2600A while the output is on. Power off the equipment from the front panel or disconnect the main power cord from the rear of the SourceMeter instrument before handling cables connected to the outputs. Putting the equipment into standby does not guarantee the outputs are not powered if a hardware or software fault occurs.*

To take an ohms measurement:

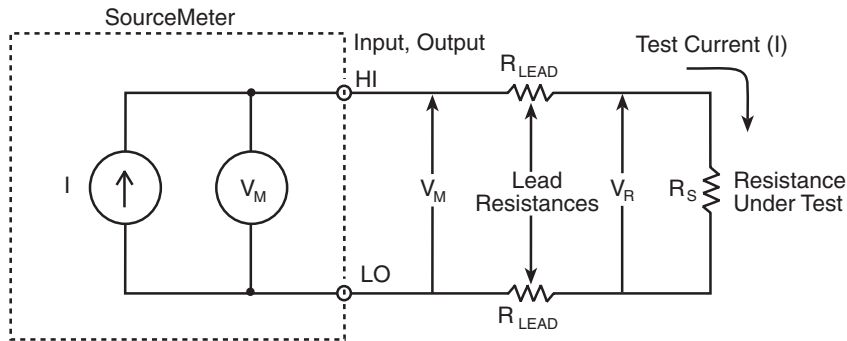
1. For the Model 2602A/2612A/2636A, press the **DISPLAY** key to select the single-channel display mode.
2. Press **SRC** to select the current source function, then set the output current to the desired value based on the expected resistance. See Step 1 of [Front panel source-measure procedure](#) earlier in this section.
3. Press the **LIMIT** key. Set the voltage limit high enough for the expected voltage across the resistance to be measured based on both the resistance value and programmed source current. See Step 2 of [Front panel source-measure procedure](#) earlier in this section.
4. Press the **MEAS** or **MODE** key to display voltage, then make sure that AUTO measurement range is on.
5. Press the **MEAS** or **MODE** key to display ohms.
6. Turn on the output, then note the reading on the display. If necessary, press the **TRIG** key to display continuous readings. Turn off the output when finished.

Ohms sensing

Ohms measurements can be made using either 2-wire or 4-wire sensing (see [Section 2](#) for information on connections and sensing methods).

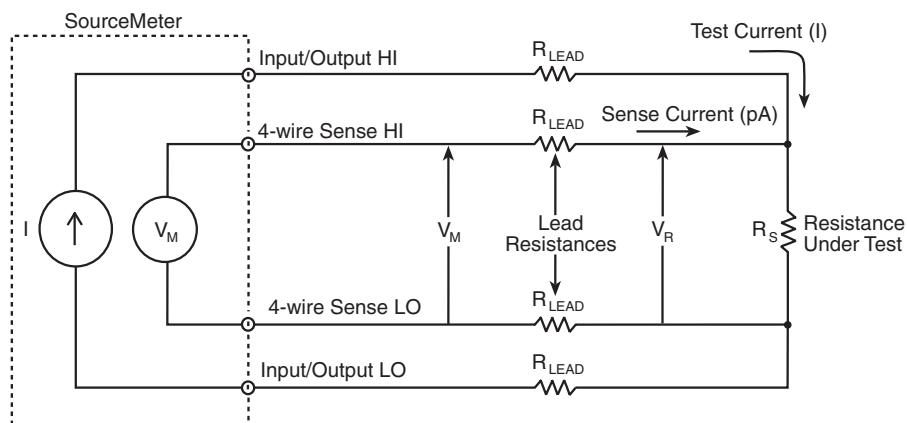
The 2-wire sensing method has the advantage of requiring only two test leads. However, as shown in [Figure 3-3](#), test lead resistance can seriously affect the accuracy of 2-wire resistance measurements, particularly with lower resistance values. The 4-wire sensing method shown in [Figure 3-4](#) minimizes or eliminates the effects of lead resistance by measuring the voltage across the resistor under test with a second set of test leads. Because of the high input impedance of the voltmeter, the current through the sense leads is negligible, and the measured voltage is essentially the same as the voltage across the resistor under test.

Figure 3-3

2-wire resistance sensing

I = Current sourced by SourceMeter
 V_M = Voltage measured by SourceMeter
 V_R = Voltage across resistor
 Measured resistance = $\frac{V_M}{I} = R_S + (2 \times R_{LEAD})$
 Actual resistance = $\frac{V_R}{I} = R_S$

Figure 3-4

4-wire resistance sensing

I = Current sourced by SourceMeter
 V_M = Voltage measured by SourceMeter
 V_R = Voltage across resistor
 Because sense current is negligible, $V_M = V_R$
 and measured resistance = $\frac{V_M}{I} = \frac{V_R}{I} = R_S$

Sense selection**Front panel sense selection**

To select sensing mode:

1. Press the **CONFIG** key then press **MEAS**. Choose **V-MEAS**, and then press **ENTER** or the **navigation wheel**.
2. Select **SENSE-MODE**, then press **ENTER**.

3. Choose **2-WIRE** or **4-WIRE**, as desired, and then press **ENTER** or the **navigation wheel**.

Remote sense selection

Use the `smuX.sense` command to control sense selection by remote. For example, send this command to enable 4-wire sensing:

```
smua.sense = smua.SENSE_REMOTE
```

See [Table 3-6](#) and [Section 19](#) for details.

Remote ohms programming

The following paragraphs summarize basic commands necessary for remote ohms programming and also give a programming example for a typical ohms measurement situation.

Remote ohms command

Use the following command to obtain a resistance reading:

```
reading = smuX.measure.r()
```

See [Table 3-6](#) for more commands necessary to set up source and measure functions, and [Section 19](#) for more details.

Ohms programming example

The set-up and command sequence for a typical ohms measurement is shown below:

- Source function: current, 10mA range, 10mA output
- Voltage measure range: auto
- Voltage compliance: 10V
- Sense mode: 4-wire

```
-- Restore Series 2600A defaults.
smua.reset()
-- Select current source function.
smua.source.func = smua.OUTPUT_DCAMPS
-- Set source range to 10mA.
smua.source.rangei = 10e-3
-- Set current source to 10mA.
smua.source.leveli = 10e-3
-- Set voltage limit to 10V.
smua.source.limitv = 10
-- Enable 4-wire ohms.
smua.sense = smua.SENSE_REMOTE
-- Set voltage range to auto.
smua.measure.autorangev = smua.AUTORANGE_ON
-- Turn on output.
smua.source.output = smua.OUTPUT_ON
-- Get resistance reading.
print(smua.measure.r())
-- Turn off output.
smua.source.output = smua.OUTPUT_OFF
```

Power measurements

Power calculations

Power readings are calculated from the sourced and measured current or voltage as follows:

$$P = V \times I$$

Where: P is the calculated power

V is the sourced or measured voltage

I is the measured or sourced current

Basic power measurement procedure

Perform the following steps to perform power measurements. The following procedure assumes that the SourceMeter instrument is already connected to the DUT as explained in [Section 19](#).

WARNING *Hazardous voltages may be present on the output and guard terminals. To prevent electrical shock that could cause injury or death, NEVER make or break connections to the Series 2600A while the output is on. Power off the equipment from the front panel or disconnect the main power cord from the rear of the SourceMeter instrument before handling cables connected to the outputs. Putting the equipment into standby does not guarantee the outputs are not powered if a hardware or software fault occurs.*

1. For the Model 2602A/2612A/2636A, press the **DISPLAY** key to select the single-channel display mode.
2. Set source function and value. Press **SRC** to select the voltage or current source function as required, then set the output voltage or current to the desired value. See Step 1 of [Front panel source-measure procedure](#) earlier in this section.
3. Press the **LIMIT** key, and set the voltage or current limit high enough for the expected voltage or current across the DUT to be measured. See Step 2 of [Front panel source-measure procedure](#) earlier in this section.
4. Press the **MEAS** or **MODE** key to display power.
5. Turn on the output, then note the reading on the display. If necessary, press the **TRIG** key to display continuous readings.
6. Turn off the output when finished.

Remote power programming

The following paragraphs summarize basic commands necessary for remote power programming and also give a programming example for a typical power measurement situation.

Remote power command

Use the following command to obtain a power reading:

```
reading = smuX.measure.p()
```

See [Table 3-6](#) for more commands necessary to set up source and measure functions and also [Section 19](#) for more details.

Power programming example

The set-up and command sequence for a typical power measurement is shown below:

- Source function: voltage, auto source range, 5V output
- Current measure function and range: current, auto
- Current compliance: 50mA

```
smua.reset()                --Restore Series 2600A defaults.
smua.source.func = smua.OUTPUT_DCVOLTS  --Select voltage source function.
smua.source.autorangev = smua.AUTORANGE_ON  --Set source range to auto.
smua.source.levelv = 5          --Set voltage source to 5V.
smua.source.limitsi = 50e-3     --Set current limit to 50mA.
smua.measure.autorangei = smua.AUTORANGE_ON  --Set current range to auto.
smua.source.output = smua.OUTPUT_ON        --Turn on output.
print(smua.measure.p())              --Get power reading.
smua.source.output = smua.OUTPUT_OFF      --Turn off output.
```

Contact check measurements

Overview

The contact check function prevents measurements that may be in error due to excessive resistance in the force or sense leads when making remotely sensed (Kelvin) measurements. Potential sources for this resistance include poor contact at the DUT, failing relay contacts on a switching card, and wires that are too long or thin. The contact check function will also detect an open circuit that may occur with a four-point probe is misplaced or misaligned. This relationship is shown schematically in [Figure 3-5](#), where R_C is the resistance of the mechanical contact at the DUT, and R_S is the series resistance of relays and cables.

WARNING *Hazardous voltages may be present on the output and guard terminals. To prevent electrical shock that could cause injury or death, NEVER make or break connections to the Series 2600A while the output is on. Power off the equipment from the front panel or disconnect the main power cord from the rear of the SourceMeter instrument before handling cables connected to the outputs. Putting the equipment into standby does not guarantee the outputs are not powered if a hardware or software fault occurs.*

Contact check commands

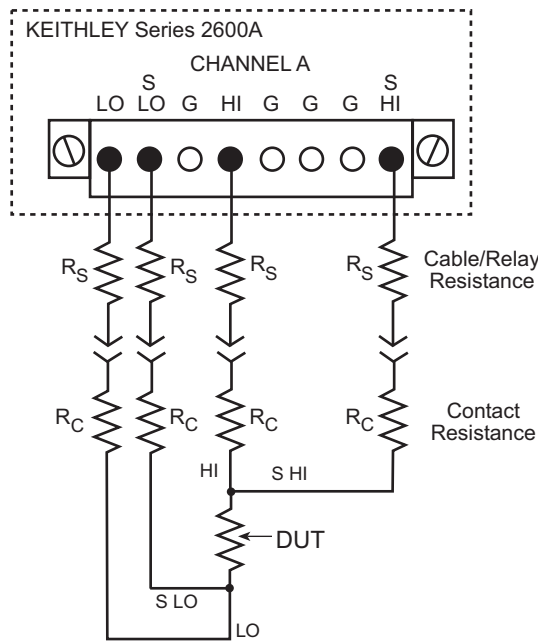
Table 3-7 summarizes basic contact check commands. See Section 19 for more information on using these commands.

Table 3-7
Basic contact check commands

Command*	Description
<pre>flag = smuX.contact.check() rhi, rlo = smuX.contact.r() smuX.contact.speed = speed_opt</pre>	Determine if contact resistance is lower than threshold. Return the contact resistance. Set speed_opt to one of the following: 0 or smuX.CONTACT_FAST 1 or smuX.CONTACT_MEDIUM 2 or smuX.CONTACT_SLOW
<pre>smuX.contact.threshold = rvalue</pre>	Resistance threshold for the contact check function.

*smuX = smua for the Model 2601A/2611A/2625A; smuX = smua (Channel A) or smub (Channel B) for the Model 2602A/2612A/2636A.

Figure 3-5
Contact check measurements



Contact check programming example

The command sequence for a typical contact measurement is shown below. These commands set the contact check speed to fast and the threshold to 10Ω. A contact check measurement against the threshold is then made. If it fails, a more accurate contact check measurement is made, and the test is aborted. Otherwise, the output is turned on, and the test continues.

```

smua.reset()                -- Restore defaults.
smua.contact.speed = smua.CONTACT_FAST  -- Set speed to fast.
smua.contact.threshold = 10  -- Set threshold to 10Ω.

if (not smua.contact.check()) then  -- Check contacts against threshold.
    smua.contact.speed = smua.CONTACT_SLOW  -- Set speed to slow.
    rhi, rlo = smua.contact.r()  -- Get resistance readings.
    print(rhi, rlo)  -- Return contact resistances to the host.
    exit()  -- Terminate execution.
end
smua.source.output = smua.OUTPUT_ON  -- Turn output on and continue.

```

User setup

The Series 2600A can be restored to one of six setup configurations: Five user setups and one factory default. As shipped from the factory, the Series 2600A powers-up to the original default settings, which are also saved in the five user setup locations. Original default settings are listed in the Instrument Command Library found in [Section 19](#). The instrument will power-up to whichever default setup was saved as the power-on setup.

Saving user setups

To save a user setup to nonvolatile memory:

1. Configure the Series 2600A for the desired operating modes to be saved.
2. Press **MENU > SETUP** and then press **ENTER**.
3. Select **SAVE** menu item, then press **ENTER**.
4. Select **INTERNAL**, then press **ENTER**.
5. Select the user number (1 through 5), and press **ENTER**.

To save a user setup to an external USB flash drive:

1. Configure the Series 2600A for the desired operating modes to be saved.
2. Insert the USB flash drive into the USB port on the front panel of the Series 2600A.
3. Press **MENU > SETUP**, then press **ENTER**.
4. Select **SAVE** menu item, then press **ENTER**.
5. Select **USB1**. The file `setup000.set` is displayed.
6. Use the **navigation wheel** to change the last three digits of the file name and then press **ENTER**.

Recalling a saved setup

Setups can be recalled from internal nonvolatile memory or a USB flash drive at any time. To recall a saved setup:

1. Press the **MENU** key to access the main menu.
2. Select **SETUP**, then press **ENTER**.
3. Select the **RECALL** menu item, then press **ENTER**.
4. Choose one of the following:
 - **INTERNAL**
 - **USB1**
5. (**INTERNAL** only) Do one of the following:
 - Select the user number (1 through 5), then press **ENTER**
 - Select **FACTORY** to restore factory defaults, then press **ENTER**.
6. (**USB1** only) Select the appropriate file and then push **ENTER**.

To select power-on setup

1. Press the **MENU** key to access the main menu.
2. Select **SETUP**, and then press **ENTER**.
3. Select **POWERON**, and then press **ENTER**.
4. Do one of the following:
 - Choose **FACTORY** to load the original defaults
 - Select **USER NUMBER** (1 through 5) to load a user preference.
5. Press **ENTER**.
6. Press **EXIT** to return to the main menu.

Saving user setups from a command interface

Saving and recalling user setups

The `setup.save` and `setup.recall` functions are used to save and recall user setups:

```
setup.save(n)      -- Save present setup to nonvolatile memory.
setup.recall(n)   -- Recall saved user setup from nonvolatile memory.
```

Where:

```
n = 1, 2, 3, 4 or 5
```

Restoring the factory default setups

The reset functions return the Series 2600A to the original factory defaults:

```
reset() or *rst   -- Restore all factory defaults.
smua.reset()     -- Restore Channel A defaults.
smub.reset()     -- Restore 2602A/2612A/2636A Channel B defaults.
setup.recall(0)  -- Restore all factory defaults.
```

Selecting the power-on setup

The `setup.poweron` attribute is used to select which setup to return to upon power-up. To select the power-on setup:

```
setup.poweron = n          -- Select power-on setup.
```

Where:

n = 0 (*RST defaults)

n = 1 to 5 (user setups 1-5)

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Source-Measure Concepts

In this section:

Topic	Page
Overview	4-1
Compliance limit	4-2
Maximum compliance	4-2
Compliance principles	4-2
Overheating protection	4-3
Power equations to avoid overheating	4-3
Operating boundaries	4-6
Source or sink	4-6
Continuous power operating boundaries	4-6
I-Source operating boundaries	4-7
V-Source operating boundaries	4-11
Source I measure I, source V measure V	4-14
Basic circuit configurations	4-15
Source I	4-15
Source V	4-15
Measure only (V or I)	4-16
Contact check	4-17
Guard	4-18
Guard overview	4-18
Guard connections	4-19
Settling time considerations	4-20
Measurement settling time considerations	4-20
Reduction in gain-bandwidth	4-22

Overview

The documentation in this section provides detailed information on source-measure concepts and includes the following information:

- [Compliance limit](#)
- [Overheating protection](#)
- [Operating boundaries](#)
- [Basic circuit configurations](#)
- [Guard](#)

Compliance limit

When sourcing voltage, the Keithley Instruments Series 2600A System SourceMeter® instrument can be set to limit current. Conversely, when sourcing current, the SourceMeter instrument can be set to limit voltage. The Series 2600A output does not exceed the compliance limit, except for the compliance limit conditions described in [Section 3](#).

Maximum compliance

The maximum compliance values for the source ranges are summarized in [Table 4-1](#).

Table 4-1
Maximum compliance limits

Model 2601A/2602A		Model 2611A/2612A		Model 2635A/2636A	
Source range	Maximum compliance value	Source range	Maximum compliance value	Source range	Maximum compliance value
100mV	3A	200mV	1.5A	200mV	1.5A
1V	3A	2V	1.5A	2V	1.5A
6V	3A	20V	1.5A	20V	1.5A
40V	1A	200V	100mA	200V	100mA
100nA	40V	100nA	200V	100pA	200V
1µA	40V	1µA	200V	1nA	200V
10µA	40V	10µA	200V	10nA	200V
100µA	40V	100µA	200V	100nA	200V
1mA	40V	1mA	200V	1µA	200V
10mA	40V	10mA	200V	10µA	200V
100mA	40V	100mA	200V	100µA	200V
1A	40V	1A	20V	1mA	200V
3A	6V	1.5A	20V	10mA	200V
				100mA	200V
				1A	20V
				1.5A	20V

Compliance principles

Compliance acts as a clamp. If the output reaches the compliance value, the SourceMeter instrument attempts to prevent the output from exceeding that value. This action implies that the source will switch from a V-source to an I-source (or from an I-source to a V-source) when in compliance.

As an example, assume the following:

SourceMeter instrument: $V_{SRC} = 10V$; $I_{CMPL} = 10mA$

Device under test (DUT) resistance: 10Ω

With a source voltage of 10V and a DUT resistance of 10Ω , the current through the DUT should be: $10V / 10\Omega = 1A$. However, because the compliance is set to 10mA, the current will not exceed that value, and the voltage across the resistance is limited to 100mV. In effect, the 10V voltage source is transformed into a 10mA current source with a 100mV compliance value.

Overheating protection

Proper ventilation is required to keep the SourceMeter instrument from overheating. Even with proper ventilation, the Series 2600A can overheat if the ambient temperature is too high or the SourceMeter instrument is operated in sink mode for long periods of time. The SourceMeter instrument has an over-temperature protection circuit that will turn the output off in the event that the instrument overheats. If the output trips due to overheating, a message indicating this condition will be displayed. You will not be able to turn the output back on until the instrument cools down.

Power equations to avoid overheating

To avoid overheating, each channel on the Series 2600A should not be operated in a manner that forces the instrument to exceed the maximum duty cycle (DC_{MAX}) computed using the [General SourceMeter instrument power equation](#) below. Factors such as the ambient temperature, quadrant of operation, and high power pulse levels (if applicable) affect the maximum duty cycle. Exceeding the calculated maximum duty cycle may cause the temperature protection mechanism to engage. When this happens, an error message will be displayed, and the SourceMeter instrument output will be disabled until the internal temperature of the SourceMeter instrument is reduced to an acceptable level.

You do **not** have to be concerned about overheating if **all** of the following are true:

- The SourceMeter instrument used as a power source and not a power sink.
- The ambient temperature is $\leq 30^{\circ}C$.
- High power pulse operation is not being used.

However, if any one of these is false, the SourceMeter instrument may overheat if operated in a manner that exceeds the calculated maximum duty cycle, DC_{MAX} .

The maximum duty cycle equation is derived from the power equation below by solving for DC_{MAX} . The general power equation describes how much power a SourceMeter instrument channel can source and/or sink before the total power cannot be fully dissipated by the Series 2600A cooling system. This equation takes into account all of the factors that can influence the power being dissipated by the SourceMeter instrument.

General SourceMeter instrument power equation

$$|(V_{OA} - V_P)(I_P)|\sqrt{DC_{MAX}} + |(V_{OA} - V_B)(I_B)| \leq (P_{CS} - P_{DER})$$

P_{CS} = The maximum power generated in a SourceMeter instrument channel that can be properly dissipated by the SourceMeter instrument cooling system.

T_{AMB} = The ambient temperature of the SourceMeter instrument operating environment.

$P_{DER} = T_{AMB} - 30$

- This factor represents the number of watts the SourceMeter instrument is de-rated when operating in environments above 30°C. This is represented as a temperature because the maximum output power of each SourceMeter instrument channel is reduced by 1W per degree C above 30°C.
- P_{DER} is 0 when the ambient temperature is below 30°C.

V_{OA} = The SourceMeter instrument output amplifier voltage. This constant can be found in the tables below.

V_P = The voltage level the SourceMeter instrument is attempting to force while at the pulse level.

- When operating in quadrants 1 or 3 (sourcing power), the sign of this voltage must be **positive** when used in the power equations.
- When operating in quadrants 2 or 4 (sinking power), the sign of this voltage must be **negative** when used in the power equations.

V_B = The voltage level the SourceMeter instrument is attempting to force while at the bias level.

- When operating in quadrants 1 or 3 (sourcing power), the sign of this voltage must be **positive** when used in the power equations.
- When operating in quadrants 2 or 4 (sinking power), the sign of this voltage must be **negative** when used in the power equations.

I_P = The current flowing through the SourceMeter instrument channel while at the pulse level.

I_B = The current flowing through the SourceMeter instrument channel while at the bias level.

Maximum duty cycle equation ¹

$$DC_{MAX} \leq \left[\frac{(P_{CS} - P_{DER}) - |(V_{OA} - V_B)(V_B)|}{|(V_{OA} - V_P)(I_P)|} \right]^2 \times 100$$

NOTE When attempting to determine the maximum duty cycle where the off state will be 0V or 0A:

- I_B is 0
- I_P and V_P are the voltage and current levels when the SourceMeter instrument is on.

1. Equations apply to both channels, sinking or sourcing power simultaneously. If a duty cycle less than 100% is required to avoid overheating, the maximum on time must be less than 10 seconds

CAUTION This maximum duty cycle equation is an approximation. In general, if the duty cycle calculation yields a number > 90%, then DC under those conditions should not cause the SourceMeter instrument to overheat. However, if the calculation yields a number < 10%, the calculated duty cycle should not be exceeded by more than 0.5% to avoid potential overheating.

Table 4-2

Model 2601A/2602A Maximum Duty Cycle equation constants

Constant	100mV range	1V range	6V range	40V range
P _{CS}	56	56	56	56
V _{OA}	18	18	18	55

Table 4-3

Model 2611A/2612A/2635A/2636A Maximum Duty Cycle equation constants

Constant	200mV range	2V range	20V range	200V range
P _{CS}	56	56	56	56
V _{OA}	40	40	40	220

Examples

Example 1:

Using a Model 2611A to charge a 5V battery with 1.5A, while operating at 50°C ambient temperature; what is the maximum duty cycle?

Assuming the 20V range will be used to measure the voltage:

$$DC_{MAX} \leq \left[\frac{(56 - 20) - |(40 - (5))(0)|}{|(40 - (5))(1.5)|} \right]^2 \times 100$$

$$DC_{MAX} \leq 47.0\%$$

Example 2:

Using a Model 2602A to pulse 10A of current from a bias level of 500mA, into a very low impedance (100 mΩ), while operating at 40°C ambient temperature; what is the maximum duty cycle?

Assuming the 1V range will be used to measure the voltage:

$$DC_{MAX} \leq \left[\frac{(56 - 10) - |(18 - (0.1)(0.5))(0.5)|}{|(18 - (10)(0.1))(10)|} \right]^2 \times 100$$

$$DC_{MAX} \leq 4.7\%$$

Example 3:

Using a Model 2612A to charge a 12V battery by sourcing 100mA and then discharging the battery by sinking 5A, while operating at 35°C ambient temperature; what is the maximum duty cycle?

Assuming the 20V range will be used to measure the voltage:

$$DC_{MAX} \leq \left[\frac{(56 - 5) - |(40 - (12))(0.1)|}{|(40 - (-12))(-5)|} \right]^2 \times 100$$

$$DC_{MAX} \leq 3.4\%$$

Operating boundaries

Source or sink

Depending on how it is programmed and what is connected to the output (load or source), the SourceMeter instrument can operate in any of the four quadrants. The four quadrants of operation are shown in [Figure 4-1](#) and [Figure 4-2](#). When operating in the first (I) or third (III) quadrant, the SourceMeter instrument is operating as a source (V and I have the same polarity). As a source, the SourceMeter instrument is delivering power to a load.

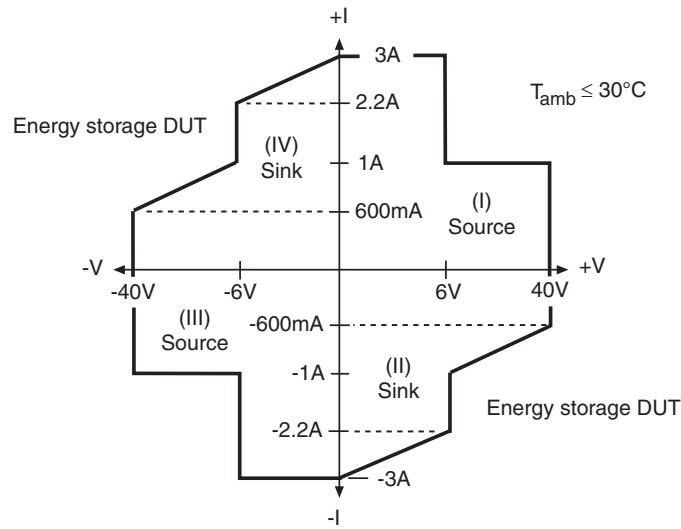
When operating in the second (II) or fourth (IV) quadrant, the SourceMeter instrument is operating as a sink (V and I have opposite polarity). As a sink, it is dissipating power rather than sourcing it. An external source or an energy storage device, such as a capacitor or battery, can force operation in the sink region.

Continuous power operating boundaries

Model 2601A/2602A continuous power operating boundaries

The general operating boundaries for Model 2601A/2602A continuous power output are shown in [Figure 4-1](#) (for derating factors, see [General SourceMeter instrument power equation](#), described earlier in this section). In this drawing, the 3A, 6V and 1A, 40V magnitudes are nominal values. Also note that the boundaries are not drawn to scale.

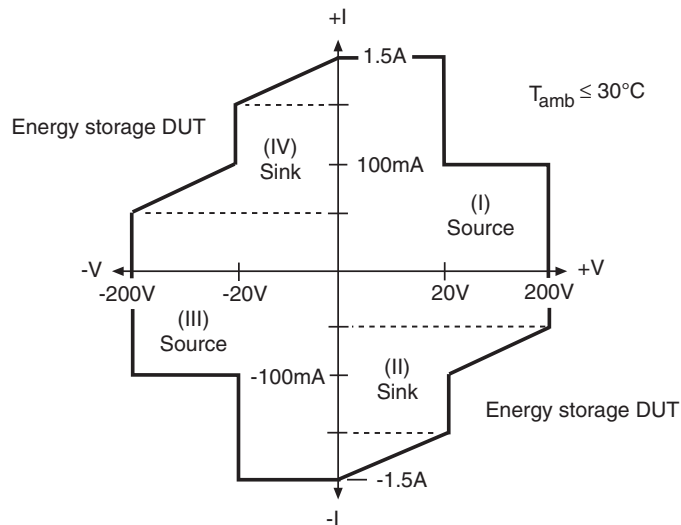
Figure 4-1
Model 2601A/2602A continuous power operating boundaries



Model 2611A/2635A/2612A/2636A continuous power operating boundaries

The general operating boundaries for Model 2611A/2612A continuous power output are shown in [Figure 4-2](#) (see [General SourceMeter instrument power equation](#) in this section for derating factors). In this drawing, the 1.5A, 20V and 100mA, 200V magnitudes are nominal values. Also note that the boundaries are not drawn to scale.

Figure 4-2
Model 2611A/2612A/2635A/2636A continuous power operating boundaries



I-Source operating boundaries

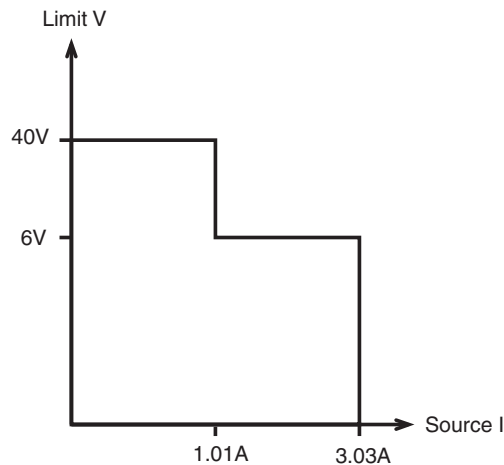
Model 2601A/2602A I-Source operating boundaries

[Figure 4-3](#) shows the operating boundaries for the I-Source. Only the first quadrant of operation is covered. Operation in the other three quadrants is similar.

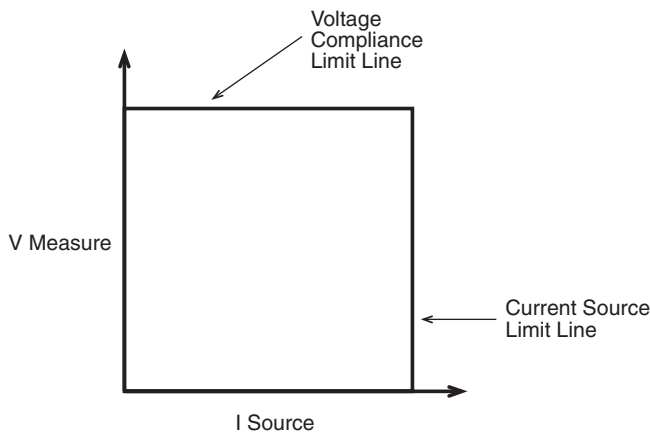
Figure 4-3A shows the output characteristics for the I-Source. As shown, the Series 2601A and 2602A can output up to 1.01A at 40V, or 3.03A at 6V. Note that when sourcing more than 1.01A, voltage is limited to 6V.

Figure 4-3B shows the limit lines for the I-Source. The current source limit line represents the maximum source value possible for the presently selected current source range. The voltage compliance limit line represents the actual compliance that is in effect (see [Compliance limit](#)). These limit lines are boundaries that represent the operating limits of the SourceMeter instrument for this quadrant of operation. The operating point can be anywhere inside (or on) these limit lines. The limit line boundaries for the other quadrants are similar.

Figure 4-3
Model 2601A/2602A I-Source boundaries



A) Output Characteristics



B) Limit Lines

Model 2611A/2612A/2635A/2636A I-Source operating boundaries

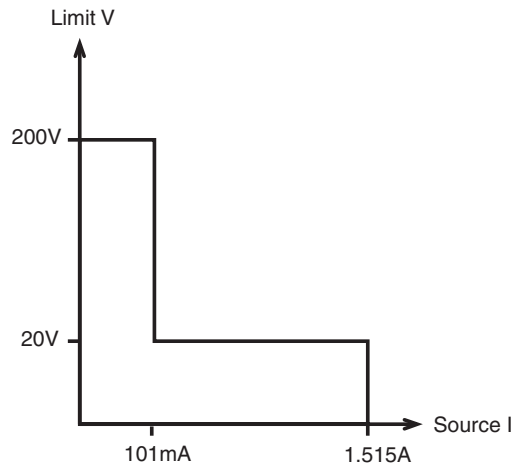
[Figure 4-4](#) shows the operating boundaries for the I-Source. Only the first quadrant of operation is covered. Operation in the other three quadrants is similar.

[Figure 4-4A](#) shows the output characteristics for the I-Source. As shown, the Model 2611A/2612A/2635A/2636A SourceMeter instrument can output up to 101mA at 200V, or 1.515A at 20V. Note that when sourcing more than 101mA, voltage is limited to 20V.

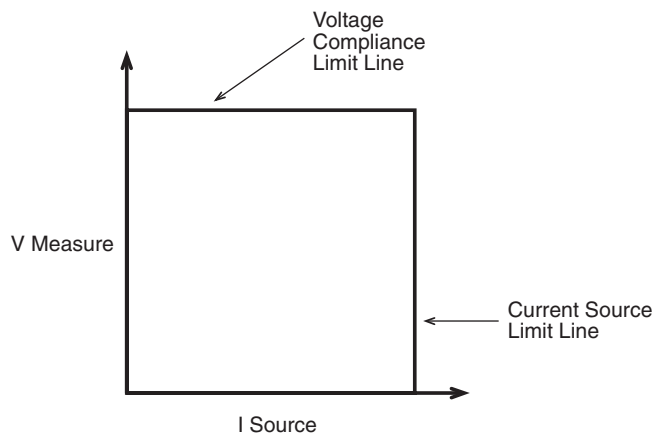
[Figure 4-4B](#) shows the limit lines for the I-Source. The current source limit line represents the maximum source value possible for the presently selected current source range. The voltage compliance limit line represents the actual compliance that is in effect (see [Compliance limit](#)). These limit lines are boundaries that represent the operating limits of the SourceMeter instrument for this quadrant of operation. The operating point can be anywhere inside (or on) these limit lines. The limit line boundaries for the other quadrants are similar.

Figure 4-4

Model 2611A/2612A/2635A/2636A I-Source boundaries



A) Output Characteristics



B) Limit Lines

Load considerations

The boundaries the SourceMeter instrument operates in depends on the load (DUT) that is connected to its output. *Figure 4-5* shows operation examples for resistive loads that are 50Ω and 200Ω, respectively. For these examples, the SourceMeter instrument is programmed to source 100mA and limit 10V.

In *Figure 4-5A*, the SourceMeter instrument is sourcing 100mA to the 50Ω load and subsequently measures 5V. As shown, the load line for 50Ω intersects the 100mA current source line at 5V.

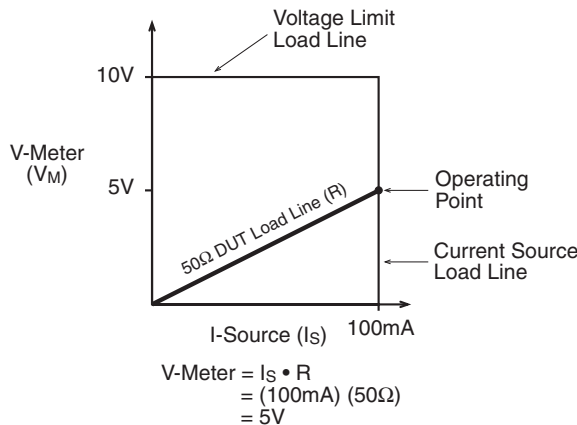
Figure 4-5B shows what happens if the resistance of the load is increased to 200Ω. The DUT load line for 200Ω intersects the voltage compliance limit line placing the SourceMeter instrument in compliance. In compliance, the SourceMeter instrument will not be able to source its programmed current (100mA). For the 200Ω DUT, the SourceMeter instrument will only output 50mA (at the 10V limit).

Notice that as resistance increases, the slope of the DUT load line increases. As resistance approaches infinity (open output), the SourceMeter instrument will source virtually 0mA at 10V. Conversely, as resistance decreases, the slope of the DUT load line decreases. At zero resistance (shorted output), the SourceMeter instrument will source 100mA at virtually 0V.

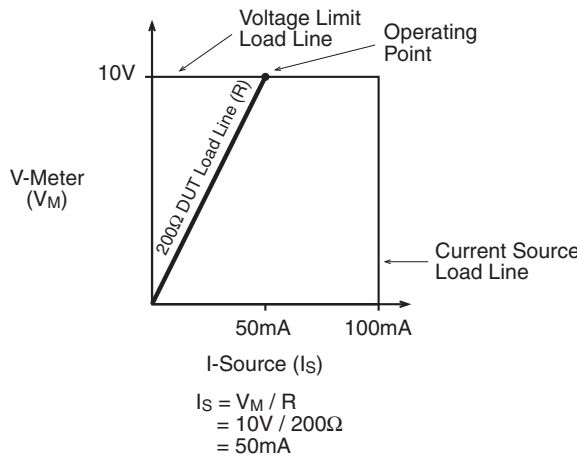
Regardless of the load, voltage will never exceed the programmed compliance of 10V.

Figure 4-5

I-Source operating examples



A) Normal I-source operation



B) I-source in compliance

V-Source operating boundaries

Model 2601A/2602A V-Source operating boundaries

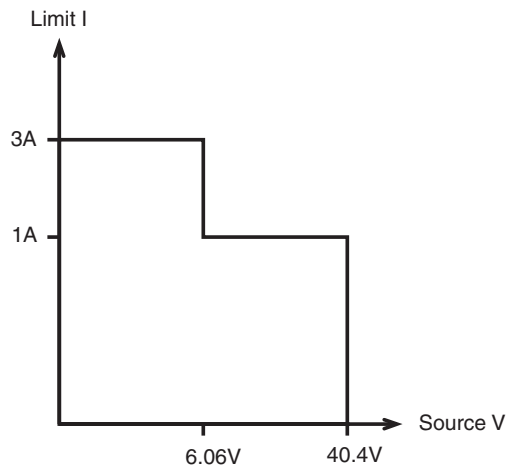
[Figure 4-6](#) shows the operating boundaries for the V-Source. Only the first quadrant of operation is covered. Operation in the other three quadrants is similar.

[Figure 4-6A](#) shows the output characteristics for the V-Source. As shown, the Series 2601A and 2602A can output up to 6.06V at 3A, or 40.4V at 1A. Note that when sourcing more than 6.06V, current is limited to 1A.

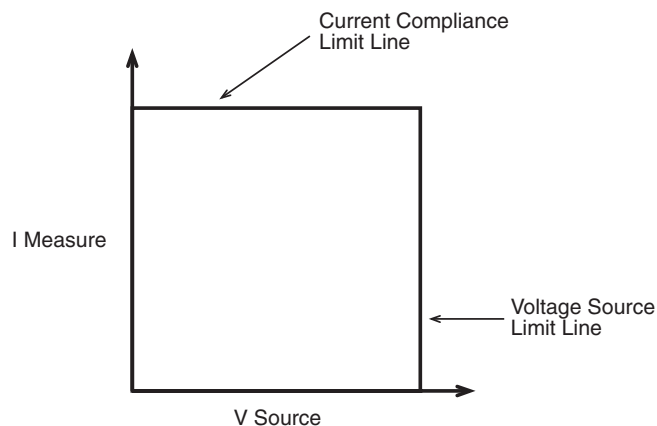
[Figure 4-6B](#) shows the limit lines for the V-Source. The voltage source limit line represents the maximum source value possible for the presently selected voltage source range. For example, if you are using the 6V source range, the voltage source limit line is at 6.3V. The current compliance limit line represents the actual compliance in effect (see [Compliance limit](#)). These limit lines are boundaries that represent the operating limits of the SourceMeter instrument for this quadrant of operation. The operating point can be anywhere inside (or on) these limit lines. The limit line boundaries for the other quadrants are similar.

Figure 4-6

Model 2601A/2602A V-Source boundaries



A) Output characteristics



B) Limit lines

Model 2611A/2612A/2635A/2636A V-Source operating boundaries

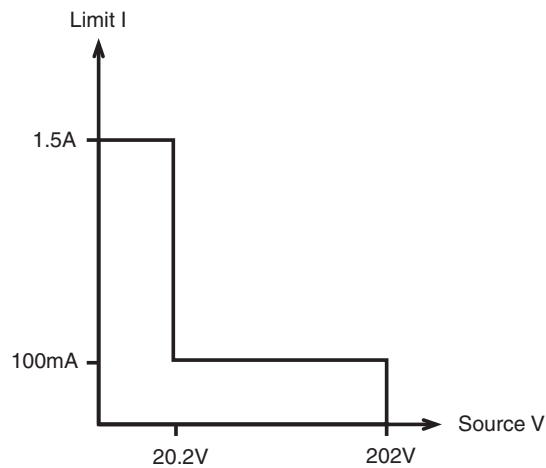
[Figure 4-7](#) shows the operating boundaries for the V-Source. Only the first quadrant of operation is covered. Operation in the other three quadrants is similar.

[Figure 4-7A](#) shows the output characteristics for the V-Source. As shown, the Series 2611A/2612A/2635A/2636A can output up to 20.2V at 1.5A, or 202V at 100mA. Note that when sourcing more than 20.2V, current is limited to 100mA.

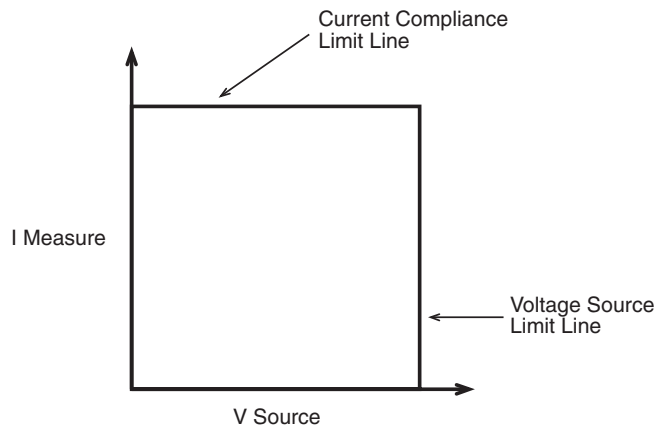
[Figure 4-7B](#) shows the limit lines for the V-Source. The voltage source limit line represents the maximum source value possible for the presently selected voltage source range. For example, if you are using the 20V source range, the voltage source limit line is at 20.2V. The current compliance limit line represents the actual compliance in effect (see [Compliance limit](#)). These limit lines are boundaries that represent the operating limits of the SourceMeter instrument for this quadrant of operation. The operating point can be anywhere inside (or on) these limit lines. The limit line boundaries for the other quadrants are similar.

Figure 4-7

Model 2611A/2612A/2635A/2636A V-Source boundaries



A) Output characteristics



B) Limit lines

Load considerations

The boundaries the SourceMeter instrument operates in depends on the load (DUT) that is connected to the output. [Figure 4-8](#) shows operation examples for resistive loads that are $2\text{k}\Omega$ and 800Ω , respectively. For these examples, the SourceMeter instrument is programmed to source 10V and limit 10mA.

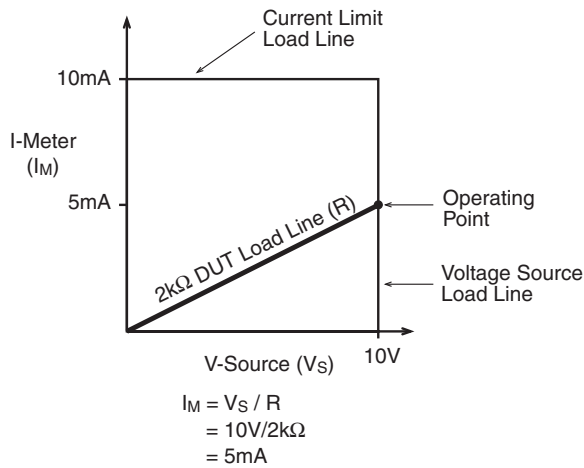
In [Figure 4-8A](#), the SourceMeter instrument is sourcing 10V to the $2\text{k}\Omega$ load and subsequently measures 5mA. As shown, the load line for $2\text{k}\Omega$ intersects the 10V voltage source line at 5mA.

[Figure 4-8B](#) shows what happens if the resistance of the load is decreased to 800Ω . The DUT load line for 800Ω intersects the current compliance limit line placing the SourceMeter instrument in compliance. In compliance, the SourceMeter instrument will not be able to source its programmed voltage (10V). For the 800Ω DUT, the SourceMeter instrument will only output 8V (at the 10mA limit).

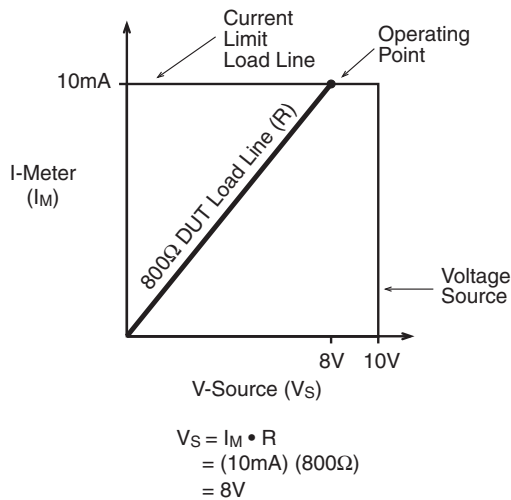
Notice that as resistance decreases, the slope of the DUT load line increases. As resistance approaches infinity (open output), the SourceMeter instrument will source virtually 10V at 0mA. Conversely, as resistance increases, the slope of the DUT load line decreases. At zero resistance (shorted output), the SourceMeter instrument will source virtually 0V at 10mA.

Regardless of the load, current will never exceed the programmed compliance of 10mA.

Figure 4-8
V-Source operating examples



A) Normal V-source operation



B) V-Source in compliance

Source I measure I, source V measure V

The SourceMeter instrument can measure the function it is sourcing. When sourcing a voltage, you can measure voltage. Conversely, if you are sourcing current, you can measure the output current. For these measure source operations, the measure range is the same as the source range.

This feature is valuable when operating with the source in compliance. When in compliance, the programmed source value is not reached. Thus, measuring the source lets you measure the actual output voltage.

Basic circuit configurations

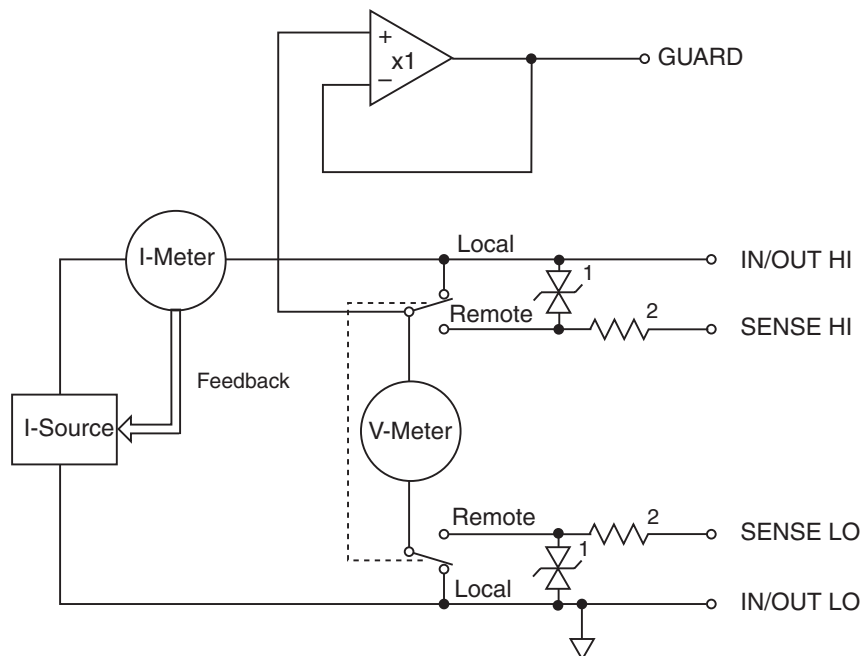
Source I

When configured to source current (I-Source) as shown in [Figure 4-9](#), the SourceMeter instrument functions as a high-impedance current source with voltage limit capability and can measure current (I-Meter) or voltage (V-Meter).

For 2-wire local sensing, voltage is measured at the Input/Output terminals of the SourceMeter instrument. For 4-wire remote sensing, voltage is measured directly at the DUT using the sense terminals. This eliminates any voltage drops that may be in the test leads or connections between the SourceMeter instrument and the DUT.

The current source does not require or use the sense leads to enhance current source accuracy. With 4-wire remote sensing selected, the sense leads must be connected or incorrect operation will result.

Figure 4-9
Source I configuration



NOTES: 1. This represents a protection circuit that is very high impedance until the voltage across it exceeds approximately 3V. Above 3V, the protection turns on and allows current to flow through it.
2. Approximately 13k Ω .

Source V

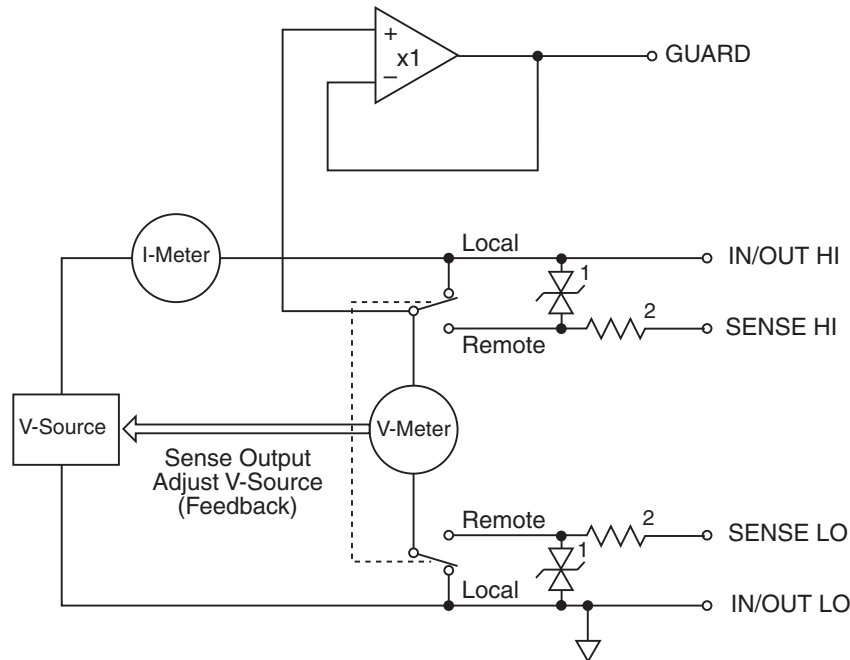
When configured to source voltage (V-Source) as shown in [Figure 4-10](#), the SourceMeter instrument functions as a low-impedance voltage source with current limit capability and can measure current (I-Meter) or voltage (V-Meter).

Sense circuitry is used to continuously monitor the output voltage and make adjustments to the V-Source as needed. The V-Meter senses the voltage at the input/output terminals (2-wire local sense) or at the DUT (4-wire remote sense using the sense terminals) and compares it to the programmed voltage level. If the sensed level and the programmed value are not the same, the

V-Source is adjusted accordingly. Remote sense eliminates the effect of voltage drops in the test leads ensuring that the exact programmed voltage appears at the DUT.

The voltage error feedback to the V-Source is an analog function. The source error amplifier is used to compensate for IR drop in the test leads.

Figure 4-10
Source V configuration



- NOTES: 1. This represents a protection circuit that is very high impedance until the voltage across it exceeds approximately 3V. Above 3V, the protection turns on and allows current to flow through it.
2. Approximately 13k Ω .

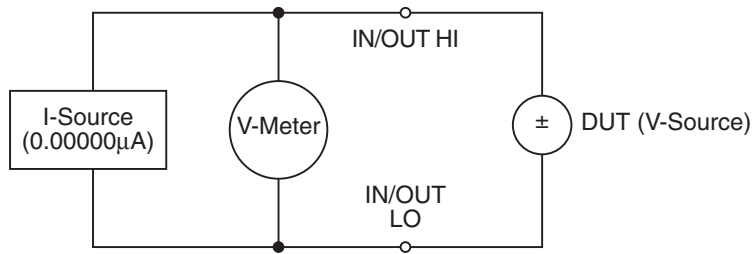
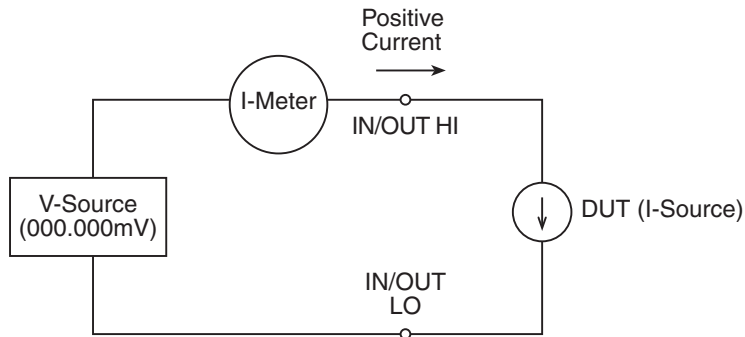
Measure only (V or I)

Figure 4-11 shows the configurations for using the SourceMeter instrument exclusively as a voltmeter or ammeter. As shown in Figure 4-11A, the SourceMeter instrument is configured to measure voltage-only by setting it to source 0A and measure voltage.

CAUTION V-Compliance must be set to a level that is higher than the measured voltage. Otherwise, excessive current will flow into the SourceMeter instrument. This current could damage the SourceMeter instrument. Also, when connecting an external voltage to the I-Source, set the output off state to the high-impedance mode. See ["Compliance limit"](#) earlier in this section for details.

In Figure 4-11B, the SourceMeter instrument is configured to measure current-only by setting it to source 0V and measure current. Note that in order to obtain positive (+) readings, conventional current must flow from IN/OUT HI to LO.

Figure 4-11

Measure only configurations**A. Measure Voltage Only**

Note: Positive current flowing out of IN/OUT HI results in positive (+) measurements.

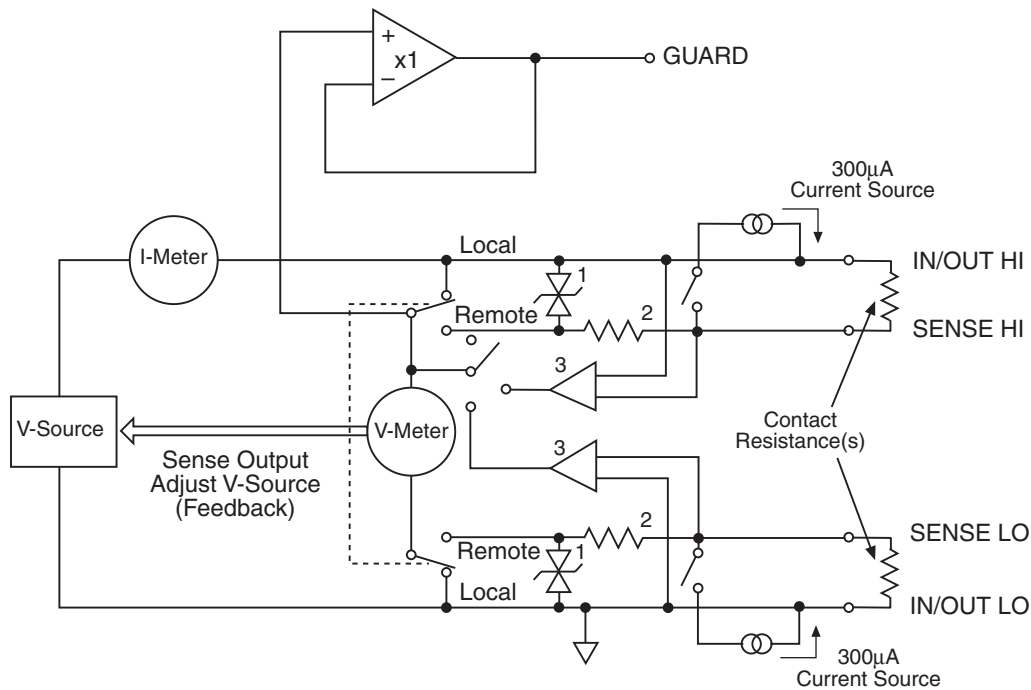
B. Measure Current Only

Note: Use 2-wire local sensing.

Contact check

When a contact check measurement is being performed, two small current sources are switched in between the HI and SENSE HI terminals and the LO and SENSE LO terminals. By controlling the switches illustrated in [Figure 4-12](#), the current from these sources flows through the test leads and through the contact resistance as shown. To accurately measure the resulting contact resistance, the differential amplifier outputs are measured once with the current sources connected, and again with the current sources disconnected. This allows for compensation of various offset voltages that can occur.

Figure 4-12
Contact check circuit configuration



- NOTES: 1. This represents a protection circuit that is very high impedance until the voltage across it exceeds approximately 3V. Above 3V, the protection turns on and allows current to flow through it.
 2. Approximately 13kΩ.
 3. High impedance differential amplifier.

Guard

WARNING *GUARD is at the same potential as output HI. Thus, if hazardous voltages are present at output HI, they are also present at the GUARD terminal.*

Guard overview

The driven guard (available at the rear panel GUARD terminals) is always enabled and provides a buffered voltage that is at the same level as the Input/Output HI (or Sense HI for remote sense) voltage. The purpose of guarding is to eliminate the effects of leakage current (and capacitance) that can exist between input/output high and low. In the absence of a driven guard, leakage in the external test circuit could be high enough to adversely affect the performance of the SourceMeter instrument.

Leakage current can occur through parasitic or non-parasitic leakage paths. An example of parasitic resistance is the leakage path across the insulator in a coax or triax cable. An example of non-parasitic resistance is the leakage path through a resistor that is connected in parallel to the DUT.

Guard connections

Guard is typically used to drive the guard shields of cables and test fixtures. Guard is extended to a test fixture from the cable guard shield. Inside the test fixture, the guard can be connected to a guard plate or shield that surrounds the DUT.

WARNING *To prevent injury or death, a safety shield must be used to prevent physical contact with a guard plate or guard shield that is at a hazardous potential (>30Vrms or 42.4V peak). This safety shield must completely enclose the guard plate or shield and must be connected to safety earth ground. [Figure 4-13B](#) shows the metal case of a test fixture being used as a safety shield.*

NOTE See [Section 2](#) for details on guarded test connections.

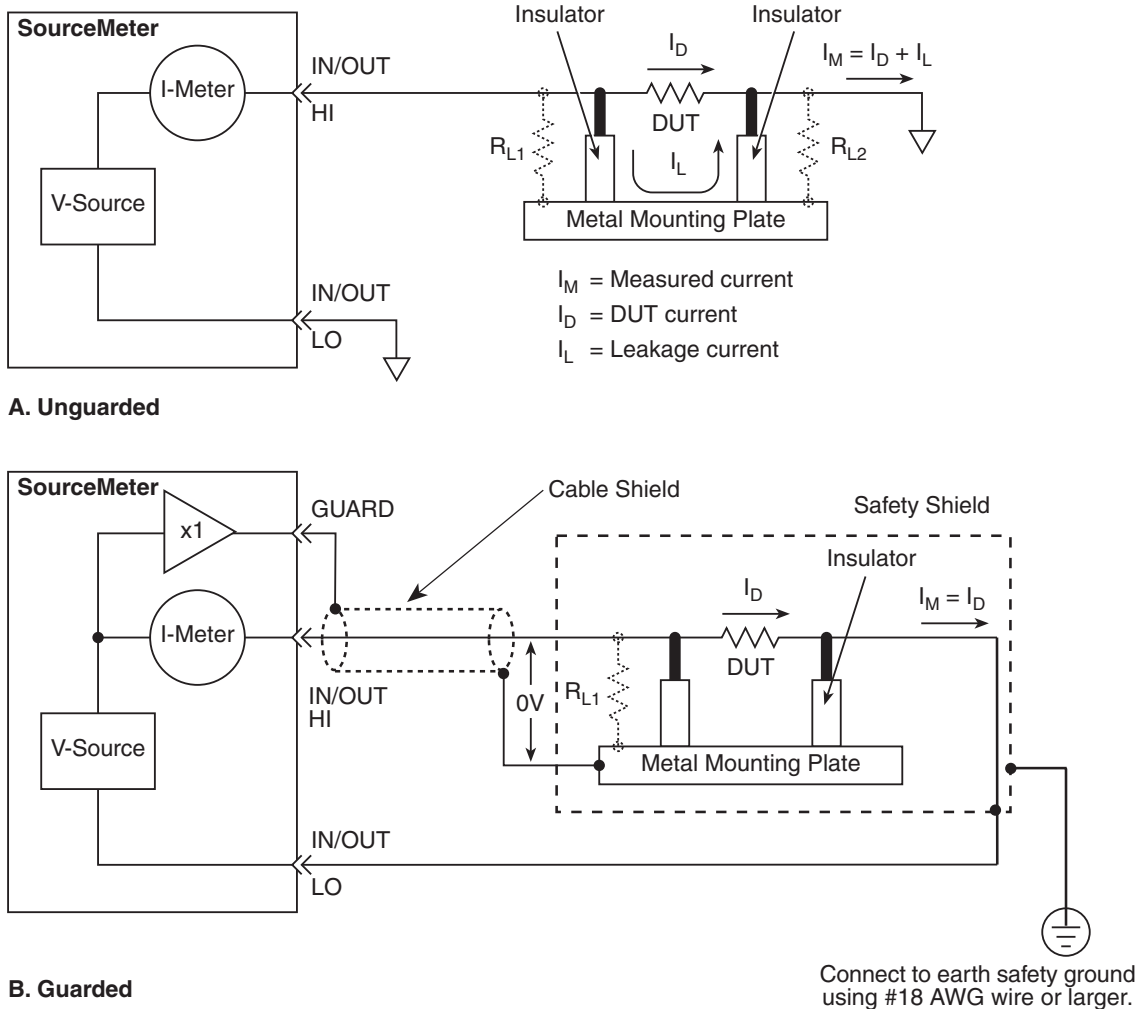
Inside the test fixture, a triaxial cable can be used to extend guard to the DUT. The center conductor of the cable is used for In/Out HI, the inner shield is used for guard, and the outer shield is used for In/Out LO and is connected to the safety shield (which is connected to safety earth ground).

A coaxial cable can be used if the guard potential does not exceed 30Vrms (42.4V peak). The center conductor is used for In/Out HI, and the outer shield is used for guard. For higher guard potentials, use a triaxial cable as previously explained.

[Figure 4-13](#) shows how cable guard can eliminate leakage current through the insulators in a test fixture. In [Figure 4-13A](#), leakage current (I_L) flows through the insulators (R_{L1} and R_{L2}) to In/Out LO, adversely affecting the low-current (or high-resistance) measurement of the DUT.

In [Figure 4-13B](#), the driven guard is connected to the cable shield and extended to the metal guard plate for the insulators. Since the voltage on either end of R_{L1} is the same (0V drop), no current can flow through the leakage resistance path. Thus, the SourceMeter instrument only measures the current through the DUT.

Figure 4-13
Comparison of unguarded and guarded measurements



Settling time considerations

Measurement settling time considerations

Several outside factors can influence measurement settling times. Effects such as dielectric absorption, cable leakages, and noise can all extend the times required to make stable measurements. Care should be taken to use appropriate shielding, guarding, and aperture selections when making low current measurements.

Each current measurement range has a combination of a range resistor and a compensating capacitor that must settle out to allow a stable measurement. By default (on power up or after `smuX.reset()`), delays are enforced to account for approximately 6τ or 6 time constants of a given range (to reach 0.1% of the final value, assuming 2.3τ per decade). The table below lists the

current ranges and associated default delays. In addition, a 1Hz analog filter is used by default on the 1nA and 100pA ranges.

Table 4-4
Current Measure Settling Time^{1, 2}

Time required to reach 0.1% of final value after source level command is processed on a fixed range. Values below for $V_{out} = 2V$ unless otherwise noted	
Current range	Settling time
1.5A to 1A	<120 μ s (typical)(Rload>6 Ω)
100mA to 10mA	<80 μ s (typical)
1mA	<100 μ s (typical)
100 μ A	<150 μ s (typical)
10 μ A	<500 μ s (typical)
1 μ A	<2.5ms (typical)
100nA	<15ms (typical)
10nA	<90ms (typical)
1nA ¹	<360ms (typical)
100pA ³	<360ms (typical)

1. Delay factor set to 1. Compliance equal to 100 mA.

2. Time for measurement to settle after a Vstep.

3. With default analog filter setting < 450ms.

NOTE Delays are on by default for Models 2635A/2636A. Delays are off by default for Models 2601A/2602A/2611A/2612A but can be enabled.

Both the analog filter and the default delays can be manipulated for faster response times. The analog filter may be turned off to yield faster settling times. The default delays may also be controlled by using the delay factor multiplier. The default value for delay factor multiplier is 1.0, but adjusting to other values will result in either a faster or slower response. For example, increasing the delay factor to 1.3 will account for settling to 0.01% of the final value. The commands to manipulate the delay factor and analog filter are shown below:

For controlling settling time delay

```
-- To turn off measure delay (default setting is smuX.DELAY_AUTO).
smuX.measure.delay = 0
```

```
-- set measure delay for all ranges to Y (in seconds).
smuX.measure.delay = Y
```

```
-- To adjust the delay factor.
smuX.measure.delayfactor = 1.0
```

This factor is used to multiply the default delays. Setting this value above 1.0 increases the delays, while a value below 1.0 decreases the delay. Setting this value to 0.0 essentially turns off measurement delays. This attribute is only used when:

```
smuX.measure.delay is set to smuX.DELAY_AUTO.
```

For analog filter (2635A/2636A only)

```
-- Default.
smuX.measure.analogfilter = 1
```

This filter is only active when the amps measure range is 1nA/100pA. Setting the attribute to zero disables the filter.

Reduction in gain-bandwidth

The settling time of the SMU can be influenced by the impedance of the DUT in several ways. One influence is caused by an interaction between the impedances of the SMU current source feedback element and the DUT. This interaction can cause a reduction in gain-bandwidth. When the SMU gain-bandwidth is reduced, the settling time of the current source increases.

Table 4-5 below can be used to determine the affect of various DUT impedances on the gain-bandwidth when the SMU is operating on each current source range. If the ratio of DUT impedance to current source feedback impedance drops below the indicated 60kHz ratio, then the settling time will increase beyond the specified times. Therefore, there is a minimum DUT impedance for each current source range. The settling time on a current range can increase significantly when measuring DUTs that have an impedance that is lower than that listed in Table 4-5.

Table 4-5
Current source gain-bandwidth

Range	SMU feedback impedance	60kHz ratio (DUT / SMU impedance)	Minimum DUT impedance
1nA	1G Ω	0.5	2G Ω
10nA	120M Ω	0.5	60M Ω
100nA	40M Ω	0.5	20M Ω
1 μ A	1.2M Ω	0.5	600k Ω
10 μ A	400k Ω	0.5	200k Ω
100 μ A	12k Ω	0.5	6k Ω
1mA	4k Ω	0.5	2k Ω
10mA	120 Ω	0.5	60 Ω
100mA	40 Ω	0.5	20 Ω
1A	1 Ω	6	6 Ω
1.5A	1 Ω	6	6 Ω
3A	0.3 Ω	5	1.5 Ω

High-Capacitance Mode

In this section:

Topic	Page
Overview	5-1
Understanding high-capacitance mode	5-2
Understanding source settling times	5-2
Adjusting the voltage source	5-3
Enabling high-capacitance mode	5-4
Front panel	5-4
Command interface	5-5

Overview

The Keithley Instruments Series 2600A System SourceMeter® instrument features a high-capacitance mode.

Because the source measure unit (SMU) has the ability to measure low current, issues can arise when driving a capacitive load. The pole formed by the load capacitance and the current range resistor can cause a phase shift in the SMU voltage control loop. This shift can lead to overshoot, ringing, and instability. Due to the large dynamic range of current measurement and wide range of internal resistors, the operating conditions for a given capacitive load can vary.

Based on the type, some test applications may require capacitors larger than 10nF. While running test scripts, it may not be possible to disconnect the capacitor from the IC (integrated circuit) and extract accurate data. For this purpose, you can use the high-capacitance mode to minimize overshoot, ringing and instability.

This section provides the details that you need to estimate performance based on load capacitance and measurement conditions.

Understanding high-capacitance mode

Each SMU in the Series 2600A drives 10nF of capacitance in normal operation. Typically, an internal capacitor across the current measuring element provides phase lead to compensate for the phase lag caused by the load capacitance on the output. This internal capacitance across the range resistance limits the speed for a specific measurement range.

It is important to note that each SMU in the Series 2600A implements frequency compensation to achieve the highest throughput possible for a 10nF or less load. In addition you must consider the settling time, voltage range, measure delay, the quality of the capacitor, the current measure range resistor, and the load resistor.

In normal operation, each SMU in the Series 2600A can drive capacitive loads as large as 10nF. In high-capacitance mode, each SMU can drive a maximum of 50 μ F of capacitance.

NOTE NOTE: When high-capacitance mode is enabled, a minimum load capacitance of 100nF is recommended. In absence of this minimum load capacitance, overshoot and/or ringing may occur.

Highest throughput is achieved by using normal operation. In high capacitance mode, the speed of the Series 2600A SMU is reduced in order to compensate for the larger load capacitance. Stability is achieved by inserting an internal capacitance across the current measuring element of the SMU. This internal capacitor limits the speed for the source and measurement ranges. Therefore, when optimizing the speed of your test configuration in high-capacitance mode, you must consider the settling time, voltage, and current ranges, measure delay, quality of the load capacitor, and load resistance.

Understanding source settling times

Each Series 2600A SMU can drive up to 50 μ F of a capacitance in high-capacitance mode. In order to accomplish this, the speed of the Series 2600A SMU is reduced. Source settling times increase when high-capacitance mode is enabled. [Table 5-1](#) and [Table 5-2](#) compare the source settling times for the Series 2602A, 2612A, and 2636A in normal and high-capacitance modes.

Table 5-1
Models 2601A and 2602A source settling times

Range	Normal mode	High capacitance mode
100 mV	50 μ s	200 μ s
1 V	50 μ s	200 μ s
6 V	100 μ s	200 μ s
40 V	150 μ s	7 ms

Table 5-2
Models 2611A/2612A and 2635A/2636A source settling times

Range	Normal mode	High capacitance mode
200 mV	50 μ s	600 μ s
2 V	50 μ s	600 μ s
20 V	110 μ s	1.5 ms
200 V	700 μ s	20 ms

In high-capacitance mode, the frequency compensation capacitance across the measure range resistors increases. This increase leads to longer settling times on some current measure ranges. The same range elements that are used to measure current are used to source current. Therefore, the current limit response times will respond in a similar manner.

Table 5-3 displays the current measure and current limits in normal mode and high-capacitance mode.

Table 5-3
Current measure and source settling times

Current measure range	Normal mode (typical)	High capacitance mode (typical)
1A - 1.5 A (2612A/2636A)	120 μ s	120 μ s ($R_{load} > 6\Omega$)
1A - 3 A (2602A)	80 μ s	120 μ s ($R_{load} > 2\Omega$)
100 mA	100 μ s	100 μ s
10 mA	80 μ s	100 μ s
1 mA	100 μ s	3 ms
100 μ A	150 μ s	3 ms
10 μ A	500 μ s	230 ms
1 μ A	2 ms	230 ms

When high-capacitance mode is enabled, the amount of time to change the current measure range increases for each SMU. The current measure range and the current limit range are locked together. Setting the current limit automatically updates the measure range.

Adjusting the voltage source

When driving large capacitive loads with high-capacitance mode enabled, the response time may be lengthened by the current limit. For example, see Table 5-3. If a 1 μ F capacitor charges to 10V in 10 μ s with a 1A limit $i = C \frac{\Delta v}{\Delta t}$ and the limit is set to 100nA, the charging time will be 100 seconds.

The total response times while in high-capacitance mode are a combination of the time spent charging the capacitor (current limit) or the response time, whichever is greater. There is a direct relationship between the current limit and the charging time. As the current limit decreases, the amount of time required to charge the capacitor increases.

Understanding the capacitor

Based on the capacitor dielectric absorption the settling time may change and the values in [Table 5-3](#) may differ.

Note the following:

- Tantalum or electrolytic capacitors are well known for long dielectric absorption settling times.
- Film capacitors and ceramics perform better, with NPO/COG dielectric ceramics yielding the best settling response.

Charging the capacitor and taking readings

Complete the following to charge the capacitor in high-capacitance mode.

1. Set the current limit to a higher value.
2. After the capacitor charges, lower the current limit and measure range to obtain the current measurement.

Enabling high-capacitance mode

Note the following before enabling high-capacitance mode:

- It is important to read the previous section to understand the impact of high-capacitance mode.
- Test the DUT and the capacitor to determine the best current source and range of output voltages.
- The settling times can vary based on the DUT. It is important to test the limits of the DUT before you use high-capacitance mode.
- Failure to test the DUT for the appropriate current source and output voltages can result in damage to or destruction of the DUT.
- For optimal performance, do not continuously switch between normal mode and high-capacitance mode.
- Before you charge the capacitor, start with 0 (zero) voltage across the capacitor.
- When high-capacitance mode is enabled, a minimum load capacitance of 100nF is recommended. In absence of this minimum load capacitance, overshoot and/or ringing may occur.

Front panel

Complete the following steps to enable high-capacitance mode from the front panel:

1. Press **CONFIG > SRC > HIGHC-MODE**.
2. Select **SRC-ENABLE > ENABLE**. High-capacitance mode is enabled.
3. Push the **ENTER** key.
4. Press **EXIT** to back out of the menu structure.

Command interface

Turning on High-C mode has the following effects on the SMU settings:

- `smuX.measure.autorangei` is set to `smuX.AUTORANGE_FOLLOW_LIMIT` and cannot be changed.
- Current ranges below 1uA are not accessible.
- If `smuX.source.limiti` is less than 1uA, it is raised to 1uA.
- If `smuX.source.rangei` is less than 1uA, it is raised to 1uA.
- If `smuX.source.lowrangei` is less than 1uA, it is raised to 1uA.
- If `smuX.measure.lowrangei` is less than 1uA, it is raised to 1uA.

Measuring current

The following inputs are required to test leakage using the factory leakage script as shown in the script example below.

- **SMU:** Indicates the Series 2600A source measure unit to use.
- **levelv:** Setting the voltage level to source.
- **limiti:** Sets the current limit for discharging or charging the capacitor.
- **Sourcedelay:** Solve $i = C \frac{\Delta v}{\Delta t}$ to determine the amount of time before taking a current reading.
Where: i is the `limiti` setting and current limit.
- **measurei:** Sets the current measure range.
- **measuredelay:** Defines the delay after the limit is lowered to measure before the measurement is taken.

Script example

Use the `smuX.source.highc` attribute to set and control the options for high capacitance mode.

NOTE The Series 2600A must be configured as a voltage source to use the `smuX.source.func` attribute to enable high-capacitance mode.

The following code contains examples that you can use to enable high-capacitance mode on SMU A:

1. To enable high-capacitance mode, send the following:


```
-- Enables high-capacitance mode.
smua.source.highc = smua.ENABLE
```
2. Run the `i_leakage_measure()` function in the KIHighC factory script (see [Figure 5-1](#)):

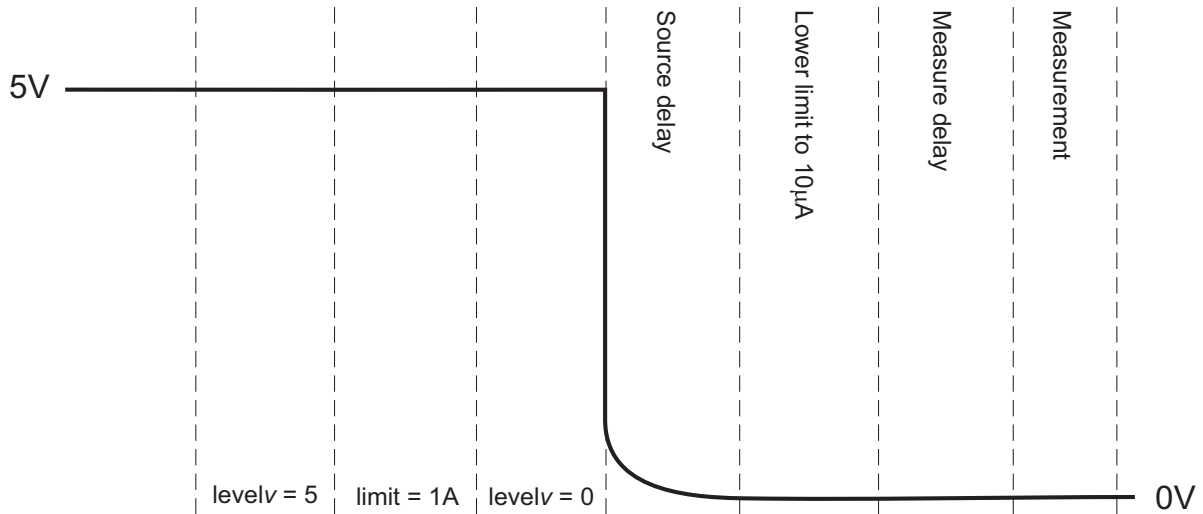
```
-- Charges the capacitor.
smua.source.levelv = 5
smua.source.output = smua.OUTPUT_ON
delay(1)

imeas = i_leakage_measure(smua, 0, 1, 300e-3, 10e-6, 100e-3)
-- The parameters in the i_leakage_measure() function represent
-- the following:
-- smu = smua
-- levelv = 0V
```

```
-- limiti = 1A
-- sourcedelay = 300ms
-- measurei = 10uA range
-- measuredelay = 100ms
```

NOTE Adjust the voltage level and source delays based on the value and type of capacitor along with the magnitude of the voltage step and the current measure range.

Figure 5-1
Enabling high-capacitance mode



Note: Not drawn to scale

Range, Digits, Speed, Rel, and Filters

In this section:

Topic	Page
Overview	6-2
Range	6-2
Available ranges	6-2
Maximum source values and readings	6-3
Ranging limitations	6-3
Manual ranging	6-3
Auto ranging	6-3
Low range limits	6-3
Range considerations	6-4
Range programming	6-4
Digits	6-6
Setting display resolution	6-6
Remote digits programming	6-6
Speed	6-6
Setting speed	6-7
Remote speed programming	6-7
Rel	6-8
Front panel rel	6-8
Remote rel programming	6-9
Filters	6-9
Filter types	6-9
Front panel filter control	6-10
Remote filter programming	6-12

Overview

The documentation in this section provides detailed information on characteristics and script programming for each of the following functions:

- [Range](#)
- [Digits](#)
- [Speed](#)
- [Rel](#)
- [Filters](#)

Range

The selected measurement range affects the accuracy of the measurements as well as the maximum signal that can be measured. Note that dashed lines are displayed (for example, --.---- μ A), to indicate that the previous measurement is not recent. This usually happens when a change occurs such as selecting a different range.

Available ranges

[Table 6-1](#) lists the available source and measurement ranges for the Keithley Instruments Series 2600A System SourceMeter® instruments.

Table 6-1
Source and measurement ranges

Model 2601A/2602A		Model 2611A/2612A		Model 2635A/2636A	
Voltage Ranges	Current Ranges	Voltage Ranges	Current Ranges	Voltage Ranges	Current Ranges
100mV	100nA	200mV	100nA	200mV	100pA ²
1V	1 μ A	2V	1 μ A	2V	1nA
6V	10 μ A	20V	10 μ A	20V	10nA
40V	100 μ A	200V	100 μ A	200V	100nA
	1mA		1mA		1 μ A
	10mA		10mA		10 μ A
	100mA		100mA		100 μ A
	1A		1A		1mA
	3A		1.5A		10mA
			10A ¹		100mA
					1A
					1.5A

1. 10A range available only in pulse mode.
2. 100pA range only in measure.

Maximum source values and readings

The full-scale output for each voltage and current source range is 101% of the selected range, while the full-scale measurement is 102% of the range. For example, $\pm 1.01A$ is the full-scale source value for the 1A range, and $\pm 102mA$ is the full-scale reading for the 100mA measurement range. Input levels that exceed the maximum levels cause the overflow message to be displayed. Note, however, that the instrument will auto range at 100% of the range.

Ranging limitations

- Model 2601A/2602A: With the 40V V-Source range selected, the highest current measurement range is 1A. With the 3A I-Source range selected, the highest voltage measurement range is 6V.
- Model 2611A/2612A/2636A: With the 200V V-Source range selected, the highest current measurement range is 100mA. With I-Source ranges above 100mA selected, the highest voltage measurement range is 20V.
- For Source V Measure I or Source I Measure V, you can set source and measure ranges separately. If both source and measure functions are the same, the measure range is locked to the source range.

Manual ranging

The **RANGE** \triangle and ∇ keys are used to select a fixed range:

- To set the source range, press **SRC**, then use the **RANGE** keys to set the range.
- To set the measure range, select the single-channel display mode (Models 2602A/2612A/2636A only), press **MEAS**, then set the range with the **RANGE** keys.

If the instrument displays the overflow message on a particular range, select a higher range until an on-range reading is displayed. Use the lowest range possible without causing an overflow to ensure best accuracy and resolution.

Auto ranging

To use auto source ranging, press **SRC** then **AUTO RANGE**. To use auto measure ranging, select the Model 2602A/2612A/2636A single-channel display mode, then press **MEAS** followed by **AUTO RANGE**. The AUTO indicator turns on when source or measure auto ranging is selected. With auto ranging selected, the instrument automatically chooses the best range to source or measure the applied signal. The instrument will auto range at 100% of range.

Note that source auto ranging will turn off when editing the source value.

Low range limits

The low range limits set the lowest range the Series 2600A will use when auto ranging is enabled. This feature is useful for minimizing auto range settling times when numerous range changes are involved.

Low range limits can be individually set for Source V, Source I, Measure V, and Measure I as follows:

1. Press the **CONFIG** key, then press either **SRC** for source or **MEAS** for measure.
2. Choose voltage or current source, or measure as appropriate, and then press **ENTER** or the **navigation wheel**.
3. Choose **LOWRANGE**, then press **ENTER** or the **navigation wheel**.
4. Set the low range to the desired setting, and then press **ENTER** or the **navigation wheel**.

5. Use **EXIT** to back out of the menu structure.

Range considerations

The source range and measure range settings can interact depending on the source function. Additionally, the output state (on/off) can affect how the range is set.

If the source function is the same as the measurement function (for example, sourcing voltage and measuring voltage), the measurement range is locked to be the same as the source range. However, the setting for the voltage measure range is retained and used when the source function is changed to current, and the present voltage measurement range will be used.

2601A/2602A Example:

```
smua.source.func = smua.OUTPUT_DCVOLTS
smua.source.rangev = 1
smua.measure.rangev = 6
-- will print 1, to match source range
print(smua.measure.rangev)
smua.source.func = smua.OUTPUT_DCAMPS
-- will print 6, the user's range
print(smua.measure.rangev)
```

Explicitly setting either a source or measurement range for a function will disable auto ranging for that function. Auto ranging is controlled separately for each source and measurement function: source voltage, source current, measure voltage, and measure current. Auto ranging is enabled for all four by default.

Changing the range while the output is off will not update the hardware settings, but querying will return the range setting that will be used once the output is turned on. Setting a range while the output is on will take effect immediately.

With source auto ranging enabled, the output level controls the range. Querying the range after the level is set will return the range the unit chose as appropriate for that source level.

The Series 2600A allows you to send ICL command values that may be out of range when auto range is off. An example is sending 1A on the 100mA range. The unit does not error check until the output is turned on. In this situation, the display will show a series of question marks:

```
???.???
```

With measure auto ranging enabled, the range will be changed only when a measurement is taken. Querying the range after a measurement will return the range selected for that measurement.

Range programming

Range commands

[Table 6-2](#) summarizes the commands necessary to control measure and source ranges. See [Section 19](#) for more details on these commands.

Table 6-2
Range commands

Commands ¹	Description
<p>Measure range commands: ²</p> <pre>smuX.measure.autorangei = smuX.AUTORANGE_ON smuX.measure.autorangei = smuX.AUTORANGE_OFF smuX.measure.autorangev = smuX.AUTORANGE_ON smuX.measure.autorangev = smuX.AUTORANGE_OFF smuX.measure.lowrangei = lowrange smuX.measure.lowrangev = lowrange smuX.measure.rangei = rangeval smuX.measure.rangev = rangeval</pre> <p>Source range commands: ³</p> <pre>smuX.source.autorangei = smuX.AUTORANGE_ON smuX.source.autorangei = smuX.AUTORANGE_OFF smuX.source.autorangev = smuX.AUTORANGE_ON smuX.source.autorangev = smuX.AUTORANGE_OFF smuX.source.limiti = level smuX.source.limitv = level smuX.source.lowrangei = lowrange smuX.source.lowrangev = lowrange smuX.source.rangei = rangeval smuX.source.rangev = rangeval</pre>	<pre>Enable current measure auto range. Disable current measure auto range. Enable voltage measure auto range. Disable voltage measure auto range. Set lowest I measure range for auto range. Set lowest V measure range for auto range. Select manual current measure range. Select manual voltage measure range.</pre> <pre>Enable current source auto range. Disable current source auto range. Enable voltage source auto range. Disable voltage source auto range. Set voltage source current limit. Set current source voltage limit. Set lowest I source range for auto range. Set lowest V source range for auto range. Select manual current source range. Select manual voltage source range.</pre>

¹ smuX = smua for the Model 2601A/2611A/2635A; smuX = smua (Channel A) or smub (Channel B) for the Model 2602A/2612A/2636A.

² See [Table 6-1](#) for measure ranges.

³ See [Table 6-1](#) for source ranges.

Range programming example

The listing below shows a programming example for controlling both source and measure ranges. The Series 2600A is set up as follows:

- Voltage source range: auto
- Current measure range: 10mA
- Voltage source current limit: 10mA

```
-- Restore Series 2600A defaults.
smua.reset()

-- Set V source range to auto.
smua.source.autorangev = smua.AUTORANGE_ON

-- Select 10mA measure range.
smua.measure.rangei = 1e-2

-- Set limit level to 10mA.
smua.source.limiti = 1e-2
```

Digits

The display resolution of the measured reading depends on the DIGITS setting. This setting is global, which means the digits setting selects display resolution for all measurement functions.

The DIGITS setting has no effect on the remote reading format. The number of displayed digits does not affect accuracy or speed. Those parameters are controlled by the SPEED setting (see [Speed](#) later in this section).

Setting display resolution

To set display resolution, press the **DIGITS** key until the desired number of digits is displayed. The display resolution will cycle through 4.5, 5.5, and 6.5 digits.

NOTE For the Model 2602A/2612A/2636A dual-channel display mode, the maximum display resolution is 4.5 digits. For the Model 2602A/2612A/2636A single-channel display mode, pressing the DIGITS key for the channel not being displayed will have no effect, but the unit will display a message advising you to change to the indicated channel.

Remote digits programming

Digits commands

[Table 6-3](#) summarizes digits commands. See [Section 19](#) for more information.

Table 6-3

Digits commands

Command ¹	Description
<code>display.smuX.digits = display.DIGITS_4_5</code>	Set display to 4.5 digits.
<code>display.smuX.digits = display.DIGITS_5_5</code>	Set display to 5.5 digits.
<code>display.smuX.digits = display.DIGITS_6_5</code>	Set display to 6.5 digits.

¹ smuX = smua for the Model 2601A/2611A/2635A; smuX = smua (Channel A) or smub (Channel B) for the Model 2602A/2612A/2636A.

Digits programming example

```
--Select 5.5 digits.
display.smua.digits = display.DIGITS_5_5
```

Speed

The **SPEED** key is used to set the integration time, or measurement aperture, of the A/D converter (period of time the input signal is measured). The integration time affects the usable digits, the amount of reading noise, and the ultimate reading rate of the instrument. The integration time is specified in parameters based on the Number of Power Line Cycles (NPLC), where 1 PLC for 60Hz is 16.67ms (1/60) and 1 PLC for 50Hz is 20ms (1/50).

In general, the fastest integration time (0.001 PLC) results in the fastest reading rate, but at the expense of increased reading noise and fewer usable digits. The slowest integration time (25 PLC)

provides the best common-mode and normal-mode noise rejection, but has the slowest reading rate. In-between settings are a compromise between speed and noise. The default power-on speed setting is **NORMAL** (1 PLC).

Setting speed

Speed is set from the SPEED configuration menu and is structured as follows.

SPEED configuration menu

Press **SPEED** (or use the **CONFIG** menu) to display the menu:

- **FAST:** Sets speed to 0.01 PLC.
- **MED:** Sets speed to 0.10 PLC.
- **NORMAL:** Sets speed to 1.00 PLC.
- **HI-ACCURACY:** Sets speed to 10.00 PLC.
- **OTHER:** Used to set speed to any PLC value from 0.001 to 25.

NOTE The **SPEED** setting affects all measurement functions. After setting speed, display resolution can be changed using the **DIGITS** key. For the Model 2602A/2612A/2636A single-channel display mode, pressing the **SPEED** key for the channel not being displayed will result in a display message to change to the other channel before setting speed.

Remote speed programming

Speed command

Table 6-4 summarizes commands to control speed. See [Section 19](#) for more information.

Table 6-4

Speed command

Command ¹	Description
<code>smuX.measure.nplc = nplc</code>	Set speed (nplc = 0.001 to 25) ²

¹ smuX = smua for the Model 2601A/2611A/2635A; smuX = smua (Channel A) or smub (Channel B) for the Model 2602A/2612A/2636A.

² The speed setting is global and affects all measurement functions.

Speed programming example

Use the NPLC command to set the speed. For example, send the following command to set the speed to 10 PLC:

```
--Set NPLC to 10.
smua.measure.nplc = 10
```

Rel

The rel (relative) feature can be used to null offsets or subtract a baseline reading from present and future readings. With rel enabled, subsequent readings will be the difference between the actual input value and the rel value as follows:

$$\text{Displayed Reading} = \text{Actual Input} - \text{Rel Value}$$

Once a rel value is established for a measurement function, the value is the same for all ranges. For example, if 0.5A is set as a rel value on the 1A range, the rel value is also 0.5A on the lower current ranges.

Selecting a range that cannot accommodate the rel value does not cause an overflow condition, but it also does not increase the maximum allowable input for that range. For example, on 1A range, the Series 2600A still overflows for a >1.02A input.

NOTE When rel is enabled, the REL indicator turns on. Changing measurement functions disables rel.

Front panel rel

Enabling and disabling rel

Rel can be used to null out zero offsets or to establish a zero baseline by pressing the **REL** key. The reading (which becomes the rel value) is subtracted from itself. As a result, a zero reading is displayed. Pressing **REL** a second time disables rel.

Defining a rel value

A unique rel value can be established for the selected measurement function from the front panel as follows:

1. Press **CONFIG** then **REL**.
2. Choose the measurement function (**CURRENT**, **VOLTAGE**, **OHMS**, or **WATTS**), then press **ENTER** or the **navigation wheel**.
3. The present rel value will be displayed.
4. Set the desired rel value.
5. With the desired rel value displayed, press **ENTER** or the **navigation wheel**, and then use **EXIT** to back out of the menu structure.

Remote rel programming

Rel commands

Rel commands are summarized in [Table 6-5](#).

Table 6-5

Rel commands

Command*	Description
To set rel values: smuX.measure.rel.leveli = relval smuX.measure.rel.levelp = relval smuX.measure.rel.levelr = relval smuX.measure.rel.levelv = relval	Set current rel value. Set power rel value. Set resistance rel value. Set voltage rel value.
To enable/disable rel: smuX.measure.rel.enablei = smuX.REL_OFF smuX.measure.rel.enablep = smuX.REL_OFF smuX.measure.rel.enabler = smuX.REL_OFF smuX.measure.rel.enablev = smuX.REL_OFF smuX.measure.rel.enablei = smuX.REL_ON smuX.measure.rel.enablep = smuX.REL_ON smuX.measure.rel.enabler = smuX.REL_ON smuX.measure.rel.enablev = smuX.REL_ON	Disable current rel. Disable power rel. Disable resistance rel. Disable voltage rel. Enable current rel. Enable power rel. Enable resistance rel. Enable voltage rel.

* smuX = smua for the Model 2601A/2611A/2635A; smuX = smua (Channel A) or smub (Channel B) for the Model 2602A/2612A/2636A.

Rel programming example

```
-- Set current rel to 100mA.
smua.measure.rel.leveli = 0.1
-- Enable current rel.
smua.measure.rel.enablei = smua.REL_ON
```

Filters

Filter lets you set the filter response to stabilize noisy measurements. The Series 2600A uses a digital filter, which is based on reading conversions. The displayed, stored, or transmitted reading is calculated using many reading conversions (from 1 to 100).

Filter types

There are three filter types from which to choose. These three filters are broken down into two **averaging filters** and one **median filter**.

The two averaging filters are repeating and moving (see [Figure 6-1](#)). For the repeat filter (which is the power-on default), the stack (filter count) is filled, and the conversions are averaged to yield a reading. The stack is then cleared, and the process starts over.

The moving average filter uses a first-in, first-out stack. When the stack (filter count) becomes full, the measurement conversions are averaged, yielding a reading. For each subsequent conversion placed into the stack, the oldest conversion is discarded. The stack is re-averaged, yielding a new reading.

The median filter is used to pass the “middle-most” reading from a group of readings that are arranged according to size. The median filter uses a first-in, first-out stack similar to the moving average filter. For each subsequent conversion placed into the stack, the oldest conversion is discarded. The median is then re-determined.

When a moving filter is first enabled, the stack is empty. The first reading conversion is placed in the stack and is then copied to the other stack locations in order to fill it. Thus, the first filtered reading is the same as the first reading conversion. The normal moving filter process continues. Note that a true average or median reading is not yielded until the stack is filled with new reading conversions (no copies in stack). For example, in [Figure 6-1A](#), it takes ten filtered readings to fill the stack with new reading conversions. The first nine filtered readings are calculated using copied reading conversions.

Front panel filter control

Configuring filter

Filter type and count is configured from the filter configuration menu. The configured filter is the same for all measurement functions.

Filter configuration menu

Press **CONFIG** and then **FILTER** to display the filter configuration menu:

- **TYPE:** Use this menu item to select filter type:
 - **AVERAGE:** Use this menu item to select an averaging filter, then select the averaging filter type:
 - Moving
 - Repeat
 - **MEDIAN:** Use this menu item to select a median filter. The MOVING WINDOW filter type is the only option.
- **COUNT:** Use this menu item to specify filter count (1 to 100 readings).

Enabling filter

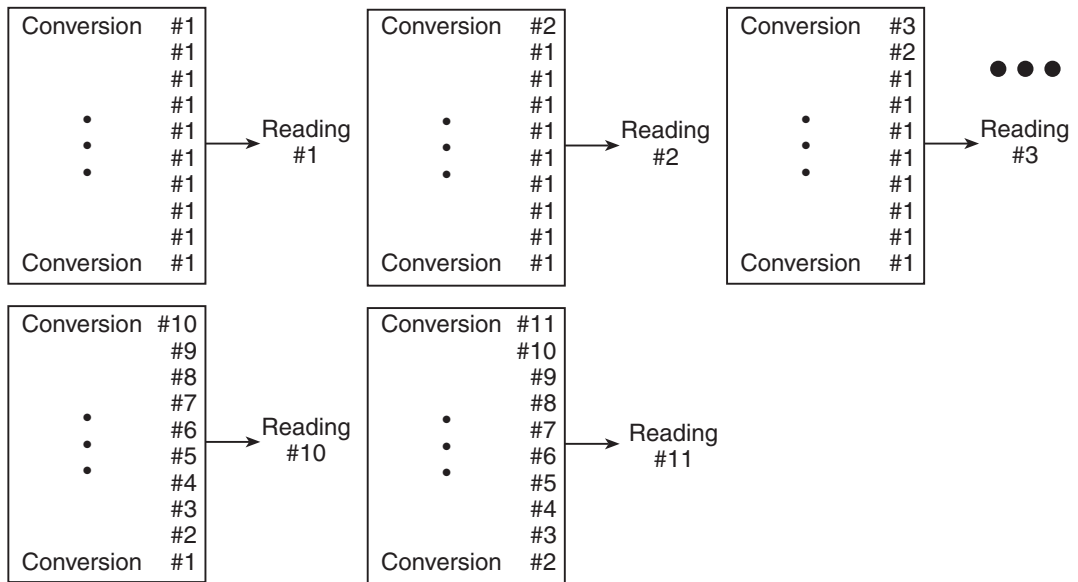
The filter is enabled by pressing the **FILTER** key. The **FILT** indicator is on while the filter is enabled. Pressing **FILTER** a second time disables filter.

Response time

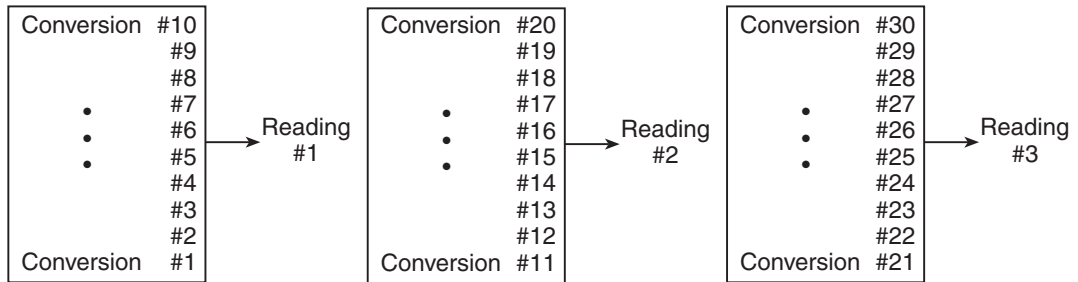
The filter parameters have speed and accuracy trade-offs for the time needed to display, store, or output a filtered reading. These affect the number of reading conversions for speed versus accuracy and response to input signal changes.

The filter averaging mode and count affect the overall reading speed. The moving averaging filter is much faster than the repeat averaging filter because the unit does not have to refill the filter stack for each reading. Also, the number of readings averaged will affect reading speed; as the number of readings averaged increases, the reading speed decreases.

Figure 6-1
Moving average and repeating filters

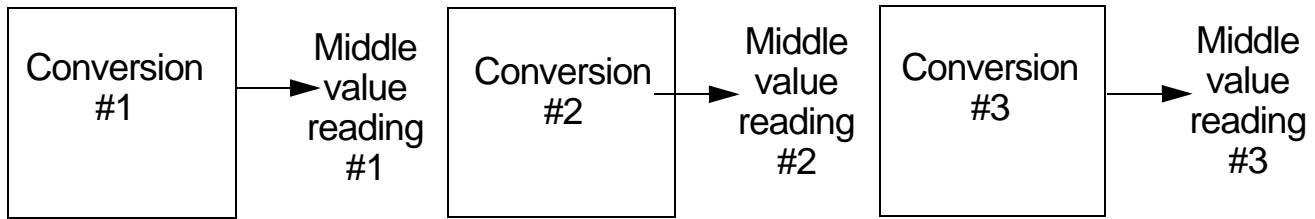


A. Type - Moving Average, Readings = 10



B. Type - Repeating, Readings = 10

Figure 6-2
Median Filter



C. Type - Median, Readings = 3

Remote filter programming

Filter commands

Table 6-6 summarizes filter commands. See [Section 19](#) for more details on commands.

Table 6-6

Filter commands

Commands*	Description
<code>smuX.measure.filter.count = count</code>	Set filter count (1 to 100).
<code>smuX.measure.filter.enable = smuX.FILTER_ON</code>	Enable filter.
<code>smuX.measure.filter.enable = smuX.FILTER_OFF</code>	Disable filter.
<code>smuX.measure.filter.type = smuX.FILTER_MEDIAN</code>	Select median filter type.
<code>smuX.measure.filter.type = smuX.FILTER_MOVING_AVG</code>	Select moving average filter type.
<code>smuX.measure.filter.type = smuX.FILTER_REPEAT_AVG</code>	Select repeat average filter type.

* smuX = smua for the Model 2601A/2611A/2635A; smuX = smua (Channel A) or smub (Channel B) for the Model 2602A/2612A/2636A.

Filter programming example

The example below programs filter aspects:

- Filter type: moving average
- Filter count: 10
- Filter state: enabled

```

--Program count to 10
smua.measure.filter.count = 10
--Moving average filter type.
smua.measure.filter.type = smua.FILTER_MOVING_AVG
--Enable filter.
smua.measure.filter.enable = smua.FILTER_ON
  
```


In this section:

Topic	Page
Reading buffer overview	7-2
Working with reading buffers in the local state	7-2
Reading buffer options.....	7-2
Configuring reading buffers	7-3
Appending or overwriting existing reading buffers.....	7-3
Storage operation	7-4
Saving reading buffers.....	7-4
Recalling readings	7-5
Working with reading buffers in the remote state	7-5
Reading buffer commands.....	7-7
Buffer status.....	7-9
Dynamic reading buffers.....	7-10
Buffer examples.....	7-10

Reading buffer overview

Reading buffers capture measurements, ranges, the instrument status, and the output state of the Keithley Instruments Series 2600A SourceMeter® instrument. The Series 2600A has two dedicated reading buffers per channel. You can use the dedicated reading buffers to acquire readings or you can use the ICL command to create dynamic reading buffers.

Each dedicated reading buffer in the Series 2600A can store over 60,000 readings with the time stamps and source values options enabled. Disable the time stamps and source values options to store over 140,000 readings internally.

You can save the dedicated reading buffers to internal nonvolatile memory in the instrument or to the USB flash drive.

Once you save the reading buffers to the USB flash drive, insert the USB flash drive into the USB port on your PC to view the data in any compatible data analysis application or transfer the data from the USB flash drive to your PC.

NOTE Reading buffers other than the dedicated reading buffers have fixed capacity and are not specifically limited to 60,000 or 140,000.

Working with reading buffers in the local state

Use this section to store and recall reading buffers while in local mode operation.

Reading buffer options

This section provides a description for the reading buffer options.

CHANA-BUFF: Configures Channel A buffer (Model 2602A/2612A/2636A only).

- **DEST:** Sets data storage destination (Buffer 1, Buffer 2, or NONE).
- **BUFFER1:** Configure Buffer 1.
 - **CLEAR:** Clear buffer (YES or NO).
 - **ELEMENTS:** Enable (ON) or disable (OFF) data storage elements; SRC-VAL (source value) or TSTAMP (time stamp).
 - **SRC-VAL:** Enable source values.
 - **TSTAMP:** Enable time stamps.
- **BUFFER2:** Configure Buffer 2.
 - **CLEAR:** Clear buffer (YES or NO).
 - **ELEMENTS:** Enable (ON) or disable (OFF) data storage elements; SRC-VAL (source value) or TSTAMP (time stamp).
 - **SRC-VAL:** Enable source values.
 - **TSTAMP:** Enable time stamps.

CHANB-BUFF: Configures Channel B buffer (Model 2602A/2612A/2636A only).

- **DEST:** Sets data storage destination (Buffer 1, Buffer 2, or NONE).
- **BUFFER1:** Configure Buffer 1.
 - **CLEAR:** Clear buffer (YES or NO).
 - **ELEMENTS:** Enable (ON) or disable (OFF) data storage elements; SRC-VAL (source value) or TSTAMP (time stamp).
 - **SRC-VAL:** Enable source values.
 - **TSTAMP:** Enable time stamps.

- **BUFFER2:** Configure Buffer 2.
 - **CLEAR:** Clear buffer (YES or NO).
 - **ELEMENTS:** Enable (ON) or disable (OFF) data storage elements; SRC-VAL (source value) or TSTAMP (time stamp).
 - **SRC-VAL:** Enable source values.
 - **TSTAMP:** Enable time stamps.

Configuring reading buffers

Complete the following steps to configure reading buffers from the front panel:

1. Press **CONFIG > STORE** and then choose one of the following:
 - **CHANA-BUFF**
 - **CHANB-BUFF**
2. Select the **DEST** option and then choose one of the following:
 - **CHANX-BUFF1**
 - **CHANX-BUFF2**
 - **NONE**
3. Select **BUFFER1** or **BUFFER2**.
4. (Optional) To clear the buffer, turn the **navigation wheel** to select **CLEAR > YES**.
5. Turn the **navigation wheel** to select **ELEMENTS**.

NOTE You must clear the reading buffer before you enable or disable the source value or the time stamp options.

6. (Optional) Push the **navigation wheel** to select **TSTAMP**, then select **OFF** or **ON**.
7. (Optional) Turn the **navigation wheel** to select **SRC-VAL**, then select **OFF** or **ON**.
8. Press the **EXIT** key to return to the main menu.

NOTE Model 2601A/2611A/2635A buffer configuration menu items are the same as covered above except for channel selection.

Appending or overwriting existing reading buffers

You can append or overwrite measurements to reading buffers with data.

Complete the following steps to configure the instrument to append or overwrite measurements the next time data is acquired:

1. Complete the steps from [Saving reading buffers](#).
2. Press **CONFIG > STORE** and then select **STORAGE-MODE**. The Storage Mode menu is shown.
3. Choose one of the following:
 - **APPEND**
 - **OVERWRITE**
4. Press **EXIT** to return to the main menu.

Storage operation

Use this option to initiate a storage operation and to configure the number of readings acquired during a store operation. The count can range from 1 to 60,000 with time stamps and source values enabled, to over 140,000 with time stamps and source values disabled.

NOTE To store the maximum number of readings in a reading buffer (over 140,000), disable the source values and time stamps for that reading buffer.

To configure the count, complete the following:

1. From the front panel, press **STORE** and then choose **TAKE_READINGS**.
2. Use the **navigation wheel** to select the number of readings.
3. Push the **navigation wheel** to switch to edit mode.
4. Use the **navigation wheel** to change the numeric value and then push the **navigation wheel** to save the numeric value.
5. Press **ENTER** to save the count.
6. Press the **Output On/Off** button to start taking readings. Note that if output-off mode is output zero it will start acquiring data immediately.

Saving reading buffers

You can save the dedicated reading buffers to nonvolatile memory or you can save them to a USB flash drive. Note that the unit will restore the dedicated reading buffers from internal nonvolatile memory when the unit is turned off and back on.

Saving the reading buffers to nonvolatile memory

After the measurements are complete, you can save the reading buffer data to the nonvolatile memory in the instrument.

To save the reading buffer data:

1. From the front panel, press **STORE** and then choose **SAVE**.
2. Select **INTERNAL** to save to internal nonvolatile memory.
3. Select one of the following:
 - **SMUA_BUFFER1**
 - **SMUA_BUFFER2**
 - **SMUB_BUFFER1**
 - **SMUB_BUFFER2**
4. The front panel displays Saving... This may take awhile.
5. Press the **EXIT** key to return to the main menu.

Saving the reading buffer to the USB flash drive

Complete the following steps to save the reading buffer data to a USB flash drive:

1. Insert the USB flash drive into the USB port.
2. Press **STORE** and use the **navigation wheel** to select **SAVE > USB1**.
3. Select one of the following file formats:
 - **CSV**
 - **XML**

4. Use the **navigation wheel** to select the desired reading buffer.
5. Use the **navigation wheel** to change the file name.
6. Push the **navigation wheel** or the **ENTER** key to save the file.
7. Push **EXIT** to return to the main menu.

Recalling readings

To recall the data stored in a reading buffer, press the **RECALL** key.

NOTE (Models 2601A/2611A/2635A) Pressing the **RECALL** key toggles between the two dedicated reading buffers for Channel A. (Models 2602A/2612A/2636A) Pressing the **RECALL** key cycles through the reading buffers for each channel. Channel A, Buffer 1 is always the first buffer displayed.

The reading display is on the top left, while the buffer location number is on the right. The source values are positioned at the lower left side of the display (if enabled), while the time stamp (if used) is positioned at the lower right side. When toggling between buffers with **RECALL**, the source display field will identify the buffer: SrcA1 (Buffer 1, Channel A), then SrcA2 (Buffer 2, Channel A); followed by (Model 2602A/2612A/2636A only) SrcB1 (Buffer 1, Channel B) then SrcB2 (Buffer 2, Channel B).

Buffer location number

The buffer location number indicates the memory location of the source-measure reading. For example, location #000001 indicates that the displayed source-measure reading is stored at the first memory location.

Time stamp

If the time stamp is enabled, the first source-measure reading stored in the buffer (#0000001) is time stamped at .000 seconds. Subsequent readings are time stamped relative to when the first measurement was made. The interval between readings will depend on the reading rate.

Displaying other buffer readings

Turn the **navigation wheel** to increment and decrement the selected digit of the location number by one. Press the **navigation wheel** or **CURSOR** keys to move to the next digit that the **navigation wheel** will change.

To exit from the reading buffer recall mode, press **EXIT**.

Working with reading buffers in the remote state

Readings can be obtained in multiple ways including synchronous or overlapped measurements. Routines that make single point measurements can be configured to make multiple measurements where one would ordinarily be made. The measured value is not the only component of a reading. The measurement status (for example, "In Compliance" or "Overranged") is also an element of data associated with a particular reading.

All routines that return measurements can return the measurements in the reading buffers. Overlapped measurements always return readings in a reading buffer. Synchronous measurement functions can return single-point measurement values or store multiple values in a reading buffer.

A reading buffer is based on a Lua table. The measurements are accessed by ordinary array accesses. If `rb` is a reading buffer, the first measurement is accessed as `rb[1]` and the 9th measurement as `rb[9]`, and so on. The additional information in the table is accessed as additional members of the table.

The load, save, and write operations for reading buffers function differently in the remote state. From a remote command interface, you can extract data from reading buffers as the instrument acquires the data.

Reading buffer designations

Each SMU contains two dedicated reading buffers:

- `smuX.nvbuffer1` (Buffer 1)
- `smuX.nvbuffer2` (Buffer 2)

[Table 7-1](#) provides an example the buffers available in the Series 2601A and the 2602A.

Table 7-1

SMU buffer example

Model	Reading buffers	Channel
2601A	<code>smua.nvbuffer1</code> <code>smua.nvbuffer2</code>	A
2602A	<code>smua.nvbuffer1</code> <code>smua.nvbuffer2</code>	A
	<code>smub.nvbuffer1</code> <code>smub.nvbuffer2</code>	B

To access the reading buffer, include the name of the SMU in the attribute. For example, the following command would store readings from Channel A into Buffer 1:

```
smua.measure.overlappedi(smua.nvbuffer1)
```

Buffer storage control attributes

[Table 7-3](#) displays the attributes for buffers. Read-only attributes used to access buffer parameters are listed in [Table 7-4](#). Control examples for Channel A, Buffer 1 are shown in [Table 7-5](#), while read-only attribute programming examples are listed in [Table 7-6](#).

NOTE You must clear the buffer using the `smuX.nvbufferY.clear()` command before changing buffer control attributes.

Reading buffer commands

Table 7-2 summarizes commands associated with the reading buffers. See [Section 19](#) for more detailed information on the commands for the reading buffers.

Table 7-2
Reading buffer commands

Command ¹	Description
<pre>smuX.savebuffer(smuX.nvbufferY) smuX.nvbuffer1.clear() smuX.nvbuffer2.clear() mybuffer = smuX.makebuffer(n) mybuffer = nil savebuffer(smuX.nvbuffer1, "csv", "/usb1/mybuffer.csv")</pre> <p>Commands to store readings:</p> <pre>smuX.measure.count = count smuX.measure.overlappedi(rbuffer) smuX.measure.overlappediv(ibuffer, vbuffer)</pre> <pre>smuX.measure.overlappedp(rbuffer) smuX.measure.overlappedr(rbuffer) smuX.measure.overlappedv(rbuffer)</pre> <pre>smuX.measure.v(rbuffer) smuX.measure.i(rbuffer) smuX.measure.r(rbuffer)</pre> <pre>smuX.measure.p(rbuffer)</pre> <pre>smuX.trigger.measure.v(rbuffer) smuX.trigger.measure.i(rbuffer) smuX.trigger.measure.r(rbuffer)</pre> <pre>smuX.trigger.measure.p(rbuffer) smuX.trigger.measure.iv(ibuffer, vbuffer)</pre> <p>Commands to access readings:</p> <pre>printbuffer(start_index, end_index, st_1 [, st_n])</pre>	<p>Saves the reading buffer to the Series 2600A. Clears Buffer 1. Clears Buffer 2. Creates a dynamically allocated buffer for n readings. Deletes dynamically allocated buffer. Saves the reading buffer to the USB flash drive.</p> <p>The number of measurements to acquire. Stores the current readings in buffer. Stores the current and voltage readings in respective buffers (current and voltage are stored in separate buffers). Stores the power readings in buffer. Stores the resistance readings in buffer. Stores the voltage readings in buffer.</p> <p>Reading buffer where voltage readings will be stored. Reading buffer where current readings will be stored. Reading buffer where resistance readings will be stored. Reading buffer where power readings will be stored.</p> <p>Reading buffer where voltage readings will be stored. Reading buffer where current readings will be stored. Reading buffer where resistance readings will be stored. Reading buffer where power readings will be stored. Stores the current and voltage readings in respective buffers (current and voltage are stored in separate buffers).</p> <p>Prints data from buffer subtables: start_index (Starting index of values to print). end_index (Ending index of values to print). st_1 ... st_n (Sub-tables from which to print).</p>

1. smuX = smua for the Model 2601A/2611A/2635A; smuX = smua (Channel A) or smub (Channel B) for the Model 2602A/2612A/2636A.

Table 7-3
Buffer storage control attributes

Storage attribute	Description
appendmode	The append modes are either off or on. When the append mode is off, a new measurement to this buffer will overwrite the previous contents. When the append mode is on, the first new measurement will be stored at what was formerly rb[n+1]. This attribute is initialized to off when the buffer is created.
collectsourcevalues	When this attribute is on, source values will be stored with readings in the buffer. This value, off or on, can only be changed when the buffer is empty. When the buffer is created, this attribute is initialized to off.
collecttimestamps	When this attribute is on, timestamps will be stored with readings in the buffer. This value, off or on, can only be changed when the buffer is empty. When the buffer is created, this attribute is initialized to off.
timestampresolution	The timestamp resolution, in seconds. When the buffer is created, its initial resolution is 0.000001 seconds. At this resolution, the reading buffer can store unique timestamps for up to 71 minutes. This value can be increased for very long tests. Note: The minimum resolution setting is 1µs (0.000001 seconds).

Table 7-4
Buffer read-only attributes

Storage attribute	Description
basetimestamp	The timestamp of when the reading at rb[1] was stored, in seconds from mid-night January 1, 1970 GMT, see page 19-14 for additional details.
capacity	The total number of readings that can be stored in the reading buffer.
n	The number of readings in the reading buffer.

Table 7-5
Buffer control programming examples

Command	Description
smua.nvbuffer1.collectsourcevalues = 1	Enable source value storage.
smua.nvbuffer1.appendmode = 1	Enable buffer append mode.
smua.nvbuffer1.collecttimestamps = 0	Disable timestamp storage.
smua.nvbuffer1.timestampresolution = 0.001	Set timestamp resolution to 0.001024s.

Table 7-6
Buffer read-only attribute programming examples

Command	Description
number = smua.nvbuffer1.n	Request number of readings in buffer.
buffer_size = smua.nvbuffer1.capacity	Request buffer size.

Reading buffer attributes

Use the reading buffer attributes to access the reading buffer data. [Table 7-7](#) displays the attributes that you can use to access the reading buffer data.

For example, the following would return 100 Channel A readings from Buffer 1:

```
printbuffer(1, 100, smua.nvbuffer1.readings)
```

Similarly, the following would return 100 Channel A source values from Buffer 1:

```
printbuffer(1, 100, smua.nvbuffer1.sourcevalues)
```


Note that `readings` is the default reading attribute and can be omitted. Thus, the following would also return 100 Channel A readings from Buffer 1:

```
printbuffer(1, 100, smua.nvbuffer1)
```

Table 7-7

Recall attributes

Recall attribute ¹	Description
<code>measurefunctions</code>	An array (a Lua table) of strings indicating the function measured for the reading (Current, Voltage, Ohms or Watts).
<code>measureranges</code>	An array (a Lua table) of full-scale range values for the measure range used when the measurement was made.
<code>readings</code>	An array (a Lua table) of the readings stored in the reading buffer. This array holds the same data that is returned when the reading buffer is accessed directly, i.e., <code>rb[2]</code> and <code>rb.readings[2]</code> are the same value.
<code>sourcefunctions</code>	An array (a Lua table) of strings indicating the source function at the time of the measurement (Current or Voltage).
<code>sourceoutputstates</code>	An array (a Lua table) of strings indicating the state of the source (Off or On).
<code>sourceranges</code>	An array (a Lua table) of full-scale range values for the source range used when the measurement was made.
<code>sourcevalues</code>	If enabled, an array (a Lua table) of the sourced values in effect at the time of the reading.
<code>statuses</code>	An array (a Lua table) of status values for all of the readings in the buffer. The status values are floating-point numbers that encode the status value into a floating-point value (see Table 7-8).
<code>timestamps</code>	An array (a Lua table) of time stamps, in seconds, of when each reading occurred. These are relative to the <code>basetime</code> stamp for the buffer (Table 7-4).

1. The default attribute is `readings` and can be omitted. For example, `smua.nvbuffer1` and `smua.nvbuffer1.readings` will both return readings from Channel A, Buffer 1.

Buffer status

The buffer reading status attribute can include the status information as a numeric value shown in [Table 7-8](#). For example to access status information for second element use the following command:

```
stat_info = smua.nvbuffer1.statuses[2]
```

Table 7-8

Buffer status bits

Bit	Name	Hex value	Description
B0	TBD	0x01	Reserved for future use.
B1	Overtemp	0x02	Over temperature condition.
B2	AutoRangeMeas	0x04	Measure range was auto ranged.
B3	AutoRangeSrc	0x08	Source range was auto ranged.
B4	4Wire	0x10	4W (remote) sense mode enabled.
B5	Rel	0x20	Rel applied to reading.
B6	Compliance	0x40	Source function in compliance.
B7	Filtered	0x80	Reading was filtered.

Dynamic reading buffers

Reading buffers can also be allocated dynamically. Dynamic reading buffers are created and allocated with the `smuX.makebuffer(n)` command, where `n` is the number of readings the buffer can store. For example, the following command allocates a Channel A reading buffer named `mybuffer` that can store 100 readings:

```
mybuffer = smua.makebuffer(100)
```

Allocated reading buffers can be deleted as follows:

```
mybuffer = nil
```

Dynamically allocated reading buffers can be used interchangeably with the `smuX.nvbufferY` buffers that are described in [Reading buffer designations](#).

Buffer examples

Defined buffer example

The listing below shows a programming example for storing data using the pre-defined Buffer 1 for Channel A. The Series 2600A loops for voltages from 0.01V to 1V with 0.01V steps (essentially performing a staircase sweep), stores 100 current readings and source values in Buffer 1, and then recalls all 100 readings and source values.

```
-- Restore Series 2600A defaults.
smua.reset()
-- Select Channel A display.
display.screen = 0
-- Display current.
display.smua.measure.func = display.MEASURE_DCAMPS
-- Select measure I auto range.
smua.measure.autorangei = smua.AUTORANGE_ON
-- Select ASCII data format.
format.data = format.ASCII
-- Clear Buffer 1.
smua.nvbuffer1.clear()
-- Enable append buffer mode.
smua.nvbuffer1.appendmode = 1
-- Enable source value storage.
smua.nvbuffer1.collectsourcevalues = 1
-- Set count to 1.
smua.measure.count = 1
-- Select source voltage function.
smua.source.func = smua.OUTPUT_DCVOLTS
-- Set bias voltage to 0V.
smua.source.levelv = 0.0
-- Turn on output.
smua.source.output =smua.OUTPUT_ON
-- Loop for voltages from 0.01 V to 1 V.
for v = 0.01, 1.0, 0.01 do
  -- Set source voltage
  smua.source.levelv = v
  -- Measure current, store in buffer.
  smua.measure.i(smua.nvbuffer1)
  --Wait for reading to complete.
  waitcomplete()
end
-- Turn off output.
smua.source.output =smua.OUTPUT_OFF
-- Return readings 1-100.
printbuffer(1, 100, smua.nvbuffer1.readings)
```

```
-- Return source values 1-100.  
printbuffer(1, 100, smua.nvbuffer1.sourcevalues)
```

Dual buffer example

The listing below shows a programming example for storing both current and voltage readings using Buffer 1 for current and Buffer 2 to store voltage readings. The Series 2600A stores 100 current and voltage readings and then recalls all 100 sets of readings.

```
-- Restore Series 2600A defaults.  
smua.reset()  
-- Select measure I auto range.  
smua.measure.autorangei = smua.AUTORANGE_ON  
-- Select measure V auto range.  
smua.measure.autorangev = smua.AUTORANGE_ON  
--Select ASCII data format.  
format.data = format.ASCII  
-- Clear buffer 1.  
smua.nvbuffer1.clear()  
-- Clear buffer 2.  
smua.nvbuffer2.clear()  
-- Set buffer count to 100.  
smua.measure.count = 100  
--Set measure interval to 0.1s.  
smua.measure.interval = 0.1  
-- Select source voltage function.  
smua.source.func = smua.OUTPUT_DCVOLTS  
-- Output 1 V.  
smua.source.levelv = 1  
-- Turn on output.  
smua.source.output = smua.OUTPUT_ON  
-- Store current readings in buffer 1, current readings in  
-- buffer 2.  
smua.measure.overlappediv(smua.nvbuffer1, smua.nvbuffer2)  
-- Wait for buffer to fill.  
waitcomplete()  
-- Turn off output.  
smua.source.output =smua.OUTPUT_OFF  
-- Return buffer 1 readings 1-100.  
printbuffer(1, 100, smua.nvbuffer1)  
-- Return buffer 2 readings 1-100.  
printbuffer(1, 100, smua.nvbuffer2)
```

Dynamically allocated buffer example

The listing below shows a programming example for storing data using an allocated buffer called mybuffer for Channel A. The Series 2600A stores 100 current readings in mybuffer and then recalls all the readings.

```
-- Restore Series 2600A defaults.
smua.reset()
-- Select measure I auto range.
smua.measure.autorangei = smua.AUTORANGE_ON
-- Select measure V auto range.
smua.measure.autorangev = smua.AUTORANGE_ON
-- Select ASCII data format.
format.data = format.ASCII
-- Set buffer count to 100.
smua.measure.count = 100
--Set measure interval to 0.1 s.
smua.measure.interval = 0.1
-- Select source voltage function.
smua.source.func = smua.OUTPUT_DCVOLTS
-- Output 1 V.
smua.source.levelv = 1
-- Turn on output.
smua.source.output = smua.OUTPUT_ON
-- Store current readings in mybuffer.
smua.measure.overlappedi(mybuffer)
-- Wait for buffer to fill.
waitcomplete()
-- Turn off output.
smua.source.output = smua.OUTPUT_OFF
-- Return 1 readings 1-100 from mybuffer.
printbuffer(1, 100, mybuffer)
-- Delete mybuffer.
mybuffer = nil
```

In this section:

Topic	Page
Digital I/O port	8-1
Port configuration.....	8-2
Digital I/O configuration	8-3
Controlling digital I/O lines	8-4
Output enable (Models 2601A/2602A)	8-5
Overview	8-5
Operation	8-6
Front panel control of output enable	8-6
Remote control of output enable.....	8-7
Interlock (Models 2612A/2612A/2635A/2636A)	8-8
Overview	8-8
Operation	8-8
Legacy mode	8-7
Overview	8-7
Features of legacy mode	8-7
Enable or disable legacy mode.....	8-8
TSP-Link synchronization lines	8-9
Connecting to TSP-Link.....	8-9
Using TSP-Link synchronization lines for digital I/O	8-9
Remote TSP-Link synchronization line commands	8-10

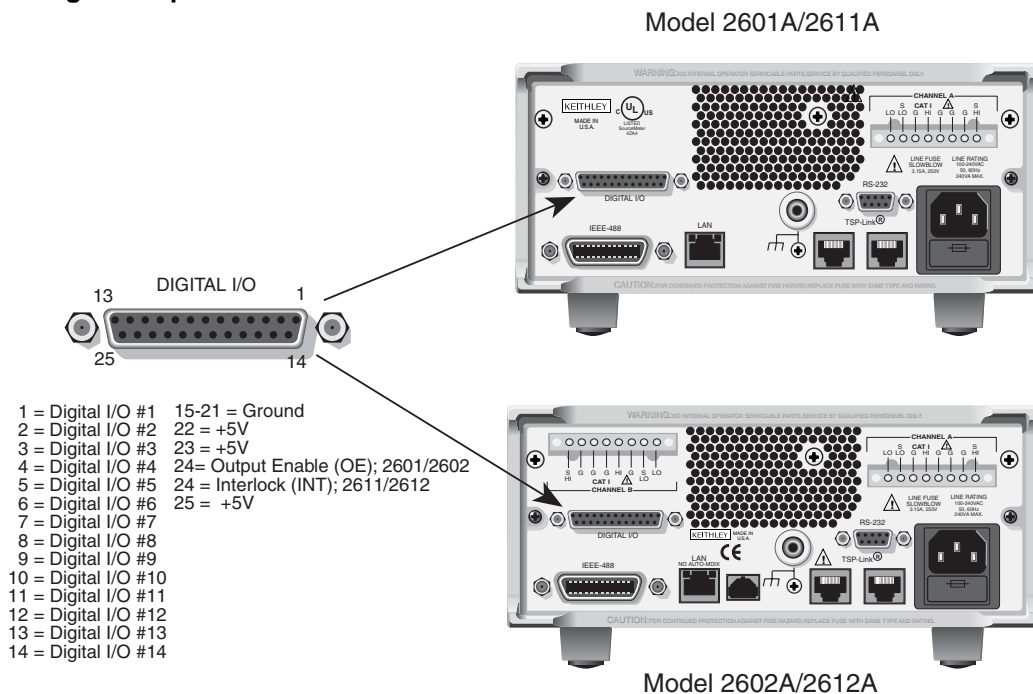
Digital I/O port

The Keithley Instruments Series 2600A System SourceMeter® instrument has a digital input/output port that can be used to control external digital circuitry. For example, a handler that is used to perform binning operations can be used with a digital I/O port.

Port configuration

The digital I/O port is located on the rear panel and is shown in [Figure 8-1](#). Note that a standard female DB-25 connector is used with the digital I/O port.

Figure 8-1
Digital I/O port



Connecting cables

Use a cable equipped with a male DB-25 connector (Keithley Instruments part number CA-126-1), or a Model 2600-TLINK cable to connect the digital I/O port to other Keithley Instruments models equipped with a Trigger Link (TLINK).

Digital I/O lines

The port provides 14 digital I/O lines. Each output is set high (+5V) or low (0V) and can read high or low logic levels. Each digital I/O line is an open-drain signal.

+5V output

The digital I/O port provides a +5V output that is used to drive external logic circuitry. Maximum current output for this line is 600mA. This line is protected by a self-resetting fuse (one hour recovery time).

Output enable and interlock line

The Model 2601A/2602A output enable (OE) line and the Model 2611A/2612A/2635A/2636A interlock (INT) line of the digital I/O can be used with a switch in the test fixture or component handler. With proper use, power is removed from the DUT when the lid of the fixture is opened. See [Output enable \(Models 2601A/2602A\)](#) or [Interlock \(Models 2612A/2612A/2635A/2636A\)](#) for more details.

WARNING *The digital I/O port of the Model 2601A/2602A is not suitable for control of safety circuits and should not be used to control a safety interlock. When an interlock is required for safety, a separate circuit should be provided that meets the requirements of the application to reliably protect the operator from exposed voltages.*

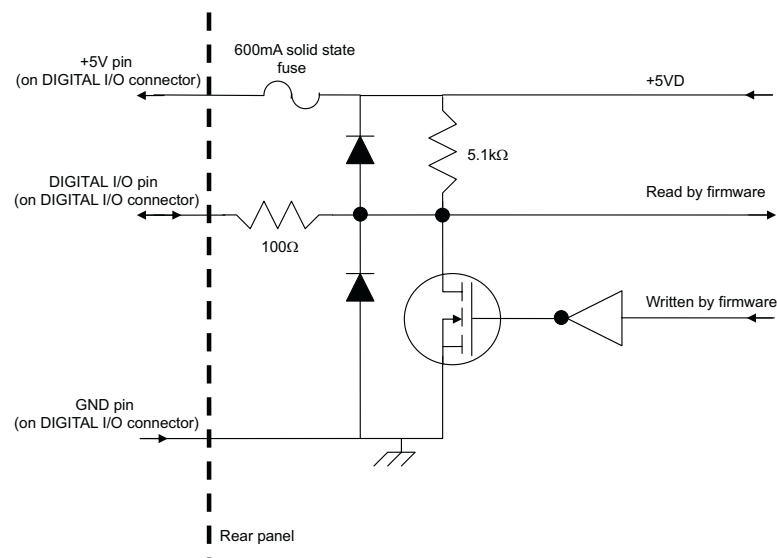
Model 2611A/2612A/2635A/2636A digital I/O ports include an interlock line that may be used as safety interlock.

Digital I/O configuration

Figure 8-2 shows the basic configuration of the digital I/O port. Writing a 1 to a line sets that line high (~ +5V). Writing a 0 to a line sets that line low (~0V). Note that an external device pulls an I/O line low by shorting it to ground, so that a device must be able to sink at least 480 μ A per I/O line.

Figure 8-2
Digital I/O port configuration

DIGITAL I/O INTERFACE (All Series 2600A Models):
 Connector: 25-pin female D
 Input/Output pins: 14 open-drain I/O bits
 Absolute maximum input voltage: 5.25V
 Absolute minimum input voltage: -0.25V
 Maximum logic low input voltage: 0.7V @ +850 μ A
 Minimum logic high input voltage: 2.1V @ +570 μ A
 Maximum source current (flowing out of digital I/O bit): +960 μ A
 Absolute Maximum sink current (flowing into digital I/O bit): -11.0A
 Maximum Sink Current @ Maximum Logic Low Voltage (0.7V): -5.0mA.



Controlling digital I/O lines

Although the digital I/O lines are primarily intended for use with a device handler for limit testing, they can also be used for other purposes such as controlling external logic circuits. You can control lines either from the front panel or via remote interface.

NOTE The trigger mode for the line must be set to `digio.TRIG_BYPASS` in order to use the line for digital I/O. See [Section 10](#) for more information.

Digital I/O bit weighting

Bit weighting for the digital I/O lines is shown in [Table 8-1](#).

Table 8-1

Digital bit weight

Line #	Bit	Decimal weighting	Hexadecimal weighting
1	B1	1	0x0001
2	B2	2	0x0002
3	B3	4	0x0004
4	B4	8	0x0008
5	B5	16	0x0010
6	B6	32	0x0020
7	B7	64	0x0040
8	B8	128	0x0080
9	B9	256	0x0100
10	B10	512	0x0200
11	B11	1024	0x0400
12	B12	2048	0x0800
13	B13	4096	0x1000
14	B14	8192	0x2000

Setting digital I/O values

To set digital I/O values:

1. Press the **MENU** key, select **DIGOUT**, and then press the **ENTER** key or push the **navigation wheel**.
2. Select **DIG-IO-OUTPUT**, and then press the **ENTER** key or the **navigation wheel**.
3. Set the decimal value as required to set digital I/O line(s) within the range of 0 to 16,383 (see [Table 8-1](#)), then press the **ENTER** key or the **navigation wheel**.
4. Press **EXIT** as needed to return to the normal.

Write protecting digital I/O lines

You can also write protect specific digital I/O lines to prevent their values from being changed:

1. Press **MENU > DIGOUT** and then press the **ENTER** key or the **navigation wheel**.
2. Select **WRITE-PROTECT**, then press the **ENTER** key or the **navigation wheel**.
3. Set the decimal value as required to write protect digital I/O line(s) within the range of 0 to 16,383 (see [Table 8-1](#)), then press the **ENTER** key or the **navigation wheel**.
4. Press **EXIT** as needed to return to the normal display.
5. To remove write protection, repeat Step 1 through Step 4 and then enter the original value.

Remote digital I/O commands

Commands that control and access the digital I/O port are summarized in [Table 8-2](#). See [Section 19](#) for complete details on these commands. See [Table 8-1](#) for decimal and hexadecimal values used to control and access the digital I/O port and individual lines. Use these commands to trigger the Series 2600A using external trigger pulses applied to the digital I/O port, or to provide trigger pulses to external devices.

Use these commands to perform basic steady-state digital I/O operations such as reading and writing to individual I/O lines or reading and writing to the entire port.

NOTE The digital I/O lines can be used for both input and output. You must write a 1 to all digital I/O lines that are to be used as inputs.

Table 8-2

Remote digital I/O commands

Command	Description
<code>digio.readbit(bit)</code>	Read one digital I/O input line
<code>digio.readport()</code>	Read digital I/O port
<code>digio.writebit(bit, data)</code>	Write data to one digital I/O output line
<code>digio.writeport(data)</code>	Write data to digital I/O port
<code>digio.writeprotect = mask</code>	Write protect mask to digital I/O port

Digital I/O programming example

The commands below set bit 1 of the digital I/O port high, and then read the entire port value.

```
digio.trigger[1].mode = digio.TRIG_BYPASS
```

```
-- Set bit 1 high.
digio.writebit(1,1)
```

```
-- Read digital I/O port.
data = digio.readport()
```

Output enable (Models 2601A/2602A)

Overview

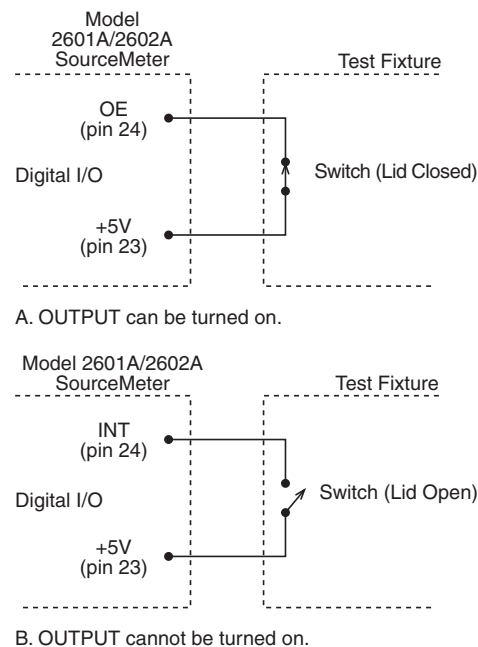
The Model 2601A/2602A digital I/O port provides an output enable line for use with a test fixture switch. When properly used, the output of the SourceMeter instrument will turn OFF when the lid of the test fixture is opened. See [Section 2](#) for important safety information when using a test fixture.

WARNING *When an interlock is required for safety, a separate circuit should be provided that meets the requirements of the application to reliably protect the operator from exposed voltages. The digital I/O port of the Model 2601A or 2602A is not suitable for control of safety circuits and should not be used to control a safety interlock.*

Operation

When enabled, the output of the Model 2601A or 2602A can only be turned on when the output enable line is pulled high through a switch to +5V, as shown in [Figure 8-3](#). If the lid of the test fixture opens (see [Figure 8-4](#)), the switch opens, and the output enable line goes low, turning the output of the SourceMeter instrument off. The output will not be automatically turned on when output enable is set high. The output cannot be turned back on until +5V is applied to the output enable line.

Figure 8-3
Using Model 2601A/2602A output enable



Front panel control of output enable

To activate the output enable line:

1. Press the **CONFIG** key followed by the **OUTPUT** key.
2. Choose **DIO-CONTROL**, then press the **ENTER** key or the **navigation wheel**.
3. Select **OE_OUTPUT_OFF** to activate the output enable signal causing the SMU output to be blocked if the output enable is not asserted (connect to +5V). Select **NONE** to deactivate the output enable signal so that its state has no effect on the SMU output.
4. Press **EXIT** as needed to return to the normal display.

Remote control of output enable

Use one of these commands to control output enable action:

```
smuX.source.outputenableaction = smuX.OE_NONE  
smuX.source.outputenableaction = smuX.OE_OUTPUT_OFF
```

When set to `smuX.OE_NONE`, the Model 2601A/2602A does not take action when the output enable line is low. When set to `smuX.OE_OUTPUT_OFF`, the SourceMeter instrument will turn its output off as if the `smuX.source.output = smuX.OUTPUT_OFF` command had been received. The SourceMeter instrument will not automatically turn its output on when the output enable line returns to the high state. For example, the following command activates the output enable for Channel A:

```
smua.source.outputenableaction = smua.OE_OUTPUT_OFF
```

Legacy mode

Overview

WARNING *Do not use legacy mode unless advised by Keithley Instruments as some of the advanced digital I/O features of your Series 2600A will become unavailable.*

Legacy mode is for customers that require digital I/O compatibility with original Series 2600 instruments. This feature was added in revision 2.1.4 of the firmware, please refer to the firmware release notes. This mode is disabled by default; entering legacy mode changes the way digital I/O works and should not be done without understanding the full ramifications of this configuration change.

When legacy mode is enabled, the Series 2600A instruments will display the following message at power-on:

```
LEGACY DIGITAL I/O  
Advanced DIGIO features DISABLED
```

Features of legacy mode

The differences between the Series 2600A default digital I/O functionality and legacy mode are:

- When legacy mode is enabled, the default trigger mode for all lines is `TRIG_FALLING`. When legacy mode is disabled, the default trigger mode for all lines is `TRIG_BYPASS`.
- When legacy mode is enabled, all digital I/O pulsing operations are blocking, meaning that script execution is held up at the digital I/O pulsing commands. When legacy mode is disabled, all digital I/O pulsing operations are non-blocking.
- When legacy mode is enabled, the `digio.writebit` and `digio.writeport` operations are functional in all trigger modes. When legacy mode is disabled, the `digio.writebit` and `digio.writeport` operations are only functional in `TRIG_BYPASS` trigger mode.
- When legacy mode is enabled, attempting to set the stimulus of a digital I/O line fails, resulting in error 1803, "Feature not supported in legacy digital I/O mode". When legacy mode is disabled, attempting to set the stimulus succeeds.

Enable or disable legacy mode

To change the legacy mode setting:

1. Press **MENU** button
2. Under **MAIN MENU**, select **DIGOUT**
3. Under **DIGITAL I/O**, select **LEGACY-MODE**
4. Under **LEGACY DIGITAL I/O**, select **ON** to enable legacy mode or **OFF** to disable it
5. Under **REQUIRES REBOOT**, select **REBOOT**

Interlock (Models 2612A/2612A/2635A/2636A)

Overview

The Model 2611A/261A2/2635A/2636A digital I/O port provides an interlock line for use with a test fixture switch. When properly used, the output of the SourceMeter instrument will turn OFF when the lid of the test fixture is opened. See [Section 2](#) for important safety information when using a test fixture.

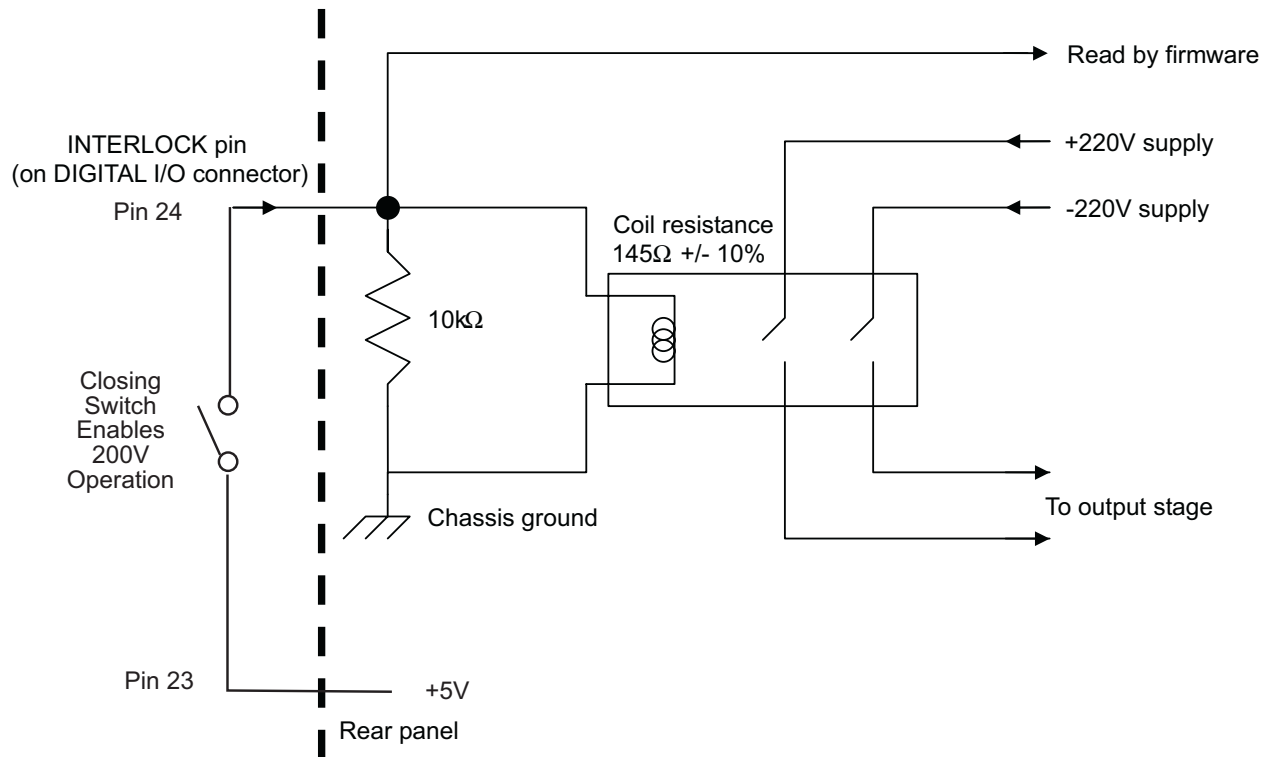
CAUTION If the interlock line is switched excessively (more than 10,000 times), its reliability may be reduced. Where the interlock is used for safety, it should be serviced regularly to ensure proper operation.

Operation

When on the 200V source range, the output of the Model 2611A/2612A/2635A/2636A can only be turned on when the interlock line is pulled high through a switch to +5V, as shown in [Figure 8-4](#). If the lid of the test fixture opens, the switch opens, and the interlock line goes low, turning the output of the Model 2611A/2612A/2635A/2636A off. The output will not be automatically turned on when the interlock line is set high. The output cannot be turned back on until the interlock line is set high.

A signal of > 3.4V at 24mA (at an absolute maximum of 6V) must be externally applied to this pin to ensure 200V operation. This signal is pulled down to chassis ground with a 10kΩ resistor. 200V operation will be blocked when the INTERLOCK signal is < 0.4V (an absolute minimum of -0.4V).

Figure 8-4

Using Model 2611A/2612A/2635A/2636A interlock

TSP-Link synchronization lines

The Series 2600A has three synchronization lines that you can use for triggering, digital I/O, and to synchronize multiple instruments on a TSP-Link network.

Connecting to TSP-Link

The TSP-Link synchronization lines are built into TSP-Link. Use the TSP-Link connectors located on the back of the Series 2600A. If you use the TSP-Link network, you do not have to modify your connections. See [System Expansion \(TSP-Link\)](#) for detailed information about connecting to TSP-Link.

Using TSP-Link synchronization lines for digital I/O

Each synchronization line is an open-drain signal. When using the TSP-Link synchronization lines for digital I/O, any node that sets the programmed line state to 0 (zero) causes all nodes to read 0 from the line state. This occurs regardless of the programmed line state of any other node.

Digital I/O bit weighting

Table 8-3 displays the bit weighting for the digital I/O lines.

Table 8-3

Digital I/O bit weight.

Line #	Bit	Decimal weighting	Hexadecimal weighting
1	B1	1	0x0001
2	B2	2	0x0002
3	B3	4	0x0004

Remote TSP-Link synchronization line commands

Commands that control and access the TSP-Link synchronization port are summarized in Table 8-4. See Section 19 for complete details on these commands. See Table 8-3 for the decimal and hexadecimal values used to control and access the digital I/O port and individual lines.

Use the commands in Table 8-4 to perform basic steady-state digital I/O operations, for example, you can program the Series 2600A to read and write to a specific TSP-Link synchronization line or to the entire port.

NOTE The TSP-Link synchronization lines can be used for both input and output. You must write a 1 to all TSP-Link synchronization lines that are used as inputs.

Table 8-4

Remote synchronization line commands

Command	Description
<code>tsplink.readbit(bit)</code>	Reads one digital I/O input line
<code>tsplink.readport()</code>	Read the digital I/O port
<code>tsplink.writebit(bit, data)</code>	Writes data to one digital I/O line
<code>tsplink.writeport(data)</code>	Writes data to the digital I/O port
<code>tsplink.writeprotect = mask</code>	Write protect mask to the digital I/O port

Programming example

The commands below set bit 1 of the I/O port high, and then read the entire port value.

```
tsplink.trigger[1].mode = tsplink.TRIG_BYPASS
```

```
-- Set bit 1 high.
tsplink.writebit(1,1)
```

```
-- Read I/O port.
data = tsplink.readport()
```

In this section:

Topic	Page
Overview	9-1
Section overview	9-2
Sweep overview	9-2
Sweep characteristics	9-3
Linear staircase sweeps	9-3
Logarithmic staircase sweeps.....	9-5
List sweeps	9-8
Pulse mode sweeps.....	9-9
Configuring and running sweeps	9-10
Configuring other sweep attributes	9-10
Configuring measurements during a sweep	9-11
Source and measurement delays	9-11
Initiating and running sweeps	9-11
Aborting a sweep	9-11
Sweeping using factory scripts	9-12
Front panel.....	9-12
Sweep programming examples	9-12
List sweep example	9-13

Overview

Section overview

Following a brief overview of the types of sweeps (linear staircase, logarithmic staircase, and list), the documentation in this section provides detailed information on characteristics, commands, and programming for each type of sweep.

Sweep overview

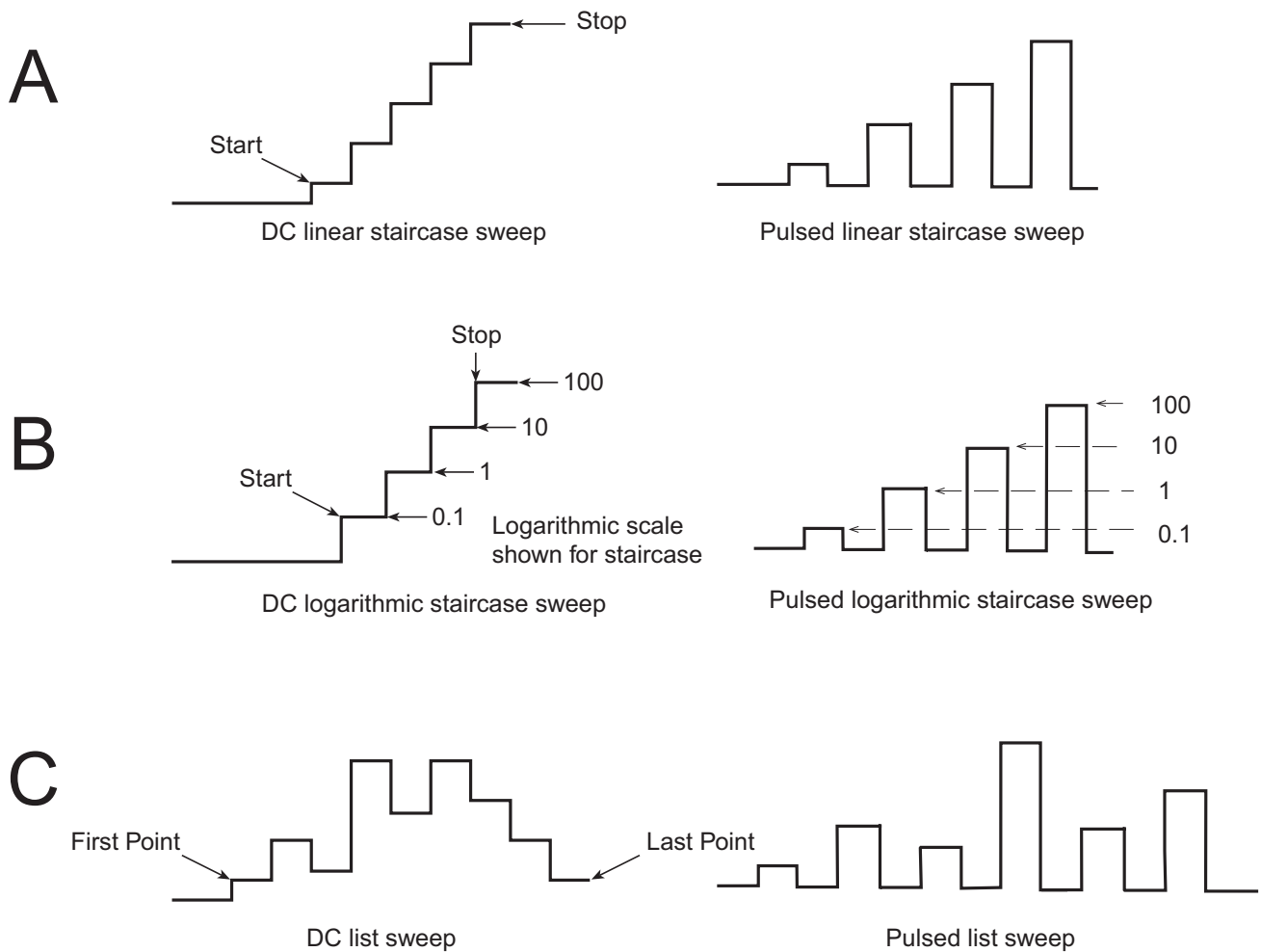
As shown in [Figure 9-1](#), the Keithley Instruments Series 2600A System SourceMeter® instrument can generate DC and pulsed sweeps to perform source-only sweeps, source-and-measure sweeps, or measure-only sweeps. The following sweeps can be programmed:

DC and pulsed linear staircase sweeps: With these sweeps, the voltage or current increases or decreases in specific steps, beginning with a start voltage or current and ending with a stop voltage or current. [Figure 9-1A](#) shows an increasing linear staircase sweep and a pulsed staircase sweep. Pulsed linear staircase sweeps function the same way as DC linear staircase sweeps except they return to the idle level between pulses.

DC and pulsed logarithmic staircase sweeps: In this case, the current or voltage increases or decreases geometrically, beginning with a start voltage or current and ending with a stop voltage or current. [Figure 9-1B](#) shows an increasing logarithmic staircase sweep and a pulsed logarithmic staircase sweep. Pulsed logarithmic staircase sweeps function the same way as DC logarithmic staircase sweeps except they return to the idle level between pulses.

DC and pulsed list sweeps: The list sweep allows you to program arbitrary sweep steps anywhere within the output voltage or current range of the Series 2600A. [Figure 9-1C](#) shows a list sweep with arbitrary steps and a pulsed list sweep. Pulsed list sweeps function the same way as DC list sweeps except they return to the idle level between pulses.

Figure 9-1
Sweep types



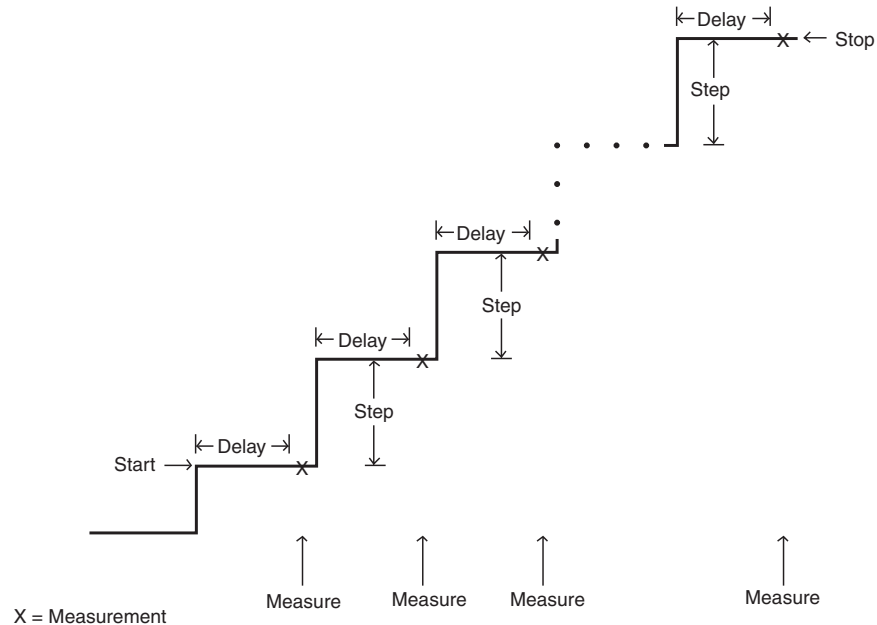
Sweep characteristics

NOTE For any of the sweep types, program a pulse mode sweep by configuring the end pulse action. Refer to [Pulse mode sweeps](#) for more information.

Linear staircase sweeps

As shown in [Figure 9-2](#), this sweep type steps from a start voltage or current value to an ending (stop) value. A measurement is made at each point after source and measurement settling time.

Figure 9-2
Linear staircase sweep



A linear staircase sweep is configured using a start level, a stop level, and the total number of points, including the start and stop points. The step size is determined by the start and stop levels, and the number of sweep points:

$$\text{step} = (\text{stop} - \text{start}) / (\text{points} - 1)$$

NOTE The number of sweep steps actually performed is determined by the trigger count. Refer to [Section 10](#) for more information.

The sweep can be either positive-going or negative-going, depending on the relative values of the start and stop parameters. When the sweep starts, the output will go to the start source level. The output will then change in equal steps until the stop level is reached. If the trigger count is greater than the number of points specified, the SMU will start over at the beginning value.

To configure a linear staircase sweep, use the following function:

```
smuX.trigger.source.linearY
```

This function configures the source values the SMU will output when performing a linear sweep. After configuring the sweep you must also enable the source action by setting the following attribute:

```
smuX.trigger.source.action
```

Example:

```
-- Sweep from 0 to 10V in 1V steps.
smua.trigger.source.linearv(0, 10, 11)
-- Enable the source action.
smua.trigger.source.action = smua.ENABLE
```

For more information, see [smuX.trigger.source.linearY](#).

Logarithmic staircase sweeps

This sweep is similar to the linear staircase sweep. The steps, however, are done on a logarithmic scale. [Figure 9-3](#) and [Figure 9-4](#) show sample sweeps.

Like a linear staircase sweep, logarithmic sweeps are configured using a start level, a stop level and the number of points in between. The step size is determined by the start and stop levels, and the number of sweep points. However, in a logarithmic sweep, the step size increases or decreases exponentially. To create an increasing logarithmic sweep, set the stop value to be greater than the start value. To create a decreasing logarithmic sweep, set the stop value to be less than the start value. A measurement is made at each step after source and measurement settling time.

NOTE The number of sweep steps actually performed is determined by the trigger count. See [Section 10](#) for more information.

The formula for a log sweep is:

$$v_i = A + kb^i$$

Where: v is the source value at source point i .

i ranges from 0 to $N-1$.

N is the number of points in the sweep.

k is the initial source value as an offset from the asymptote.

b is the step size ratio.

A is the asymptote value.

The asymptote is used to change the inflection of the sweep curve and allow it to sweep through zero. [Figure 9-3](#) and [Figure 9-4](#) depict the effect of the asymptote on the inflection of the sweep curve.

Figure 9-3
Increasing logarithmic sweep

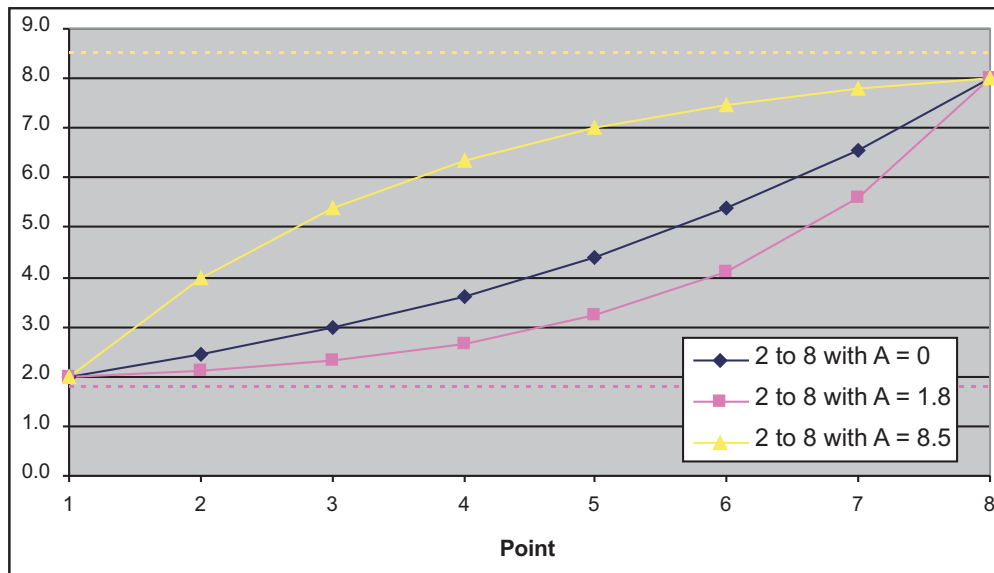
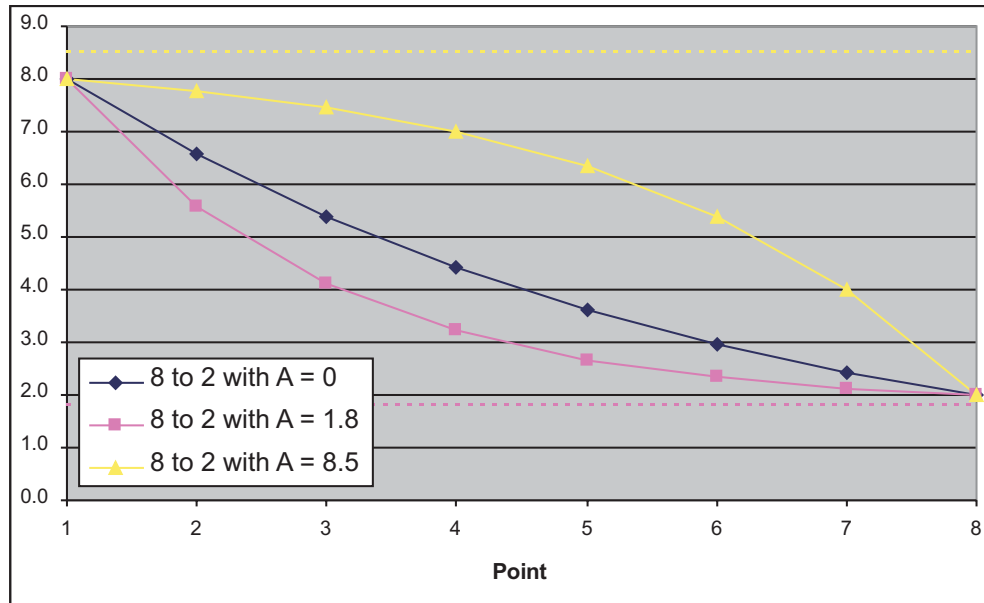


Figure 9-4
Decreasing logarithmic sweep



Solving for k and b provides the following formulas:

$$k = V_{start} - A$$

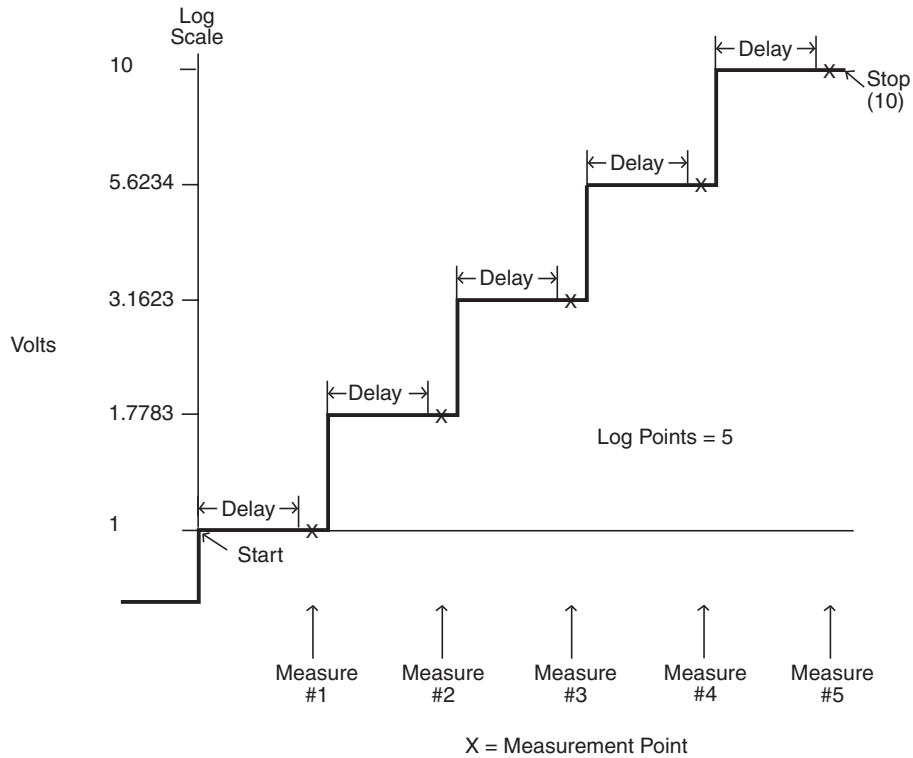
$$b = 10^{\left(\frac{\log_{10}(V_{end} - A) - \log_{10}(V_{start} - A)}{N - 1} \right)}$$

Where: V_{end} is the source value at the end point.
 V_{start} is the source value at the start point.
 N is the number of points in the sweep.
 A is the asymptote value.

NOTE The number of points in a sweep is one greater than the number of steps in the sweep.

Figure 9-5 is an example of a 5-point log sweep from 1V to 10V.

Figure 9-5
Logarithmic staircase sweep (1V to 10V, five steps)



In this example:

$$A = 0, V_{start} = 1, V_{end} = 10, N = 5$$

Using the formula above $k = 1$

Step size (b) for the sweep in [Figure 9-5](#) is calculated as follows:

$$\left(\begin{aligned} \text{Log Step Size} &= \frac{\log_{10}(\text{stop}-0) - \log_{10}(\text{start}-0)}{\text{Points} - 1} \\ &= \frac{\log_{10}(10) - \log_{10}(1)}{5 - 1} \\ &= \frac{(1 - 0)}{4} \\ &= 0.25 \end{aligned} \right)$$

Therefore, $b = 10^{(\log \text{ step size})} = 1.7783$

The five log steps for this sweep are listed in [Table 9-1](#).

Table 9-1
Logarithmic sweep points

Measure point (<i>N</i>)	Source level (<i>V</i>)	Step number (<i>i</i>)
Point 1	1	0
Point 2	1.7783	1
Point 3	3.1623	2
Point 4	5.6234	3
Point 5	10	4

When this sweep starts, the output will go to the start level (1V) and sweep through the symmetrical log points.

To configure a logarithmic staircase sweep, use the following function:

```
smuX.trigger.source.logY
```

This function configures the source values the SMU will output when performing a logarithmic sweep. After configuring the sweep you must also enable the source action by setting the following attribute:

```
smuX.trigger.source.action
```

Example:

```
-- Sweep from 1 to 10V in 10 steps with an asymptote of 0V.
smua.trigger.source.logv(1, 10, 11, 0)
-- Enable the source action.
smua.trigger.source.action = smua.ENABLE
```

For more information, see [smuX.trigger.source.logY](#).

List sweeps

Use a list sweep to configure a sweep with arbitrary steps. A measurement is made at each point after source and measurement settling time.

To configure a list sweep, use the following function:

```
smuX.trigger.source.listY
```

This function configures the source values the SMU will output when performing a list sweep. After configuring the sweep you must also enable the source action by setting the following attribute:

```
smuX.trigger.source.action
```

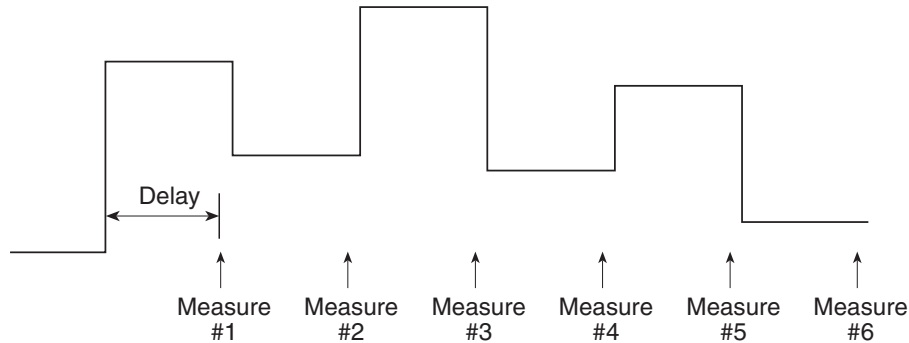
Example:

```
-- Sweep through 3V, 1V, 4V, 5V, and 2V.
smua.trigger.source.listv({3, 1, 4, 5, 2})
-- Enable the source action.
smua.trigger.source.action = smua.ENABLE
```

When the sweep is started, the output level goes to the first point in the sweep. The sweep will continue through the steps in the order they were programmed.

[Figure 9-6](#) shows a different example of a list sweep with six measurement points. When the sweep starts, the current or voltage goes to the first point in the sweep. The unit cycles through the sweep points in the programmed order.

Figure 9-6
List sweep example



Pulse mode sweeps

A pulse mode sweep can be created for any of the sweep types by configuring the end pulse action. To configure a pulse mode sweep, use:

```
smuX.trigger.endpulse.action = smuX.SOURCE_IDLE
```

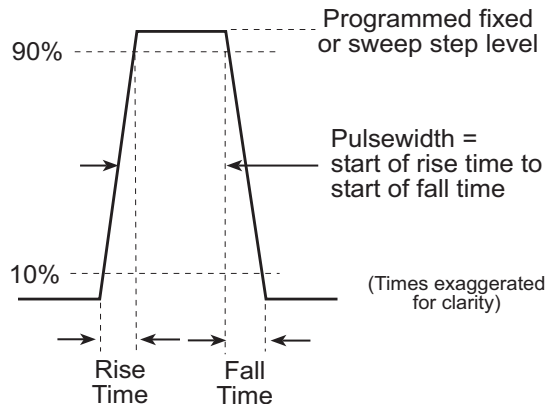
To configure a DC sweep, use:

```
smuX.trigger.endpulse.action = smuX.SOURCE_HOLD
```

Timers must be used to configure pulse width and period. Refer to [Section 10](#) for details on how to use timers in pulse mode sweeps.

As shown in [Figure 9-7](#), the pulse rise time is the interval it takes the pulse to go from 10% of maximum value to 90% of maximum value. For the Series 2600A, pulse rise and fall times depend on the transient response and source output settling times, which are in turn affected by the selected source range. See the Series 2600A specifications for details on transient response and source settling times.

Figure 9-7
Pulse rise and fall times



Pulsing in the extended operating area (EOA)

Pulse sweeps can be performed outside of the standard operating area by setting the appropriate compliance level. Please review the specifications for the Series 2600A to determine the maximum current and voltage values available in pulse mode. When pulsing in the extended operating area (EOA), the SMU will force the pulse to end early if the pulse width exceeds the maximum value. It will also hold off the next source action as necessary to stay within the duty cycle capabilities of the SMU.

Pulse duty cycle

Duty cycle is the percentage of time during the pulse period that the output is on. It is calculated as follows:

$$\text{Duty cycle} = \text{Pulse width} / (\text{Pulse width} + \text{Off time})$$

For example, if the pulse width is 10ms and the off time is 90ms, the duty cycle is calculated as follows:

$$\begin{aligned} \text{Duty cycle} &= 10\text{ms} / (10\text{ms} + 90\text{ms}) \\ &= 10\text{ms} / 100\text{ms} \\ &= 0.10 \\ &= 10\% \end{aligned}$$

Configuring and running sweeps

Configuring other sweep attributes

Compliance

Voltage and current limits can be configured using the `smuX.trigger.source.limitY` attributes which set the sweep source limits. For example, to set the sweep limit to 10V:

```
smua.trigger.source.limitv = 10
```

End sweep action

Use the end sweep action to configure the source action at the end of the sweep. The SMU can be programmed to return to the idle source level or hold the last value of the sweep. Configure the end sweep action by setting the `smuX.trigger.endsweep.action` attribute. For example, send the following command to program SMU A to return the source back to the idle source level at the end of a sweep:

```
smua.trigger.endsweep.action = smua.SOURCE_IDLE
```


Configuring measurements during a sweep

Measurements can be performed during a sweep using the `smuX.trigger.measure.Y` function. When sweeps are run, measurements are stored in the specified reading buffer for later recall. The reading buffer in which to store the readings can be specified. For example, to store voltage readings during the sweep:

```
smua.trigger.measure.v(vbuffername)
smua.trigger.measure.action = smua.ENABLE
```

Sweep data can be recalled as follows:

- **Front panel:** Press the **RECALL** key, select the channel and buffer, and then choose reading numbers to display using the **navigation wheel** or **cursor keys**. Recalling readings from the reading buffer using the front panel can only be done if one of the dedicated reading buffers is used to store the sweep data.
- **Remote:** Use the `printbuffer` command to request buffer readings.

See [Section 7](#) for details on recalling data from the buffer.

NOTE *When measurements are disabled during a sweep, the source values will not be displayed on the front panel.*

Source and measurement delays

Whenever the SMU outputs a source value in a sweep, it also applies the programmed source delay. The default source delay is zero seconds. Set an additional source delay using `smuX.source.delay`.

Whenever the SMU performs a measurement in a sweep, it also applies any configured measurement delays. Use `smuX.measure.delay` to program a specific measurement delay. The default measurement delay varies by model.

Initiating and running sweeps

In order to run a sweep, the number of sweep points to output and the number of sweeps to perform must be configured. Use the trigger count to set the number of sweep points to output. Use the arm count to set the number of times to perform the sweep. See [Section 10](#) for more information.

Example:

To sweep 15 source points:

```
smua.trigger.count = 15
```

To perform 8 sweeps:

```
smua.arm.count = 8
```

To start a sweep, use the `smuX.trigger.initiate` function. Sweeps are overlapped operations, so you can use the `waitcomplete` function as a way to suspend further operation until the sweep is complete.

Aborting a sweep

The `smuX.abort` command can be used to terminate all overlapped operations on a SMU, including sweeps. It returns the SMU to the idle state of the remote trigger model. See [Section 10](#) for more information.

Sweeping using factory scripts

Factory script functions that perform linear staircase, logarithmic staircase, and list sweeps are defined in [Section 19](#). You can use the factory script functions to perform and execute simple sweeps or use them as examples on which to program your own custom sweeps.

Front panel

To run a sweep, press the **LOAD** key, then select **FACTORY**, and then the name of the test to run. Press the **RUN** key, then follow the display prompts to complete the test. See [Section 19](#) for more information on using factory scripts.

Press the **RECALL** key to access sweep data stored in dedicated reading Buffer 1. See [Section 7](#) for more details on the buffer.

Sweep programming examples

Procedures for programming and running a sweep for three sweep types are given on the following pages. Each of these procedures includes commands for a typical sweep example. [Table 9-2](#) summarizes parameters for each of these examples.

Table 9-2
Sweep example parameters

Sweep type	Parameters for sweep examples
Linear staircase sweep	Start current: 1mA Stop current: 10mA # points: 10 Settling time: 0.1s
Pulse current sweep	Bias current: 1mA On current: 10mA Pulse on time: 10ms Pulse off time: 50ms # points: 10
List sweep	Five points: 3V, 1V, 4V, 5V, 2V Settling time 0.1s

Linear staircase sweep example

1. Configure source functions.

Examples: The following commands restore defaults and set the compliance to 1V:

```
-- Restore Series 2600A defaults.
smua.reset()
-- Set compliance to 1V.
smua.source.limitv = 1
```

2. Configure and execute the sweep.

Example: The following parameters configure a linear staircase current sweep from 1mA to 10mA with 10 points and a 0.1 second settling time:

```
-- Linear staircase sweep, Channel A, 1mA to 10mA, 0.1 second delay,
-- 10 points.
SweepILinMeasureV(smua, 1e-3, 10e-3, 0.1, 10)
```

3. Request readings.

Request readings from Buffer 1 as follows:

```
printbuffer(1, 10, smua.nvbuffer1.readings)
```

Pulse sweep example

1. Configure source functions

Examples: The following commands restore defaults and set the compliance to 10V:

```
-- Restore Series 2600A defaults.
smua.reset()
--Set compliance to 10V.
smua.source.limitv = 10
```

2. Configure and execute the sweep.

Example: The following parameters configure a 10mA current pulse sweep with a 10ms pulse on time, a 50ms pulse off time, and 10 pulse-measure cycles:

```
-- Pulse current sweep, Channel A, 1mA bias, 10mA level, 10ms pulse on,
-- 50ms pulse off, 10 cycles.
PulseIMeasureV(smua, 1e-3, 10e-3, 20e-3, 50e-3, 10)
```

3. Request readings.

Request readings from Buffer 1 as follows:

```
printbuffer(1, 10, smua.nvbuffer1.readings)
```

List sweep example

1. Configure source functions

Examples: The following commands restore defaults and set the compliance to 10mA:

```
-- Restore Series 2600A defaults.
smua.reset()
-- Set compliance to 10mA.
smua.source.limiti = 10e-3
```

2. Configure and execute the sweep.

Example: The following parameters configure a list sweep with 3V, 1V, 4V, 5V, 2V points using a 0.1s settling time:

```
-- Define voltage list.
vlist = {3, 1, 4, 5, 2}
-- List sweep, channel A, 3V, 1V, 4V, 5V, 2V steps, 0.1s delay, 5
-- points.
SweepVListMeasureI(smua, vlist, 0.1, 5)
```

3. Request readings.

Request readings from Buffer 1 as follows:

```
printbuffer(1, 5, smua.nvbuffer1.readings)
```

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In this section:

Topic	Page
Remote triggering overview	10-1
Using the remote trigger model	10-4
Configuring source and measure actions	10-6
Enabling pulse mode sweeps (end pulse action)	10-6
SMU event detectors	10-6
Clearing SMU event detectors	10-7
Using the TRIG key to trigger a sweep	10-7
Using trigger events to start actions on trigger objects	10-8
Action overruns	10-9
Digital I/O Port and TSP-Link synchronization lines	10-9
Common attributes	10-9
Trigger configuration on hardware lines	10-10
Action overruns on hardware lines	10-11
Timers	10-11
Timer attributes	10-11
Triggering a timer	10-12
Using timers to perform pulse mode sweeps	10-13
Timer action overruns	10-17
Event blenders	10-17
Event blender modes	10-17
Assigning input trigger events	10-18
Action overruns	10-18
LAN triggering overview	10-18
Understanding hardware value and pseudo line state	10-18
Understanding LXI trigger event designations	10-19
Generating LXI trigger packets	10-19
Logging LAN trigger events in the event log	10-20
Accessing the event log from the command interface	10-22
Command interface triggering	10-22
Manual triggering	10-23
Interactive triggering	10-23

Detecting trigger events using the wait() function	10-23
Using the assert() function to generate trigger events	10-24
Using the release() function of the hardware lines	10-24
Using the set() function to bypass SMU event detectors	10-24
Event detector overruns	10-25
Examples using interactive triggering	10-25
Hardware trigger modes for synchronization lines	10-27
Falling edge trigger mode	10-27
Rising edge master trigger mode	10-29
Rising edge acceptor trigger mode	10-30
Either edge trigger mode	10-31
Understanding synchronous triggering modes	10-32
Synchronous master trigger mode (SynchronousM)	10-32
Synchronous acceptor trigger mode (SynchronousA)	10-34
Synchronous trigger mode	10-35

Remote triggering overview

There are two programming methods for triggering:

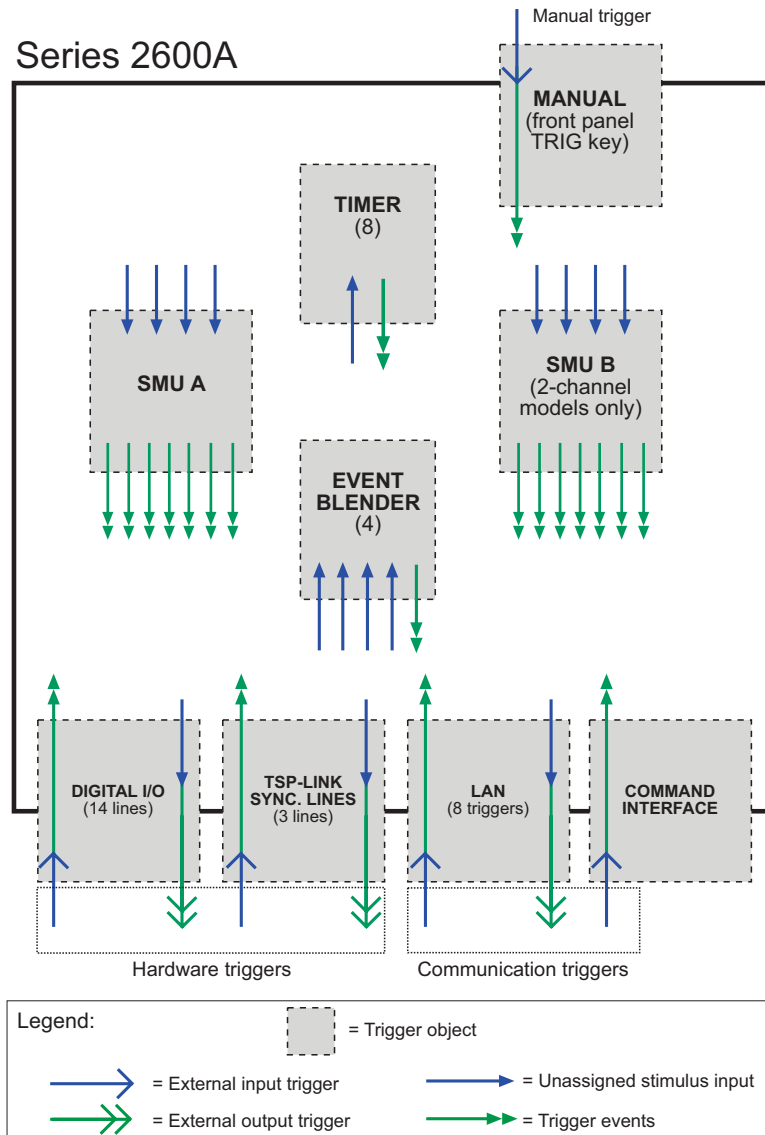
- Using the trigger model.
- Interactive triggering.

Using the trigger model to control the actions of the SMU allows the user to obtain very precise timing and synchronization between SMUs of a single instrument or between channels of multiple instruments. To achieve such precise timing, a static trigger configuration must be used. When a static trigger configuration is not possible, the interactive triggering method can be used to control the timing and actions of the SMU.

Both programming methods use trigger objects. Trigger objects generate and monitor for trigger events. External triggers are possible using digital I/O, TSP-Link synchronization lines, LAN, command interface, and the manual trigger (the **TRIG** key).

Figure 10-1 graphically represents all the trigger objects of the Series 2600A instrument.

Figure 10-1
Triggering overview



Trigger events are identified by means of an event ID. [Table 10-1](#) describes the trigger event IDs.

Table 10-1
Event IDs

Event ID	Event description
<code>smuX.trigger.SWEEPING_EVENT_ID</code>	Occurs when the SMU transitions from idle state to arm layer of trigger mode.
<code>smuX.trigger.ARMED_EVENT_ID</code>	Occurs when the SMU moves from the arm layer in to the trigger layer of the trigger model.
<code>smuX.trigger.SOURCE_COMPLETE_EVENT_ID</code>	Occurs when the SMU completes a source action.
<code>smuX.trigger.MEASURE_COMPLETE_EVENT_ID</code>	Occurs after the SMU completes a measure action.
<code>smuX.trigger.PULSE_COMPLETE_EVENT_ID</code>	Occurs after the SMU completes a pulse.
<code>smuX.trigger.SWEEP_COMPLETE_EVENT_ID</code>	Occurs when the SMU completes a sweep.
<code>smuX.trigger.IDLE_EVENT_ID</code>	Occurs when the SMU returns to the idle state.
<code>digio.trigger[N].EVENT_ID</code>	Occurs when an edge is detected on a digital I/O line.
<code>tsplink.trigger[N].EVENT_ID</code>	Occurs when an edge is detected on a TSP-Link line.
<code>lan.trigger[N].EVENT_ID</code>	Occurs when the appropriate LXI trigger packet is received on LAN trigger object N.
<code>display.trigger.EVENT_ID</code>	Occurs when the TRIG key on the front panel is pressed.
<code>trigger.EVENT_ID</code>	Occurs when a *TRG command is received on the remote interface. (GPIB only) Occurs when a GET bus command is received. (VXI-11 only) Occurs with the VXI-11 command <code>device_trigger</code> . Note: Reference the VXI-11 standard for additional details on the device trigger operation.
<code>trigger.blender[N].EVENT_ID</code>	Occurs after a collection of events is detected.
<code>trigger.timer[N].EVENT_ID</code>	Occurs when a delay expires.

Using the remote trigger model

Each source measure unit (SMU) in Series 2600A has a remote trigger model that supports a wide range of triggering features for source sweeps, triggered measurements, and pulse actions.

[Figure 10-2](#) graphically illustrates the remote trigger model. The trigger model consists of an idle state and two layers, arm and trigger.

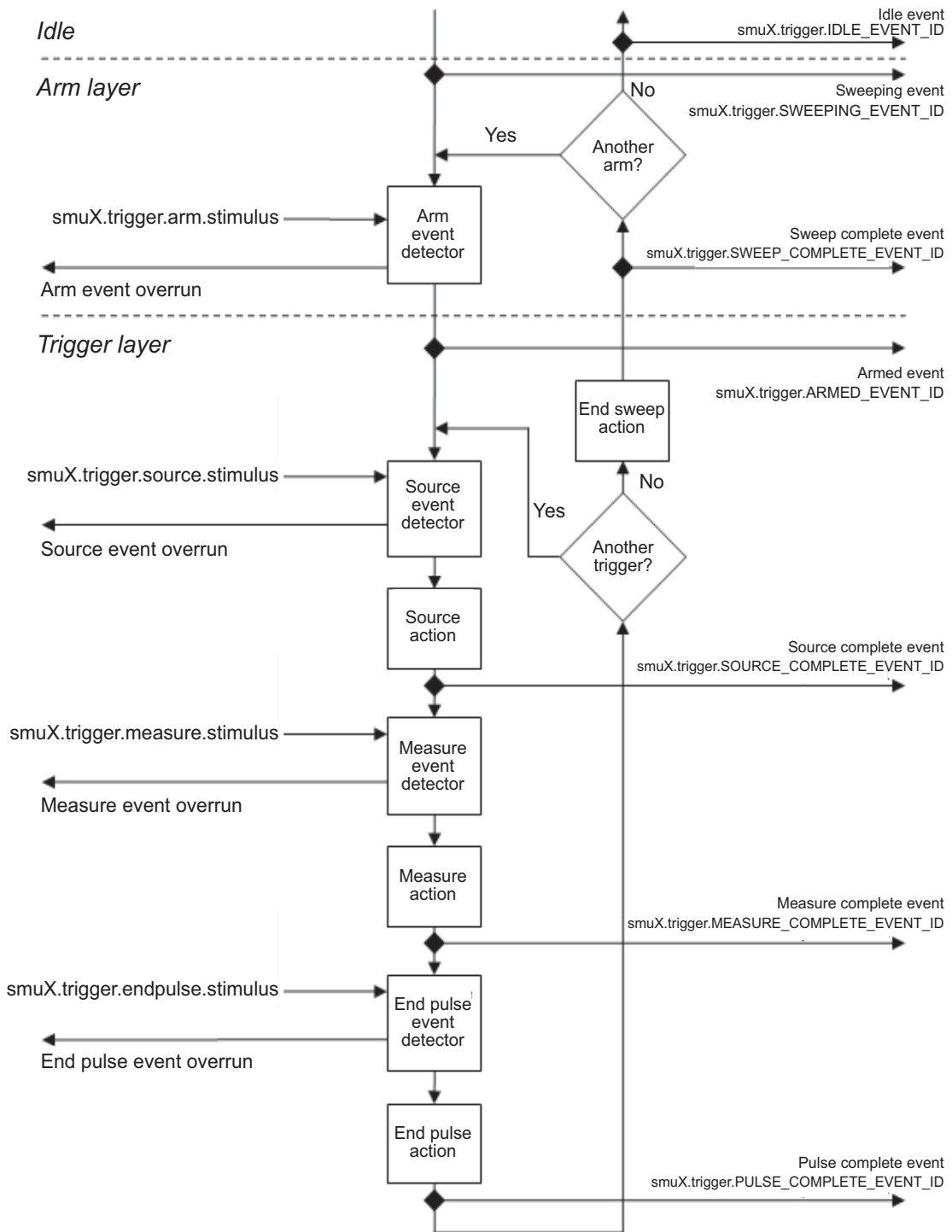
Idle state: If a sweep is not in process, the SMU is in the idle state. Use the ICL command `smuX.trigger.initiate` to move the SMU from the idle state in to the arm layer.

Each layer in the trigger model performs a function:

- **Arm:** Begins a sweep. Each sweep starts and ends in the arm layer.
- **Trigger:** All source, measure, and pulse actions occur in the trigger layer.
 - **Source:** Outputs the programmed voltage or current source value.
 - **Measure:** Where the current, voltage, resistance, and power measurements occur.
 - **End pulse:** The end pulse action turns the SMU off if the pulse mode is enabled.

The remote trigger model dictates the sequence of operation for the SMU when it is configured to perform a sweep. When the SMU comes to an event detector, it suspends operation and waits for the event you have assigned to the stimulus input. If no event is assigned, the SMU continues uninterrupted through the trigger model. When the SMU comes to an action block, it performs the appropriate action. The SMU loops through the arm and trigger layers until the programmed arm and trigger counts are satisfied.

Figure 10-2
Remote trigger model



Configuring source and measure actions

The source action can be configured using any of the following functions:

```
smuX.trigger.source.linearY
smuX.trigger.source.logY
smuX.trigger.source.listY
```

Where: "X" is the SMU channel and "Y" designates the source function. Source functions cannot be changed within a sweep. See [Section 9](#) for more details on the sweep functions.

To enable the source action, set `smuX.source.action` to `smuX.ENABLE`.

The SMU can be configured to perform any or all available measurements during a sweep using the `smuX.trigger.measure.Y` function. To enable the measure action, set `smuX.measure.action` to `smuX.ENABLE`.

Configured source and measure delays are imposed when the SMU executes the source and measure action blocks. Additionally, if the measure count setting is greater than one, then the measure count is satisfied each time the measure action is performed. Refer to [Section 9](#) for information on configuring source and measure sweeps.

The arm and trigger counts must be set to control how many times the SMU executes the source and measure actions. The arm count indicates the number of times to execute the complete sweep. The trigger count sets the number of loops in the trigger layer. Typically, you set the trigger count to be equal to the number of points in the configured sweep. If the trigger count is not equal to the number of points configured in the sweep, then one of the following occurs:

- If the trigger count is greater than the number of points in a sweep as configured by `smuX.trigger.source.linearY`, or `smuX.trigger.source.logY`, or `smuX.trigger.source.listY`, then the SMU will satisfy the trigger count by restarting the sweep values from the beginning.
- If the trigger count is less than the number of source values configured, then the SMU will satisfy the trigger count and ignore the remaining source values.

For example, configure a three-point linear voltage sweep from 1 to 3 volts, with the trigger count set to 2. The SMU will output 1 V, 2 V. If the trigger count is set to 6, then the SMU will output the values 1 V, 2 V, 3 V, 1 V, 2 V, 3 V, repeating the source values twice in a single sweep.

Enabling pulse mode sweeps (end pulse action)

Enable pulse mode sweeps using the end pulse action. Configure pulse mode sweeps by setting the end pulse action as shown in the following example:

```
smua.trigger.endpulse.action = smua.SOURCE_IDLE
```

Timers can be used to configure the pulse width and period (see [Timers](#) for more information). To disable pulse mode sweeps, set the `smuX.trigger.endpulse.action` attribute to `smuX.SOURCE_HOLD`.

SMU event detectors

As shown in [Figure 10-2](#), the SMU has multiple event detectors (see [Table 10-2](#)) in order to control the timing of various actions. Each event detector monitors for the trigger event assigned to the stimulus input. Operation through the trigger model is held up at the event detector until the programmed trigger event occurs.

If the stimulus input is set to zero, then the SMU continues uninterrupted through the remote trigger model.

Table 10-2
Event detectors

Event detector	Function
Arm	Controls entry into the trigger layer of the trigger model.
Source	Controls execution of the source action.
Measure	Controls execution of the measurement action.
End pulse	Controls execution of the end pulse action.

Clearing SMU event detectors

When an event detector is cleared, the event detector discards previously detected trigger events. This prevents the SMU from using trigger events that were detected during the last sweep or while in the arm layer and allows it to start monitoring for new trigger events.

SMU event detectors are automatically cleared when:

- A sweep is initiated using the `smuX.trigger.initiate` command.
- The SMU moves from the arm layer into the trigger layer and the `smuX.trigger.autoclear` attribute is enabled.

Using the TRIG key to trigger a sweep

The SMU can be configured to perform a sweep where each source step is triggered by the front panel **TRIG** key. The source action is preceded by the source event detector (see [Figure 10-1](#)). The SMU pauses operation at an event detector until a programmed event occurs. The SMU can be programmed to wait at the source event detector (that is, not start the source action) until the front panel **TRIG** key is pressed.

To configure the front panel **TRIG** key to trigger the source action, assign the trigger event created by the **TRIG** key (`digio.trigger[N].EVENT_ID`) to the source stimulus input (`smuX.trigger.source.stimulus`).

The example below shows a command sequence to configure a ten-point linear voltage sweep on SMU A where each step is triggered by the front panel **TRIG** key:

```
-- Configure a 10-point source voltage sweep.
smua.trigger.source.linearv(1, 10, 10)
smua.trigger.source.action = smua.ENABLE

-- Configure TRIG key press as input trigger for source action.
smua.trigger.source.stimulus = display.trigger.EVENT_ID

-- Command SMU to execute a single 10-point sweep.
smua.trigger.count = 10
smua.trigger.arm.count = 1

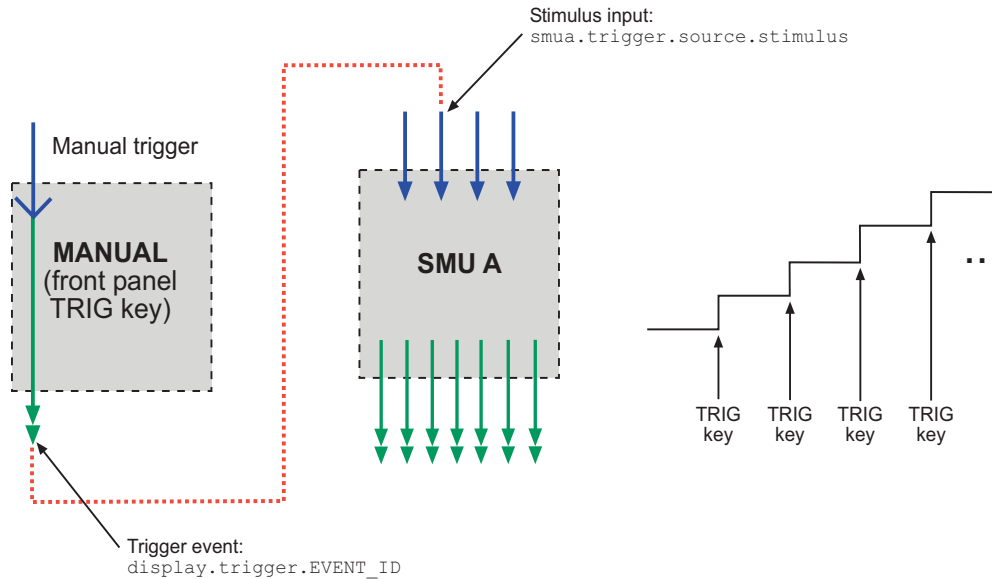
-- Turn on the output in preparation for the sweep
smua.source.output = suma.OUTPUT_ON

-- Start the sweep and clear the event detectors.
smua.trigger.initiate()

-- The SMU will wait for the front panel TRIG key press before executing
-- each source action.
```

[Figure 10-3](#) graphically illustrates this example. See [Section 9](#) for more information on sweep operation.

Figure 10-3
Front panel TRIG key triggering



Using trigger events to start actions on trigger objects

Trigger objects can be configured to respond to events generated by other trigger objects, such as using a digital I/O trigger to initiate a sweep. To configure a trigger object to monitor for an event, assign the event ID of the trigger event to the stimulus input. When the specified trigger event occurs, the trigger object will perform an action.

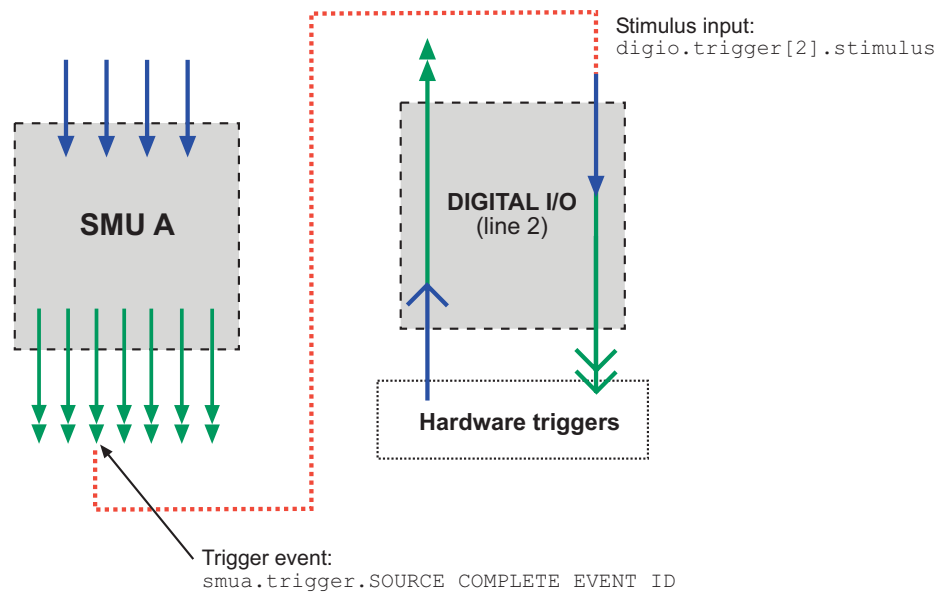
Example:

```
-- Configure digio line 2 to generate an output trigger pulse each
-- time SMU A generates a source complete event.
digio.trigger[2].stimulus = smua.trigger.SOURCE_COMPLETE_EVENT_ID
```

[Figure 10-4](#) illustrates this example.

The stimulus input can be configured to monitor for only one trigger event ID at a time. To monitor more than one event, use an event blender. For example, you can configure the Series 2600A to generate an external output trigger when sweeps on both SMU A and SMU B are complete. See [Event blenders](#) for more information.

Figure 10-4
Using trigger events to start actions



Action overruns

An action overrun occurs when a trigger object receives a trigger event and is not ready to act on it. The action overruns of all trigger objects are reported in the operation event registers of the status model. Please refer to [Appendix C](#) and the appropriate sections on each trigger object for further details on conditions under which an object generates an action overrun.

Digital I/O Port and TSP-Link synchronization lines

The Series 2600A has two sets of hardware lines that can be used for triggering: 14 digital I/O lines and 3 TSP-Link synchronization lines. These trigger objects can be configured and controlled in the same way.

See [Section 8](#) for more information on connections and direct control of the digital I/O and TSP-Link synchronization lines.

Common attributes

Mode

Indicates the type of edge the hardware lines detects as an external input trigger. Mode also indicates the type of signal generated as an external output trigger. [Table 10-3](#) describes the hardware trigger modes for the hardware trigger lines. The hardware trigger modes are described in greater detail in [Hardware trigger modes for synchronization lines](#).

NOTE Setting the mode to bypass will not allow the hardware line to be used for triggering.

Pulsewidth

Specifies the pulse width of the output trigger signal when the hardware line is asserted.

Table 10-3
Hardware trigger mode summary

Trigger mode	Output		Input
	Unasserted	Asserted	Detects
Bypass	N/A	N/A	N/A
Either Edge	High	Low	Either
Falling Edge	High	Low	Falling
Rising Edge	The programmed state of the line determines if the behavior is similar to RisingA or RisingM: <ul style="list-style-type: none"> • High similar to RisingA • Low similar to RisingM 		
RisingA	High	Low	Rising
RisingM	Low	High	None
Synchronous	High latching	Low	Falling
SynchronousA	High latching	High	Falling
SynchronousM	High	Low	Rising

Trigger configuration on hardware lines

The Series 2600A can be configured to send digital signals to trigger external instruments. Linking these output triggers to the completion of certain source-measure actions enables hardware handshaking.

Example:

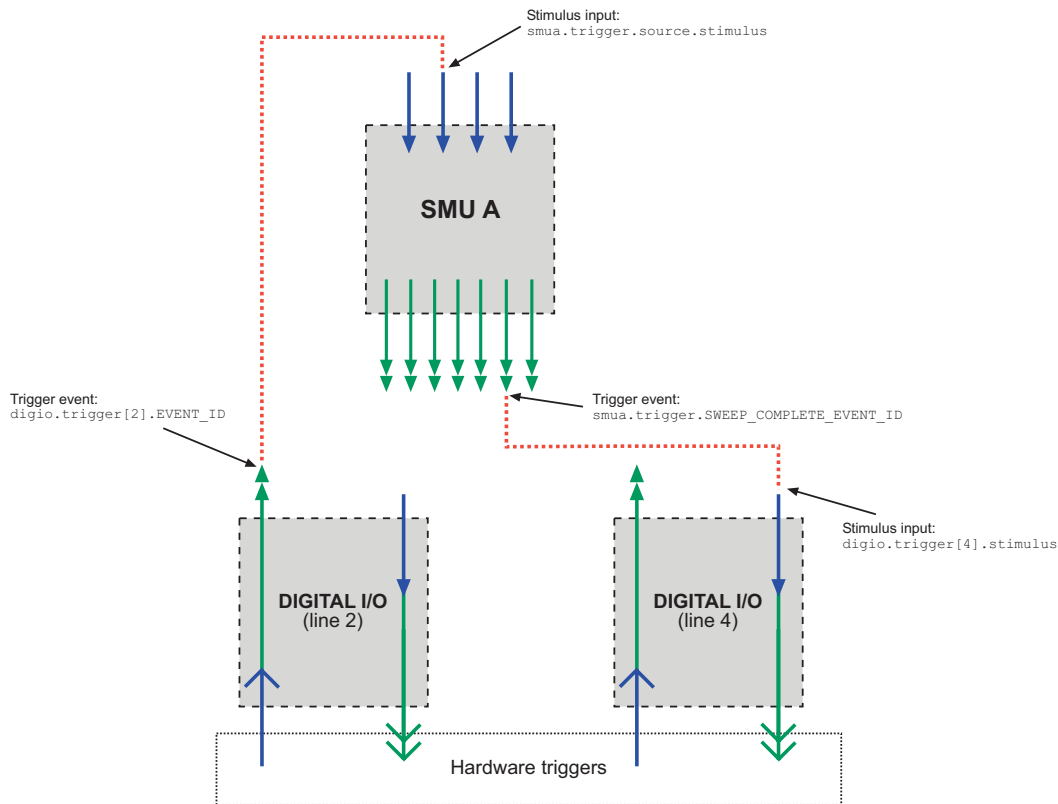
```
-- Configure Series 2600A to detect rising edge on digital I/O line 2.
digio.trigger[2].mode = digio.TRIG_RISINGA
digio.trigger[2].clear()

-- Configure SMU A to start its source action when a trigger event
-- occurs on digital I/O line 2.
smua.trigger.source.stimulus = digio.trigger[2].EVENT_ID

-- Configure digital I/O line 4 to output a 1ms rising-edge trigger
-- pulse at the completion of SMU sweep.
digio.trigger[4].mode = digio.TRIG_RISINGM
digio.trigger[4].pulsewidth = 0.001
digio.trigger[4].stimulus = smua.trigger.SWEEP_COMPLETE_EVENT_ID
```

This example's triggering setup is shown in [Figure 10-5](#).

Figure 10-5
External instrument triggering



Action overruns on hardware lines

An action overrun occurs when a trigger event is received before the digital I/O or TSP-Link line is ready to process it. The generation of an action overrun is dependent upon the trigger mode selected for that line. For more details on the causes of action overruns, see [Hardware trigger modes for synchronization lines](#).

Timers

A timer is a trigger object that performs a delay when triggered. Timers can be used to create delays and to start measurements and step the source value at timed intervals. When a delay expires the timer generates a trigger event. The Series 2600A has 8 independent timers.

Timer attributes

Each timer has four attributes that can be configured.

Count

Configures the number of events to generate each time the timer is triggered. Each event is separated by a delay.

To configure the count, use the following attribute:

```
trigger.timer[N].count
```

Set the count number to 0 (zero) to cause the timer to generate trigger events indefinitely.

Timer delays

Timers can be configured to perform the same delay each time or configured with a delay list that allows the timer to sequence through an array of delay values. All delay values are specified in seconds.

- **Delay**
 - A delay is the period of time after the timer is triggered and before the timer generates a trigger event. Use the following as an example to configure the delay attribute:

```
trigger.timer[N].delay = 10
```

- **Delay list**
 - A custom list can be configured to allow the timer to use a different interval each time it performs a delay. Each time the timer is triggered, it uses the next delay in the list. The timer repeats the delay list after all of the elements in the delay list have been used.

Use the following example to configure the delay list attribute:

```
-- Configure timer 4 to complete delays of 2 seconds, 10 seconds,  
-- 15 seconds, and 7 seconds.  
trigger.timer[3].delaylist = {2, 10, 15, 7}
```

NOTE Assigning a value to the delay attribute creates a one element delay list.

Pass-through

When enabled, the timer generates a trigger event immediately when it is triggered. The timer generates additional trigger events each time a delay expires. If the pass-through attribute is disabled, the timer does not generate a trigger event until after the first delay elapses.

To enable passthrough mode, use the following command:

```
trigger.timer[N].passthrough = true
```

Triggering a timer

A timer can be configured to start a delay when a trigger object generates a trigger event. Timers cannot be started with a command. A trigger event from a trigger object must be used to initiate a delay.

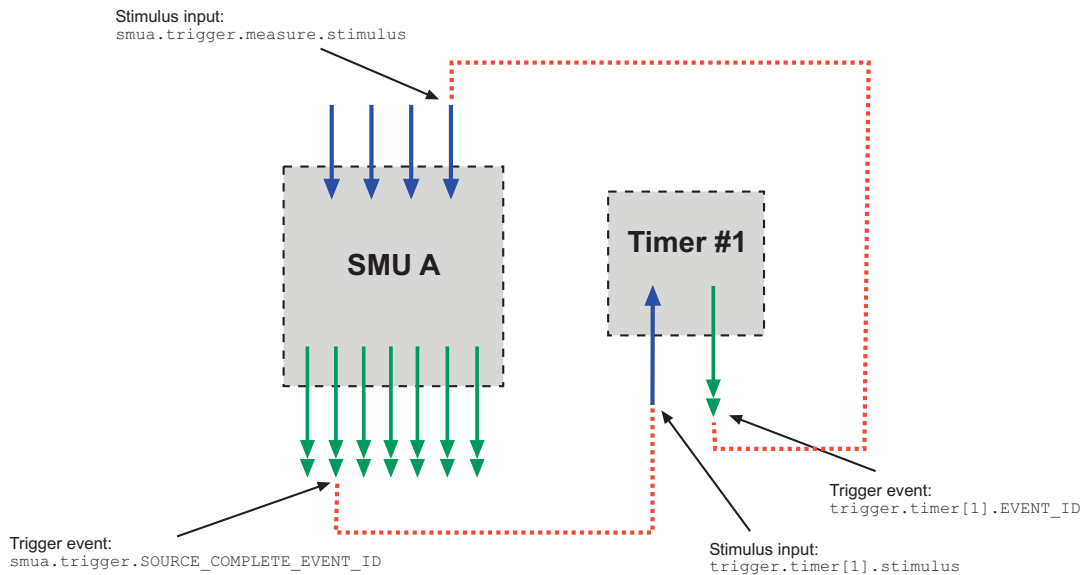
Assigning the stimulus attribute

Assign the event ID to the `trigger.timer[N].stimulus` attribute to configure the timer to start a delay when a specific trigger event occurs.

Use the following example to configure a source - delay - measure (SDM) cycle.

```
-- Configure the timer to begin when source action completes.  
trigger.timer[1].stimulus = smua.trigger.SOURCE_COMPLETE_EVENT_ID  
  
-- SMUA delay before a measurement begins.  
smua.trigger.measure.stimulus = trigger.timer[1].EVENT_ID
```


Figure 10-6
Using a timer for an SDM cycle



Using timers to perform pulse mode sweeps

Timers can also be used to control the pulse width during a pulsed sweep. To create a pulse train, a second timer must be used to configure the pulse period. The examples below show a single pulse output and a pulse train output.

NOTE The SMU endpulse action `smux.trigger.endpulse.action` must be set to `smuX.SOURCE_IDLE` in order to create a pulse.

Single pulse example:

- Set the delay attribute of a timer equal to the desired pulse width.
 - Trigger the timer to start when the SMU moves out of the arm layer of the trigger model.
 - Assign the trigger event generated by the timer to the stimulus input of the SMU end pulse event detector.
 - Configure the source action to start immediately by setting the stimulus input of the source event detector to 0.
 - Set the endpulse action to `SOURCE_IDLE`.
- ```
-- Generate a single 500us, 5V pulse.

-- Configure a single-point voltage list sweep.
smua.trigger.source.listv({5})
smua.trigger.source.action = smua.ENABLE
smua.trigger.measure.action = smua.DISABLE

-- Configure other source parameters for best timing possible.
smua.trigger.source.limiti = 0.1
smua.source.rangev = 5

-- Configure timer parameters to output a single 500us pulse.
```

```

trigger.timer[1] = 0.0005
trigger.timer[1].count = 1
trigger.timer[1].passthrough = false

-- Trigger timer when the SMU passes through the ARM layer.
trigger.timer[1].stimulus = smua.trigger.ARMED_EVENT_ID

-- Configure source action to start immediately.
smua.trigger.source.stimulus = 0

-- Configure endpulse action to achieve a pulse.
smua.trigger.endpulse.action = smua.SOURCE_IDLE
smua.trigger.endpulse.stimulus = trigger.timer[1].EVENT_ID

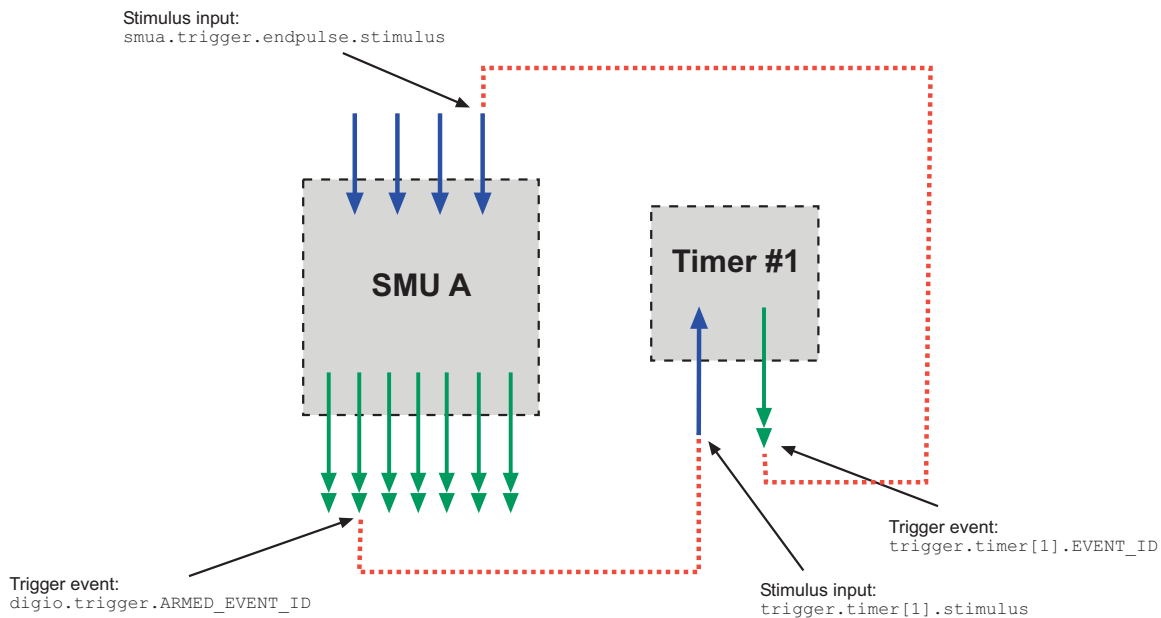
-- Set appropriate counts of trigger model.
smua.trigger.count = 1
smua.trigger.arm.count = 1

-- Turn on output and trigger SMU to output a single pulse.
smua.source.output = smua.OUTPUT_ON
smua.trigger.initiate()

```

Figure 10-7 shows the trigger setup for this example.

Figure 10-7  
Single pulse triggering



### Pulse train example:

In this example, two timers are required: one to control the pulse period and a second to control the pulse width.

Configure the timers and SMUs as follows:

#### Timer 1: Pulse period timer

- Set delay attribute to the desired pulse period (see [Figure 10-8](#)).

- Trigger the timer to start when the sweep is initiated.
- Enable the passthrough attribute so that the timer generates a trigger event at start of the first delay.
- Set the count equal to one less than the total number of pulses to output.

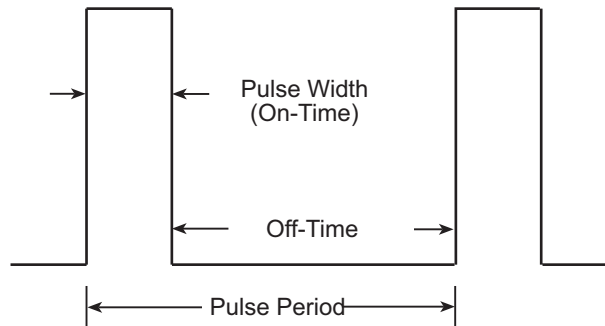
#### Timer 2: Pulse width timer

- Set the delay attribute to the desired pulse width (see [Figure 10-8](#)).
- Set the stimulus input to Timer 1 event ID (the start of each pulse is the start of the pulse period).
- Set the count equal to 1 so that only one pulse is issued per period.

#### SMU A

- Set the source stimulus input to Timer 1 event ID so that the source action starts when the period starts.
- Set the endpulse action to `SOURCE_IDLE` so that the output is returned to idle value after the source action completes.
- Set the endpulse stimulus input to Timer 2 event ID so that the endpulse action executes when the pulse width timer expires.
- Set the trigger count equal to 1.
- Set the arm count equal to the total number of pulses to output.

Figure 10-8  
Pulse train



```
-- Generate a 10-point pulse train where each pulse has a width of 600
-- microseconds and a pulse period of 5 milliseconds.
```

```
-- Alias the trigger timers to use for pulse width and period.
period_timer = trigger.timer[1]
pulse_timer = trigger.timer[2]
```

```
-- Create a fixed level voltage sweep.
smua.trigger.source.listv({5})
smua.trigger.source.action = smua.ENABLE
smua.source.rangev = 5
smua.trigger.measure.action = smua.DISABLE
```

```
-- Set pulse width.
pulse_timer.delay = 0.0006
```

```
-- Trigger pulse width timer with period timer.
pulse_timer.stimulus = period_timer.EVENT_ID
```

```
-- Output one pulse per period.
pulse_timer.count = 1

-- Set the pulse period.
period_timer.delay = 0.005

-- Set pulse period count to generate 10 pulses.
period_timer.count = 9

-- Trigger pulse period timer when a sweep is initiated.
period_timer.stimulus = smua.trigger.SWEEPING_EVENT_ID

-- Configure the timer to output a trigger event when it starts the first
-- delay.
period_timer.passthrough = true

-- Trigger SMU source action using pulse period timer
smua.trigger.source.stimulus = period_timer.EVENT_ID

-- Trigger SMU endpulse action using pulse width timer.
smua.trigger.endpulse.stimulus = pulse_timer.EVENT_ID

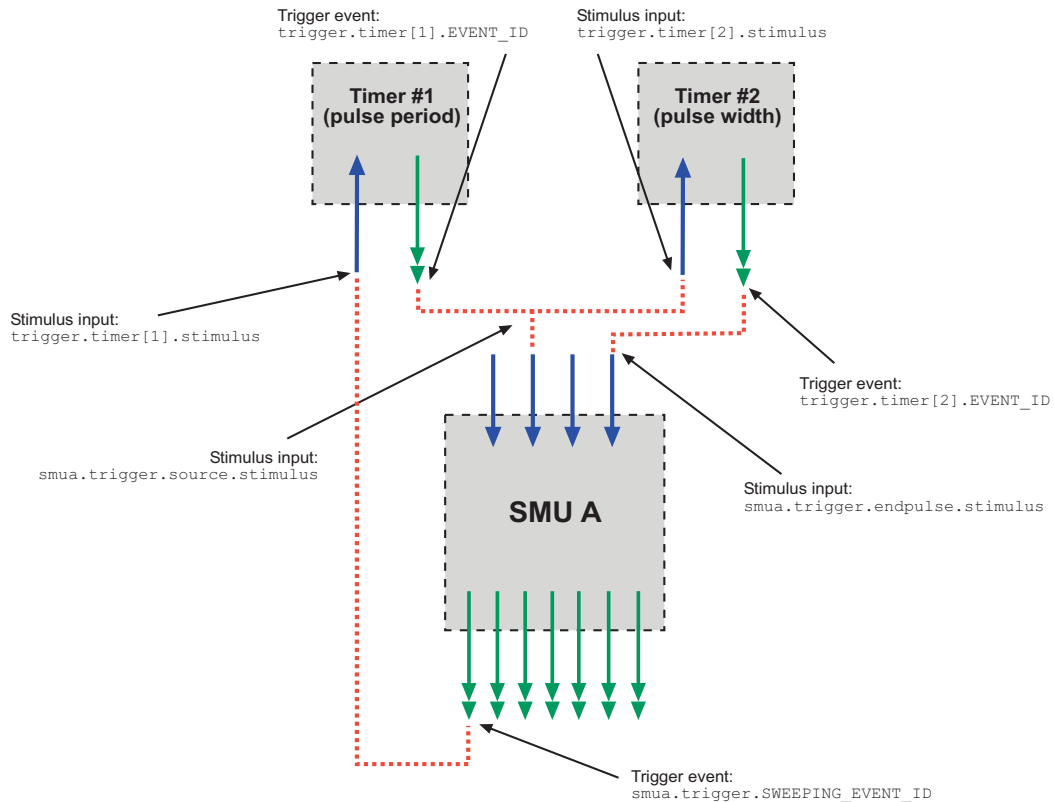
-- Set Trigger Model counts.
smua.trigger.count = 1

-- Configure the SMU to execute a 10-point pulse train.
smua.trigger.arm.count = 10

-- Prepare SMU to output pulse train.
smua.source.output = smua.OUTPUT_ON
smua.trigger.initiate()
```

[Figure 10-9](#) shows the trigger setup for this example.

Figure 10-9  
Pulse train triggering



## Timer action overruns

The timer generates an action overrun when it is triggered while a timer delay is still in progress.

## Event blenders

The ability to combine trigger events that occur at different times is known as event blending. An event blender can be used to wait for a specific input trigger or to wait for up to four input triggers to occur before responding with an output event.

There are four event blenders that can be used to monitor and respond to multiple stimulus events. Each event blender can be configured to monitor a maximum of four different trigger events.

## Event blender modes

Event blenders can be used to perform logical AND and logical OR functions on trigger events. For example, trigger events can be triggered when either a manual trigger or external input trigger is detected.

- **Or:** Generates an event when an event is detected on *any* one of the four stimulus inputs.
- **And:** Generates an event when an event is detected on *all* of the assigned stimulus inputs.

Set the `trigger.blender[N].orenable` attribute to configure the event blender mode. Setting the attribute to `true` enables OR mode; setting the attribute to `false` enables AND mode.

## Assigning input trigger events

Each event blender has four stimulus inputs. A different trigger event ID can be assigned to each stimulus input. The following example assigns the source complete event IDs of SMUA and SMU B to stimulus inputs 1 and 2 of event blender 1:

```
trigger.blender[1].stimulus[1] = smua.SOURCE_COMPLETE_EVENT_ID
trigger.blender[1].stimulus[2] = smub.SOURCE_COMPLETE_EVENT_ID
```

## Action overruns

Action overruns are generated by event blenders depending on the mode, as shown in [Table 10-4](#).

Table 10-4  
Action overruns

| Mode | Action overrun                                                                                               |
|------|--------------------------------------------------------------------------------------------------------------|
| And  | Generates an overrun when a second event on any of its inputs is detected before generating an output event. |
| Or   | Generates an overrun when two events are detected simultaneously.                                            |

## LAN triggering overview

Triggers can be sent and received over the LAN interface. The Series 2600A supports LAN extensions for Instrumentation (LXI) and has eight LAN triggers that generate and respond to LXI trigger packets.

## Understanding hardware value and pseudo line state

LAN triggering is very similar to hardware synchronization except LXI trigger packets are used instead of hardware signals. The **hardware value** is a bit in the LXI trigger packet that simulates the state of a hardware trigger line. The Series 2600A stores the hardware value of the last LXI trigger packet sent or received as the **pseudo line state**.

The **stateless event flag** is a bit in the LXI trigger packet that indicates if the hardware value should be ignored. If set, the Series 2600A ignores the hardware value of the packet and generates a trigger event. The Series 2600A always sets the stateless flag for outgoing LXI trigger packets. If the stateless event flag is not set, then the hardware value indicates the state of the signal. Changes in the hardware value of consecutive LXI trigger packets are interpreted as edge transitions. Edge transitions generate trigger events. If the hardware value does not change between successive LXI trigger packets, the Series 2600A assumes an edge transition was missed and generates a trigger event. [Table 10-5](#) illustrates edge detection in LAN triggering.

---

NOTE Instruments that are compliant to LXI versions prior to 1.2 always process the hardware value. Instruments compliant to LXI version 1.2 and later are required to ignore the hardware value when the stateless event flag is set.

---

Table 10-5  
LXI trigger edge detection

| Stateless event flag | Hardware value | Pseudo line state | Falling edge | Rising edge |
|----------------------|----------------|-------------------|--------------|-------------|
| 0                    | 0              | 0                 | Detected     | Detected    |
| 0                    | 1              | 0                 | -            | Detected    |
| 0                    | 0              | 1                 | Detected     | -           |
| 0                    | 1              | 1                 | Detected     | Detected    |
| 1                    | -              | -                 | Detected     | Detected    |

Set the LAN trigger mode to configure edge detection method in incoming LXI trigger packets. The mode selected also determines the hardware value in outgoing LXI trigger packets. [Table 10-6](#) lists the LAN trigger modes.

Table 10-6  
LAN trigger modes

| Trigger mode | Input   | Output    | Notes                |
|--------------|---------|-----------|----------------------|
|              | Detects | Generates |                      |
| Either Edge  | Either  | Negative  |                      |
| Falling Edge | Falling | Negative  |                      |
| Rising Edge  | Rising  | Positive  |                      |
| Rising A     | Rising  | Positive  | Same as Rising       |
| RisingM      | Rising  | Positive  | Same as Rising       |
| Synchronous  | Falling | Positive  | Same as SynchronousA |
| SynchronousA | Falling | Positive  |                      |
| SynchronousM | Rising  | Negative  |                      |

The following is an example of how to configure the LAN trigger mode:

```
-- Set LAN trigger 2 to have falling-edge mode.
lan.trigger[2].mode = lan.TRIG_FALLING
```

## Understanding LXI trigger event designations

LAN trigger objects generate LXI trigger events. The LXI standard designates trigger events as LAN0 to LAN7 (zero based). In the command table, the LXI trigger events can be accessed using `lan.trigger[1]` through `lan.trigger[8]`. `lan.trigger[1]` corresponds to LXI trigger event LAN0 and `lan.trigger[8]` corresponds to LXI trigger event LAN7.

## Generating LXI trigger packets

The Series 2600A can be configured to output a LXI trigger packet to other LXI instruments. In order to generate LXI trigger packets, you must first call the `lan.trigger[N].connect` function. Select the event that triggers the outgoing LXI trigger packet by assigning the specific event ID to the LAN stimulus input.

## Logging LAN trigger events in the event log

The event log can be used to record all LXI triggers generated and received by the Series 2600A and can be viewed over any command interface. The event log can also be viewed using the embedded web interface. [Figure 10-10](#) shows the view of the LXI event log from the embedded web interface.

Figure 10-10  
Event log

The screenshot shows the Keithley LXI Event Log web interface. The top header includes the Keithley logo and the LXI logo. Below the header is a navigation menu on the left with the following items: Welcome Page, IP Configuration, Set Password, TSB Embedded, Virtual Front Panel, Flash Upgrade, TSP® Express, Log, and Glossary. The main content area displays the title "LXI Event Log ... 00:26:41.000 1 Jan 1970" and a table with the following columns: Receive Time, EventID, From, PTP Timestamp (subdivided into Seconds and FractionalSeconds), HWDetect, Sequence, Domain, Flags, and Data. A "Refresh" button is located below the table.

The time stamp, event identifier, the IP address and the domain name identify the incoming and outgoing LXI trigger packets. [Table 10-7](#) provides detailed descriptions for the columns in the event log.



Table 10-7  
Event log descriptions

| Column title  | Description                                                                                                                                                                                                                                      | Example                                                                                                                                                                                                                                                                                                      |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Received Time | <ul style="list-style-type: none"> <li>Displays the date and time of the LAN trigger occurred.</li> <li>Displays the value in UTC, 24-hour time.</li> </ul>                                                                                      | 06:56:28.000 8 May 2008                                                                                                                                                                                                                                                                                      |
| EventID       | Identifies the <code>lan.trigger[N]</code> that generates an event.                                                                                                                                                                              | LAN0 = <code>lan.trigger[1]</code><br>LAN1 = <code>lan.trigger[2]</code><br>LAN2 = <code>lan.trigger[3]</code><br>LAN3 = <code>lan.trigger[4]</code><br>LAN4 = <code>lan.trigger[5]</code><br>LAN5 = <code>lan.trigger[6]</code><br>LAN6 = <code>lan.trigger[7]</code><br>LAN7 = <code>lan.trigger[8]</code> |
| From          | Displays the IP address for the device that generates the LAN trigger.                                                                                                                                                                           | <ul style="list-style-type: none"> <li><code>localhost</code></li> <li><code>192.168.5.20</code></li> </ul>                                                                                                                                                                                                  |
| Timestamp     | A timestamp that identifies the time the event occurred. The timestamp uses the following: <ul style="list-style-type: none"> <li>PTP timestamp</li> <li>Seconds</li> <li>Fractional Seconds</li> </ul>                                          | The Series 2600A does not support the IEEE 1588 standard. The values in this field are always 0 (zero).                                                                                                                                                                                                      |
| HWDetect      | Identifies a valid LXI trigger packet                                                                                                                                                                                                            | LXI                                                                                                                                                                                                                                                                                                          |
| Sequence      | Each instrument maintains independent sequence counters. <ul style="list-style-type: none"> <li>One for each combination of UDP multicast network interface and UDP multicast destination port.</li> <li>One for each TCP connection.</li> </ul> |                                                                                                                                                                                                                                                                                                              |
| Domain        | Displays the LXI domain number. <ul style="list-style-type: none"> <li>The default value is zero (0).</li> </ul>                                                                                                                                 | 0<br>1523                                                                                                                                                                                                                                                                                                    |
| Flags         | Contain data about the LXI trigger packet.                                                                                                                                                                                                       | Values: <ul style="list-style-type: none"> <li>1 - Error</li> <li>2 - Retransmission</li> <li>4 - Hardware</li> <li>8 - Acknowledgments</li> <li>16 - Stateless bit</li> </ul>                                                                                                                               |
| Data          | The Series 2600A does not support the IEEE 1588 standard. The values in this are always 0 (zero).                                                                                                                                                |                                                                                                                                                                                                                                                                                                              |

## Accessing the event log from the command interface

The Instrument Control Library (ICL) can be used to view the event log from any command interface. The event log must be enabled before LXI trigger events can be viewed.

To enable the event log:

```
eventlog.enable = 1
```

To view the event log from a remote interface:

```
print(eventlog.all())
```

This command returns one or more strings similar to the following:

```
14:14:02.000 17 Jun 2008, LAN0, 10.80.64.191, LXI, 0, 1213712000, not available, 0, 0x10,0x00
```

The string displays the same information as the web interface. Commas separate the different fields. The fields are returned in the following order:

- UTC time
- Event Id
- Sender
- HwDetect/ version
- Domain
- sequence number
- ptp time
- epoch (from 1588)
- flags
- Data

See [Table 10-7](#) for detailed descriptions.

## Command interface triggering

A command interface trigger occurs when:

- A GPIB GET command is detected (GPIB only).
- A VXI-11 `device_trigger` method is invoked (VXI-11 only).
- A \*TRG message is received.

Use `trigger.EVENT_ID` to monitor for command interface triggers. To ensure that commands and triggers issued over the command interface are processed in the correct order, a trigger event is not generated until:

- The trigger command is executed.
- `trigger.wait()` retrieves the trigger command from the input queue before it would normally be executed.

Command interface triggering does not generate action overruns. The triggers are processed in the order that they are received in the Series 2600A input queue. The Series 2600A does not process incoming commands while a script is running. Input triggers that are not processed can cause an overflow in the input queue. It is important to make sure a script processes triggers while it is running.

---

**NOTE** The input queue can fill up with trigger entries if too many \*TRG messages are received while a test script is running. This can be averted by using the `localnode.prompts4882` attribute (see [Section 19](#) for more information) and by using `trigger.wait()` calls that remove the \*TRG messages from the input queue. If the input queue fills with too many trigger entries, messages like **abort** will not be processed.

---

## Manual triggering

The **TRIG** key is the stimulus input for manual triggering. Each time the **TRIG** key is pressed, a trigger event is generated. You can monitor for a manual trigger event using the event ID `display.trigger_EVENT_ID`. See [Using the TRIG key to trigger a sweep](#) for an example of how to use a manual trigger.

There are no action overruns for manual triggering.

## Interactive triggering

The complexity of certain test system configurations may not permit a static trigger setup, but instead requires more dynamic control of triggering. In such cases, the interactive triggering programming method allows the generation and detection of trigger events that can be controlled on demand under remote control. For example, interactive triggering can be used when you need to make multiple source function changes or implement conditional branching to other test setups based on recent measurements.

## Detecting trigger events using the `wait()` function

All of the Series 2600A trigger objects (except the SMUs) have built-in event detectors that monitor for trigger events. The event detector only monitors events generated by that object and cannot be configured to monitor events generated by any other trigger object. Using the `wait()` function of the trigger object causes the Series 2600A instrument to suspend the script until a trigger event occurs or until the specified timeout period elapses.

For example, use `trigger.blender[N].wait(Y)` to suspend script operation until an event blender generates an event, where `N` is the specific event blender and `Y` is the timeout period. After executing the `wait` function, the event detector of the trigger object is cleared.

Example:

```
-- Wait up to 10 seconds for a front panel TRIG key press.
display.trigger.wait(10)

-- Wait up to 60 seconds for timer 1 to complete its delay.
trigger.timer[1].wait(60)

-- Wait up to 30 seconds for input trigger to digital I/O line 10.
digio.trigger[10].wait(30)
```

## Using the `assert()` function to generate trigger events

Certain trigger objects can be used to generate output triggers on demand. These trigger objects are the digital I/O lines, TSPLink synchronization lines and the LAN.

To generate an output trigger, use the `assert` function of the trigger object as shown in the following example:

```
-- Generate a falling-edge trigger on digital I/O line 3.
digio.trigger[3].mode = digio.TRIG_FALLING
digio.trigger[3].assert()

-- Generate a rising edge trigger on TSP-Link sync line 1.
tsplink.trigger[1].mode = tsplink.TRIG_RISINGM
tsplink.trigger[1].assert()

-- Generate a LAN trigger on LAN pseudo line 6.
lan.trigger[6].mode = lan.TRIG_EITHER
lan.trigger[6].assert()
```

## Using the `release()` function of the hardware lines

Use the `release()` function to allow the hardware line to output another external trigger when the pulse width is set to 0.

Setting the pulse width to 0 results in an indefinite length pulse when the `assert()` function is used to output an external trigger. The `release()` function must be used to release the line in order to output another external trigger.

The `release()` function can also be used to release latched input triggers when the hardware line mode is set to Synchronous. In Synchronous mode, the receipt of a falling edge trigger latches the line low. The `release()` function releases this line high in preparation for another input trigger.

Example:

```
-- Set digio line 1 to output a indefinite external trigger.
digio.trigger[1].mode = digio.TRIG_FALLING
digio.trigger[1].pulsewidth = 0
digio.trigger[1].assert()

-- Release digio line 1.
digio.trigger[1].release()

-- Output another external trigger.
digio.trigger[1].assert()
```

## Using the `set()` function to bypass SMU event detectors

The `set()` function is useful whenever you want the SMU to continue operation without waiting for a programmed trigger event.

There is a `set()` function for each SMU event detector. When called, the function immediately satisfies the event detector, allowing the SMU to continue through the trigger model.

A common example of when the `set()` function can be used is when you want the SMU to immediately perform an action the first time through the trigger model even if a programmed trigger event does not occur. The `set()` function can be used to start actions on the SMU in case of a missed trigger event.

Example:

```
-- Immediately satisfies the Arm Event Detector of SMU A.
smua.trigger.arm.set()

-- Sets the Measure Event Detector of SMU A.
smua.trigger.measure.set()
```

## Event detector overruns

If another trigger event is generated before the event detector clears then the trigger object will generate a detector overrun. Detector overruns can be checked by reading the `overrun` attribute of the trigger object. The attribute is set to `true` when an overrun occurs. The `clear()` function can be used to immediately clear the event detector, discarding any history of previous trigger events. The `clear()` function also clears any detector overruns.

---

**NOTE** Detector overruns are not the same as action overruns that are reported in the status model.

---

The following is an example of how to check and respond to detector overruns:

```
testOver = digio.trigger[4].overrun
if testOver == true then
 print ("Digital I/O overrun occurred.")
end
```

## Examples using interactive triggering

### Command interface interactive trigger example

The example below clears triggers, turns on the SMU output, and then enables a 30 second timeout to wait for a command interface trigger. Upon receipt of the trigger, the Series 2600A performs a voltage reading.

**\*TRG example:**

```
-- Clear any previously detected command interface triggers.
trigger.clear()

-- Turn on output.
smua.source.output = smua.OUTPUT_ON

-- Wait 30 seconds for a command interface trigger.
triggered = trigger.wait(30)

-- Get voltage reading.
reading = smua.measure.v()

-- Send command interface trigger to trigger the measurement.
*TRG
```

### Manual triggering example

The following code pauses a script and prompts the operator to press the **TRIG** key when they are ready to continue. If the **TRIG** key is not pressed, the test will continue after waiting 10 minutes (600 seconds).

```
display.clear()
display.trigger.clear()
display.setcursor(1, 1, 0)
display.settext("Take a Break")
display.setcursor(2, 1, 0)
display.settext("Press TRIG to continue")
display.trigger.wait(600)
display.clear()
```

### Digital I/O triggering interactive example

The following example configures digital I/O line 2 as an input trigger and digital I/O line 14 as an output trigger. It commands the Series 2600A to wait for an external input trigger on digital I/O line 2. If a trigger event occurs, the Series 2600A outputs an external trigger on digital I/O line 14. If no trigger event is received on digital I/O line 2, the test is aborted.

```
-- Configure digital I/O lines 2 and 14 for input trigger detection and
-- output trigger generation, respectively.
digio.trigger[2].mode = digio.TRIG_RISINGA
digio.trigger[2].clear()
digio.trigger[14].mode = digio.TRIG_FALLING
digio.trigger[14].pulsewidth = 0.0001

--Wait 15 seconds for a trigger event to occur on digital I/O line 2
trigInput = digio.trigger[2].wait(15)

-- If a trigger event occurs on digital I/O line 2, assert an output
-- trigger on digital I/O line 14. If a trigger event does not occur,
-- then turn off the output of smua and issue a message on the front
-- panel display.
if trigInput == true then
 digio.trigger[14].assert()
else
 smua.source.output = smua.OUTPUT_OFF
 display.screen = display.USER
 display.clear()
 display.setcursor(1, 1)
 display.settext("No trigger received. Test aborted.")
 exit()
end
```

## Hardware trigger modes for synchronization lines

Use hardware triggers to integrate Keithley Instruments and non-Keithley instruments in a test system. The Series 2600A supports 14 digital I/O lines and three TSP-Link synchronization lines that can be used for input or output triggering. For additional information on the hardware trigger modes, see [Section 19](#).

---

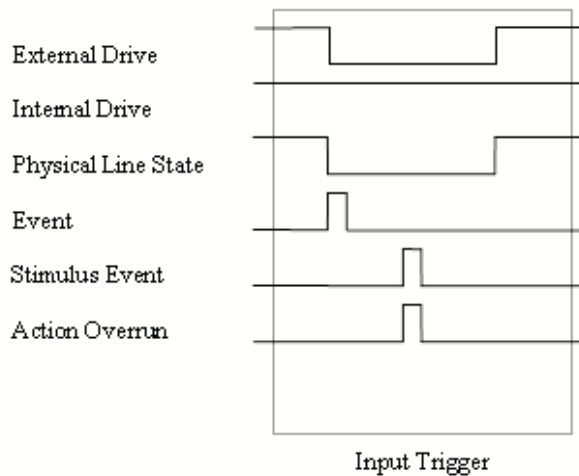
NOTE For direct control of the line state, use the bypass trigger mode.

---

### Falling edge trigger mode

The falling edge trigger mode generates low pulses and detects all falling edges. [Figure 10-11](#) shows the characteristics of the falling edge input trigger. [Figure 10-12](#) shows the falling edge output trigger.

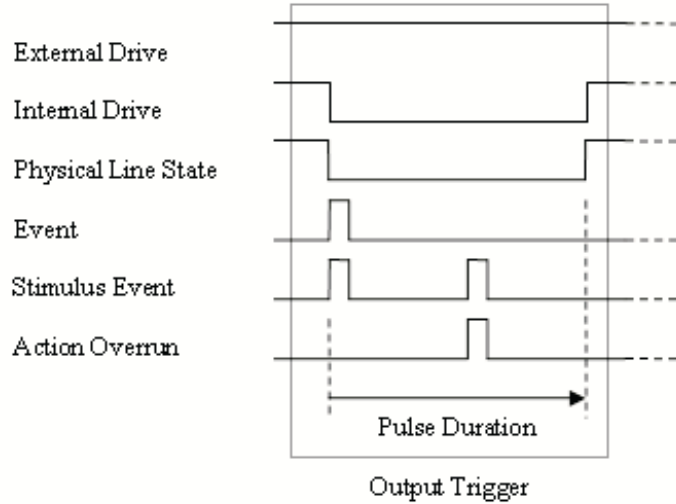
Figure 10-11  
Falling edge input trigger



#### Input characteristics:

- Detects all falling edges as input triggers.
- Output triggers generate a low pulse on the line.

Figure 10-12  
**Falling edge output trigger**



### Output characteristics

- In addition to trigger events from other trigger objects, the `digio.trigger[N].assert` and `tsplink.trigger[N].assert` commands generate a low pulse for the programmed pulse duration.
- An action overrun occurs if the physical line state is low and a source event occurs.



## Rising edge master trigger mode

Use the rising edge master (RisingM) trigger mode (see [Figure 10-13](#)) to synchronize with non-Keithley instruments that require a high pulse. Input trigger detection is not available in this trigger mode. You can use the RisingM trigger mode to generate rising edge pulses.

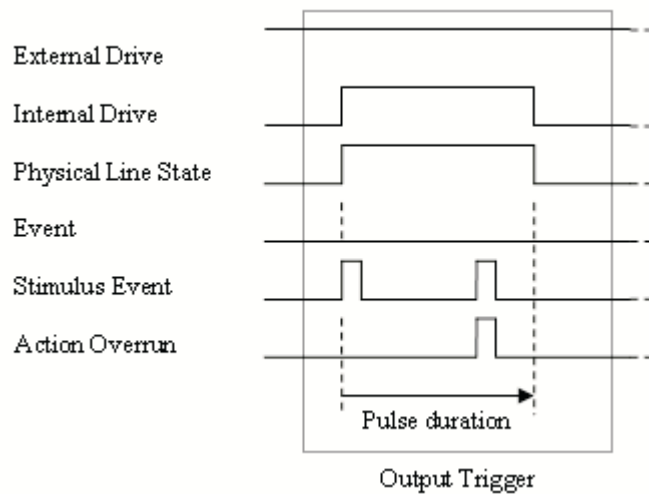
---

NOTE The RisingM trigger mode does not function properly if the line is driven low by an external drive.

---

Figure 10-13

### RisingM output trigger



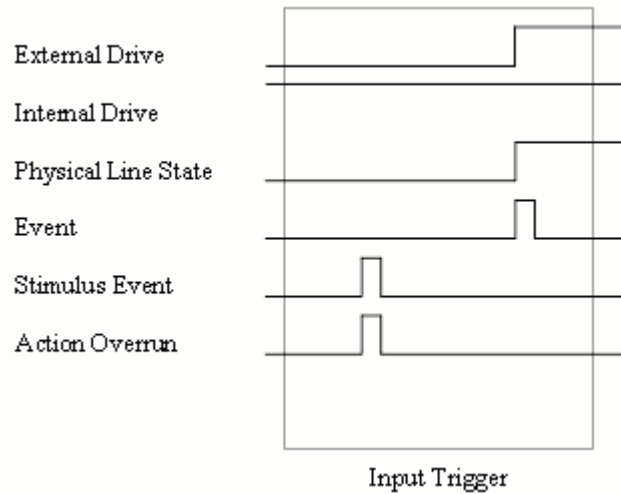
#### Output characteristics:

- Configured trigger events as well as the `digio.trigger[N].assert` and `tsplink.trigger[N].assert` commands cause the physical line state to float high during the trigger pulse duration.
- An action overrun occurs if the physical line state is high while a source event occurs.

## Rising edge acceptor trigger mode

The rising edge acceptor trigger mode (RisingA) generates a low pulse and detects rising edge pulses. [Figure 10-14](#) displays the RisingA input trigger. [Figure 10-15](#) shows the RisingA output trigger.

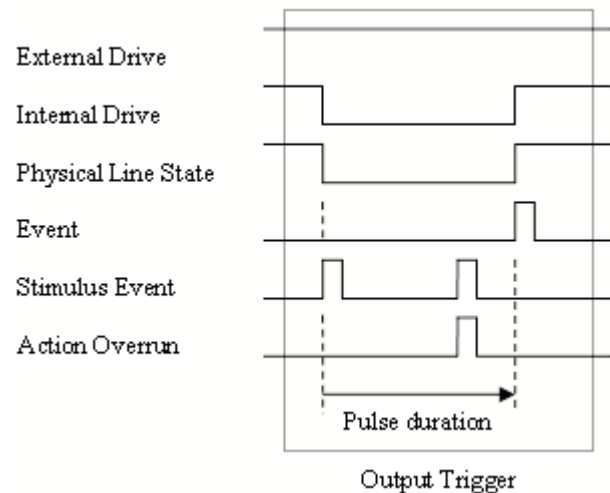
Figure 10-14  
RisingA input trigger



### Input characteristics:

- All rising edges generate an input event.

Figure 10-15  
RisingA output trigger



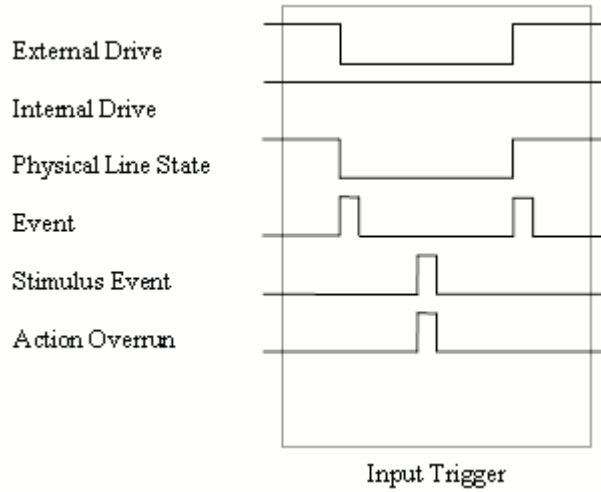
### Output characteristics:

- In addition to trigger events from other trigger objects, the `digio.trigger[N].assert` and `tsplink.trigger[N].assert` commands generate a low pulse that is similar to the falling edge trigger mode.

## Either edge trigger mode

The either edge trigger mode generates a low pulse and detects both rising and falling edges.

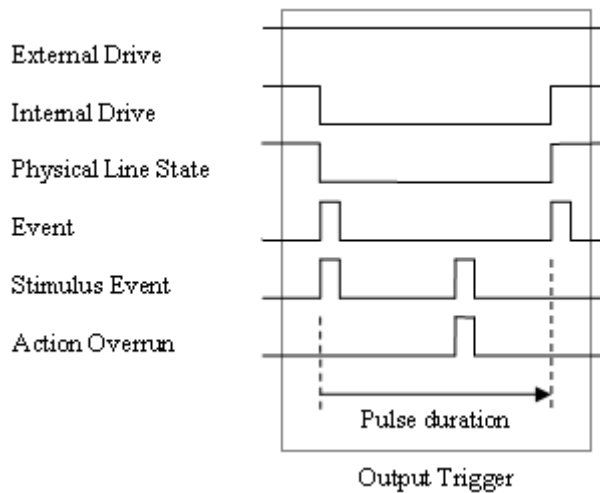
Figure 10-16  
**Either Edge input trigger**



**Input characteristics:**

- All rising or falling edges generate an input trigger event

Figure 10-17  
**Either edge output trigger**



**Output characteristics:**

- In addition to trigger events from other trigger objects, the `digio.trigger[N].assert` and `tsplink.trigger[N].assert` commands generate a low pulse that is similar to the falling edge trigger mode.
- An action overrun occur if the physical line state is low while a source event occurs.

## Understanding synchronous triggering modes

Use the synchronous triggering modes to implement bidirectional triggering, to wait for one node, or to wait for a collection of nodes to complete all triggered actions.

All non-Keithley instrumentation must have a trigger mode that functions similar to the SynchronousA or SynchronousM trigger modes.

To use synchronous triggering, configure the triggering master to SynchronousM trigger mode or the non-Keithley equivalent. Configure all other nodes in the test system to SynchronousA trigger mode or a non-Keithley equivalent.

### Synchronous master trigger mode (SynchronousM)

Use the synchronous master trigger mode (SynchronousM) to generate falling edge output triggers, to detect the rising edge input triggers, and to initiate an action on one or more external nodes with the same trigger line.

In this mode, the output trigger consists of a low pulse. All non-Keithley instruments attached to the synchronization line in a trigger mode equivalent to SynchronousA must latch the line low during the pulse duration.

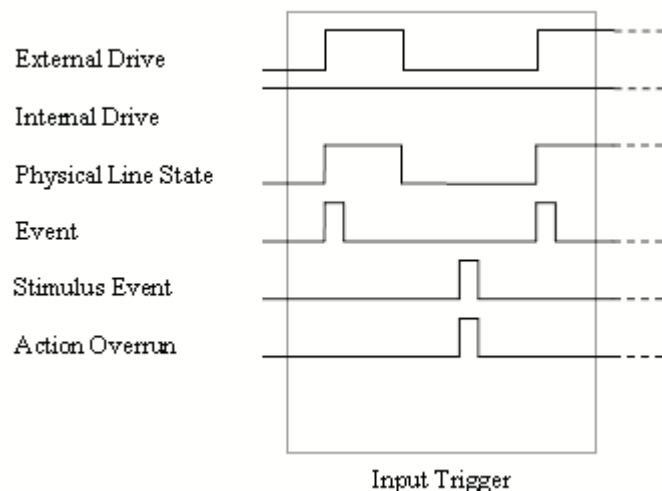
To use the SynchronousM trigger mode, configure the triggering master as SynchronousM and then configure all other nodes in the test system as Synchronous, SynchronousA, or to the non-Keithley Instruments equivalent.

---

NOTE Use the SynchronousM trigger mode to receive notification when the triggered action on all nodes is complete.

---

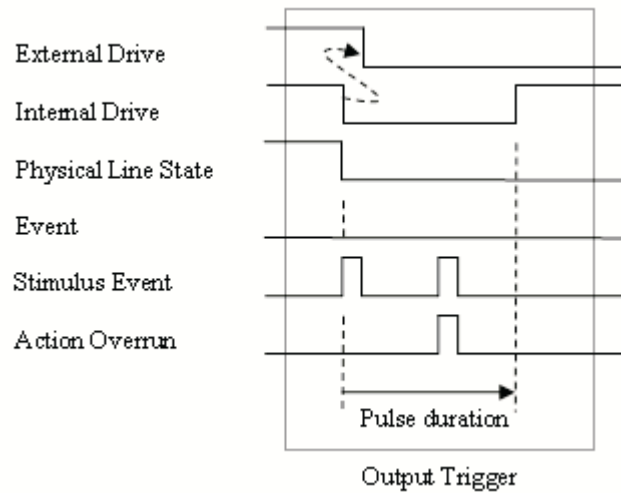
Figure 10-18  
SynchronousM input trigger



#### Input characteristics:

- All rising edges are input triggers
- When all external drives release the physical line, the rising edge is detected as an input trigger
- A rising edge is not detected until all external drives release the line and the line floats high

Figure 10-19  
**SynchronousM output trigger**



**Output characteristics:**

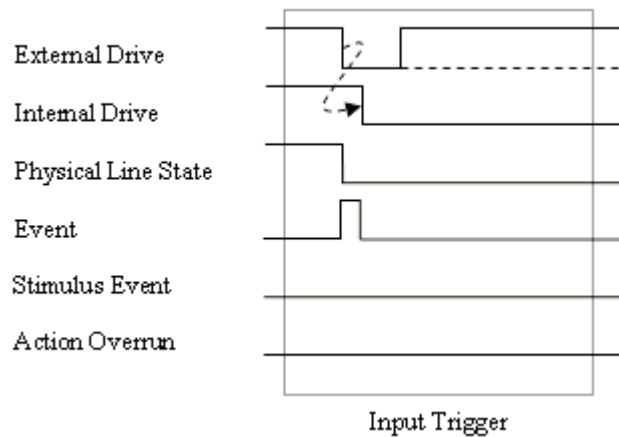
- In addition to trigger events from other trigger objects, the `digio.trigger[N].assert` and `tsplink.trigger[N].assert` commands generate a low pulse that is similar to the falling edge trigger mode
- An action overrun occurs if the physical line state is low while a source event occurs

## Synchronous acceptor trigger mode (SynchronousA)

Use the synchronous acceptor trigger mode (SynchronousA) in conjunction with the SynchronousM trigger mode. The role of the internal and external drives are reversed in the SynchronousA trigger mode.

Figure 10-20

### SynchronousA input trigger

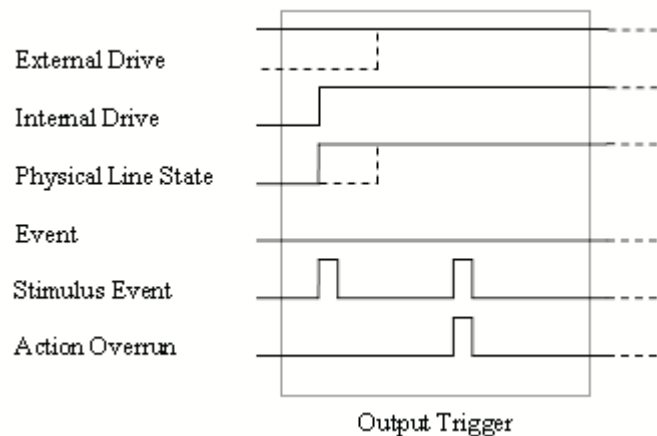


### Input characteristics:

- The falling edge is detected as the external drive pulses the line low, and the internal drive latches the line low.

Figure 10-21

### SynchronousA output trigger



### Output characteristics:

- In addition to trigger events from other trigger objects, the `digio.trigger[N].assert` and `tsplink.trigger[N].assert` commands release the line if the line is latched low. The pulse width is not used.
- The physical line state does not change until all drives (internal and external) release the line.
- Action overruns occur if the internal drive is not latched low and a source event is received.

## Synchronous trigger mode

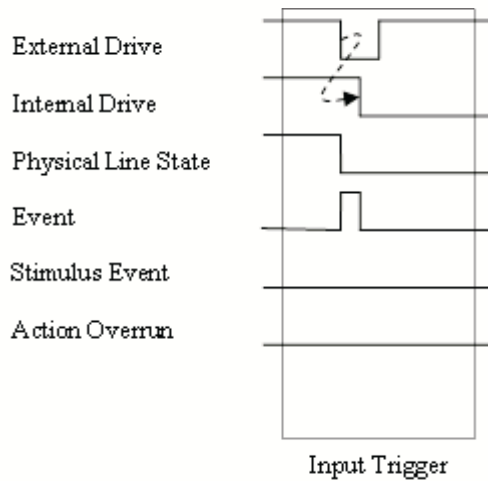
The synchronous trigger mode is a combination of SynchronousA and SynchronousM trigger modes. Use the Synchronous trigger mode for compatibility with older Keithley Instruments products.

---

NOTE Keithley Instruments recommends using SynchronousA and SynchronousM modes only.

---

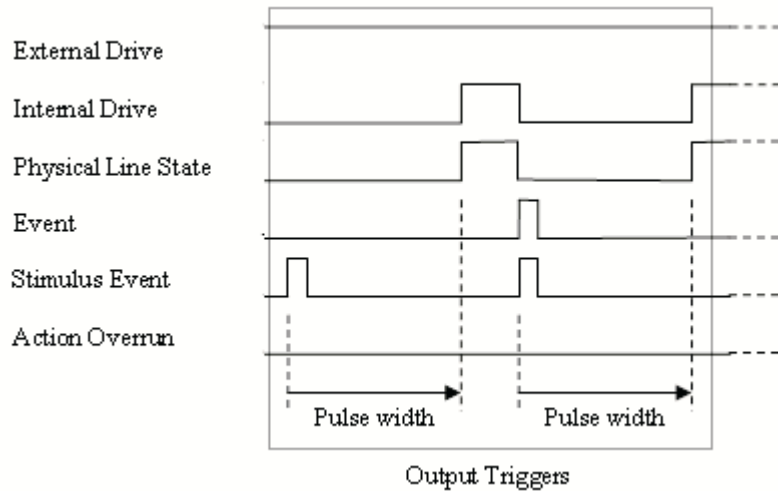
Figure 10-22  
**Synchronous input trigger**



**Input characteristics:**

- The falling edge generates an input event and latches the internal drive low

Figure 10-23  
**Synchronous output trigger**



**Output characteristics:**

- In addition to trigger events from other trigger objects, the `digio.trigger[N].assert` and `tsplink.trigger[N].assert` commands generate a low pulse for the programmed pulse duration if the line is latched low, a falling edge does not occur.
- A normal falling edge pulse generates when the internal drive is not latched low and the `digio.trigger[N].assert` and `tsplink.trigger[N].assert` commands are issued.
- To mirror the SynchronousA trigger mode, set the pulse width to 1  $\mu$ s or any small nonzero value.
- Action overruns are disabled.



---

## Display Operations

### In this section:

| Topic                                         | Page         |
|-----------------------------------------------|--------------|
| <b>Display functions and attributes</b> ..... | <b>11-1</b>  |
| <b>Display features</b> .....                 | <b>11-2</b>  |
| Display screen .....                          | 11-2         |
| Measurement functions .....                   | 11-3         |
| Display resolution .....                      | 11-3         |
| <b>Display messages</b> .....                 | <b>11-4</b>  |
| Clearing the display .....                    | 11-4         |
| Cursor position .....                         | 11-4         |
| Displaying text messages .....                | 11-5         |
| <b>Input prompting</b> .....                  | <b>11-7</b>  |
| Menu .....                                    | 11-7         |
| Parameter value prompting .....               | 11-8         |
| <b>Indicators</b> .....                       | <b>11-9</b>  |
| <b>LOCAL lockout</b> .....                    | <b>11-10</b> |
| <b>Load test menu</b> .....                   | <b>11-10</b> |
| Loading and saving a user script .....        | 11-11        |
| Adding USER TESTS menu entries .....          | 11-11        |
| Deleting USER TESTS menu entries .....        | 11-12        |
| Running a test from the front panel .....     | 11-12        |
| <b>Key-press codes</b> .....                  | <b>11-12</b> |
| Sending key codes .....                       | 11-12        |
| Capturing key-press codes .....               | 11-13        |

## Display functions and attributes

The display functions and attributes are used to perform the display operations covered in this section. [Table 11-1](#) lists each display function/attribute (in alphabetical order) and cross references it to the section topic where the function/attribute is explained.

[Section 19](#) provides additional information on the display functions and attributes.

Table 11-1

**Cross referencing functions/attributes to section topics**

| Function/Attribute                                                        | Section Topic                             |
|---------------------------------------------------------------------------|-------------------------------------------|
| <code>display.clear</code>                                                | <a href="#">Clearing the display</a>      |
| <code>display.getannunciators</code>                                      | <a href="#">Indicators</a>                |
| <code>display.getcursor</code>                                            | <a href="#">Cursor position</a>           |
| <code>display.gettext</code>                                              | <a href="#">Displaying text messages</a>  |
| <code>display.input</code>                                                | <a href="#">Capturing key-press codes</a> |
| <code>display.inputvalue</code>                                           | <a href="#">Parameter value prompting</a> |
| <code>display.loadmenu.add</code><br><code>display.loadmenu.delete</code> | <a href="#">Load test menu</a>            |
| <code>display.locallockout</code>                                         | <a href="#">LOCAL lockout</a>             |
| <code>display.menu</code>                                                 | <a href="#">Menu</a>                      |
| <code>display.prompt</code>                                               | <a href="#">Parameter value prompting</a> |
| <code>display.screen</code>                                               | <a href="#">Display screen</a>            |
| <code>display.sendkey</code>                                              | <a href="#">Sending key codes</a>         |
| <code>display.setcursor</code>                                            | <a href="#">Cursor position</a>           |
| <code>display.settext</code>                                              | <a href="#">Displaying text messages</a>  |
| <code>display.smuX.digits</code>                                          | <a href="#">Display resolution</a>        |
| <code>display.smuX.measure.func</code>                                    | <a href="#">Measurement functions</a>     |
| <code>display.trigger.clear</code><br><code>display.trigger.wait</code>   | <a href="#">Key-press codes</a>           |

## Display features

### Display screen

The Keithley Instruments Series 2600A System SourceMeter® instrument can display source-measure values and readings or user defined messages. The display screen options include the following:

- Source-measure, compliance screens:
  - Display source and compliance values, and measure readings for SMU A.
  - Display source and compliance values, and measure readings for SMU B (Models 2602A/2612A/2636A only).
- Source-measure screen – Display source values and measure readings for SMU A and SMU B (Models 2602A/2612A/2636A only).
- User screen – Display user-defined messages and prompts.

The `display.screen` attribute is used to select the display screen:

```
display.screen = displayId
```

where: `displayId` is set to one of the following values or names:

```
0 Or display.SMUA
```

```
1 Or display.SMUB
2 Or display.SMUA_SMUB
3 Or display.USER
```

**Display screen example:**

The following command displays source-measure and compliance for SMU A:

```
display.screen = display.SMUA
```

## Measurement functions

With a source-measure screen selected, the measured reading can be displayed as volts, amps, ohms or watts.

The `display.smuX.measure.func` attribute is used to select the displayed measure function:

```
display.smuX.measure.func = function
```

where: `smuX = smua Or smub`

`function` is set to one of the following values:

```
0 Or display.MEASURE_DCAMPS
1 Or display.MEASURE_DCVOLTS
2 Or display.MEASURE_OHMS
3 Or display.MEASURE_WATTS
```

**Measurement function example:**

The following command sets SMU A to display ohms measurements:

```
display.smua.measure.func = display.MEASURE_OHMS
```

## Display resolution

Display resolution for measured readings can be set to 4-1/2, 5-1/2 or 6-1/2 digit resolution.

The `display.smuX.digits` attribute is used to set display resolution for measured readings:

```
display.smuX.digits = digits
```

Where: `smuX = smua Or smub`

`digits` is set to one of the following values:

```
4 Or display.DIGITS_4_5
5 Or display.DIGITS_5_5
6 Or display.DIGITS_6_5
```

**Display resolution example:**

The following command sets SMU A for 5-1/2 digit resolution for measured readings:

```
display.smua.digits = display.DIGITS_5_5
```

## Display messages

---

**NOTE** Most of the display functions and attributes that are associated with display messaging will automatically select the user screen. The attribute for the display screen is explained in [Display screen](#).

The reset functions (`reset` or `smuX.reset`) have no effect on the defined display message or its configuration, but will set the display mode back to the previous source-measure display mode.

---

The display of the Series 2600A can be used to display user-defined messages. For example, while a test is running, the following message can be displayed on the Series 2600A.

```
Test in Process
Do Not Disturb
```

The top line of the display can accommodate up to 20 characters (including spaces). The bottom line can display up to 32 characters (including spaces) at a time.

---

**NOTE** The `display.clear`, `display.setcursor`, and `display.settext` functions (which are explained in the following paragraphs) are overlapped, non-blocking commands. The script will NOT wait for one of these commands to complete.

These non-blocking functions do not immediately update the display. For performance considerations, they write to a shadow and will update the display as soon as processing time becomes available.

---

## Clearing the display

When sending a command to display a message, a previously defined user message is not cleared. The new message starts at the end of the old message on that line. It is good practice to routinely clear the display before defining a new message.

After displaying an input prompt, the message will remain displayed even after the operator performs the prescribed action. The `clear` function must be sent to clear the display.

The following command clears both lines of the display, but does not affect any of the indicators:

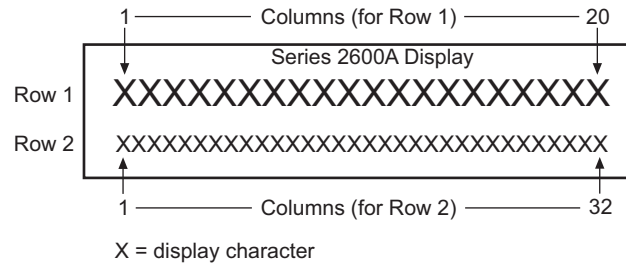
```
display.clear()
```

## Cursor position

When displaying a message, the cursor position determines where the message will start. On power-up, the cursor is positioned at Row 1, Column 1 (see [Figure 11-1](#)). At this cursor position, a user-defined message will be displayed on the top row (Row 1).

Top line text will not wrap to the bottom line of the display automatically. Any text that does not fit on the current line will be truncated. If the text is truncated, the cursor will be left at the end of the line.

Figure 11-1  
**Row/column format for display messaging**



The function to set cursor position can be used two ways:

```
display.setcursor(row, column)
```

```
display.setcursor(row, column, style)
```

where: row = 1 or 2

column = 1 to 20 (Row 1)

= 1 to 32 (Row 2)

style = 0 (invisible)

= 1 (blink)

When set to 0, the cursor will not be seen. When set to 1, a display character will blink to indicate its position.

The `display.getcursor` function returns the present cursor position, and can be used three ways:

```
row, column, style = display.getcursor()
```

```
row, column = display.getcursor()
```

```
row = display.getcursor()
```

**Example:** The following code positions the cursor on Row 2, Column 1, and then reads the cursor position:

```
display.setcursor(2, 1)
```

```
row, column = display.getcursor()
```

```
print (row, column)
```

Output: 2.000000e+00 1.000000e+00

## Displaying text messages

The `display.settext` function is used to define and display a message. The message will start at the present cursor position.

```
display.settext(text)
```

where: text is the text string to be displayed.

**Example:** The following code will display “Test in Process” on the top line, and “Do Not Disturb” on the bottom line:

```
display.clear()
display.setcursor(1, 1, 0)
display.settext("Test in Process")
display.setcursor(2, 6, 0)
display.settext("Do Not Disturb")
```

### Character codes

The following special codes can be embedded in the `text` string to configure and customize the message:

|      |                                                                                                                               |
|------|-------------------------------------------------------------------------------------------------------------------------------|
| \$N  | Newline – Starts text on the next line. If the cursor is already on line 2, text will be ignored after the '\$N' is received. |
| \$R  | Sets text to Normal.                                                                                                          |
| \$B  | Sets text to Blink.                                                                                                           |
| \$D  | Sets text to Dim intensity.                                                                                                   |
| \$F  | Set text to background blink.                                                                                                 |
| \$\$ | Escape sequence to display a single "\$".                                                                                     |

In addition to displaying alpha-numeric characters, other special characters can be displayed. Refer to [Appendix D](#) for a complete listing of special characters and their corresponding codes. For example, to display the Greek symbol omega,  $\Omega$ , use the following:

```
display.clear()
c = string.char(18)
display.settext(c)
```

### Examples

The following code uses the \$N and #B character codes to display the message “Test in Process” on the top line and the blinking message “Do Not Disturb” on the bottom line:

```
display.clear()
display.settext("Test in Process NBDo Not Disturb")
```

The following code uses the \$\$ character code to display the message “You owe me \$8” on the top line:

```
display.clear()
display.setcursor(1, 1)
display.settext("You owe me $$8")
```

If the extra \$ character is not included, the \$8 would be interpreted as an undefined character code and will be ignored. The message “You owe me” will instead be displayed.

---

**NOTE** Care must be taken when imbedding character codes in the text string. It is easy to forget that the character following the `$` is part of the code. For example, assume you want to display “Hello” on the top line and “Nate” on the bottom line, and so you send the following command:

```
display.settext("Hello$Nate")
```

The above command displays “Hello” on the top line and “ate” on the bottom line. The correct syntax for the command is as follows:

```
display.settext("Hello$NNate")
```

---

## Returning a text message

The `display.gettext` function returns the displayed message and can be used in five ways:

```
text = display.gettext()
```

```
text = display.gettext(embellished)
```

```
text = display.gettext(embellished, row)
```

```
text = display.gettext(embellished, row, column start)
```

```
text = display.gettext(embellished, row, column start, column end)
```

`embellished` Set to `false` to return text as a simple character string. Set to `true` to include character codes.

`row` Set to 1 or 2 to select which row to read text from. If not included, text from both rows is read.

`column start` Set to starting column for reading text.

`column end` Set to ending column for reading text.

Sending the command without the `row` parameter returns both lines of the display. The `$N` character code will be included to show where the top line ends and the bottom line begins. The `$N` character code will be returned even if `embellished` is set to `false`.

With `embellished` set to `true`, all other character codes that were used in the creation of each message line will be returned along with the message. With `embellished` set to `false`, only the message will be returned.

Sending the command without the `column start` parameter defaults to Column 1. Sending the command without the `column end` argument defaults to the last column (Column 20 for Row 1, Column 32 for Row 2).

## Input prompting

Display messaging can also be used along with front panel controls to make a user script interactive. For an interactive script, input prompts are displayed so that the operator can perform a prescribed action using the front panel controls. While displaying an input prompt, the test will pause and wait for the operator to perform the prescribed action from the front panel.

## Menu

A user-defined menu can be presented on the display. The menu consists of the menu name on the top line, and a selectable list of menu items on the bottom line. The following function is used to define a menu:

```
display.menu(menu, items)
```

where: `menu` is the name of the menu (string up to 20 characters, including spaces). The `items` string is made up of one or more menu items, where each item must be separated by whitespace.

When the `display.menu` function is executed, script execution will wait for the operator to select one of the menu items. Rotate the Wheel to place the blinking cursor on the desired menu item. Items that don't fit in the display area will be displayed by rotating the wheel to the right. With the cursor on the desired menu item, press the Rotary Wheel (or the Enter key) to select it.

Pressing the EXIT key will not abort the script while the menu is displayed, but it will return `nil`. The script can be aborted by calling the `exit` function when `nil` is returned.

Example: The menu for the following code will present the operator with the choice of two menu items: Test1 or Test2. If Test1 is selected, the message "Running Test1" will be displayed. If Test2 is selected, the message "Running Test2" will be displayed.

```
display.clear()
menu = display.menu("Sample Menu", "Test1 Test2")
if (menu == "Test1") then
 display.settext("Running Test1")
else display.settext("Running Test2")
end
```

## Parameter value prompting

There are two functions to create an editable input field on the user screen at the present cursor position: `display.inputvalue` and `display.prompt`.

The `display.inputvalue` function uses the user screen at the present cursor position. Once the command is finished, it returns the user screen back to its previous state. The `display.prompt` function creates a new edit screen and does not use the user screen.

Each of these two functions can be used in four ways:

```
display.inputvalue(format)
display.inputvalue(format, default)
display.inputvalue(format, default, min)
display.inputvalue(format, default, min, max)
display.prompt(format, units, help)
display.prompt(format, units, help, default)
display.prompt(format, units, help, default, min)
display.prompt(format, units, help, default, min, max)
```

`format` – The `format` string creates an editable input field on the user screen at the present cursor position. Examples of the `format` for an input field:

```
+0.00 00 +00.0000E +00 0.00000E+0
```

Value field:

- + Include a "+" sign for positive/negative value entry. Not including the "+" sign prevents negative value entry.
- 0 Defines the digit positions for the value. Up to six zeros (0) can be used for the value (as shown above in the third and fourth examples).



- . If used, include the decimal point (.) where needed for the value.

Exponent field (optional):

- E Include the “E” for exponent entry.
- + Include a “+” sign for positive/negative exponent entry. Not including the “+” sign prevents negative exponent entry.
- 0 Defines the digit positions for the exponent.

`default` – Use this option to set a default value for the parameter. The `default` value will be displayed when the command is sent.

`min and max` There are options to specify minimum and maximum limits for the input field. When NOT using the “+” sign for the value field, the minimum limit cannot be set to less than zero. When using the “+” sign, the minimum limit can be set to less than zero (for example, -2).

`units and help` `units` is a text string to identify the units for the value (8 characters maximum). Example units text is “V” for volts and “A” or amps. `help` is an information text string to display on the bottom line (32 characters maximum).

The two functions are similar in that they both display the editable input field, but the `display.inputvalue` function does not include the text strings for `units` and `help`.

After one of the above functions is executed, script execution will pause and wait for the operator in input the source level. The program will continue after the operator enters the value by pressing the Rotary Wheel or the Enter key.

### Examples:

The following code will prompt the operator to enter a source value:

```
display.clear()
value = display.prompt("0.00", "V", "Enter source voltage")
display.screen = display.SMUA
smua.source.levelv = value
```

The script will pause after displaying the prompt message and wait for the operator to enter the voltage level. The display will then toggle to the source-measure display for SMU A and set the source level to `value`.

---

**NOTE** If the operator presses EXIT instead of entering a source value, `value` will be set to `nil`.

---

The second line of the above code can be replaced using the other input field function:

```
value = display.inputvalue("0.00")
```

The only difference is that the display prompt will not include the “V” units designator and the “Enter source value” message.

## Indicators

Send the following code to determine which display indicators are turned on:

```
annun = display.getannunciators()
print(annun)
```

The 16-bit binary equivalent of the returned value is a bitmap. Each bit corresponds to an indicator. If the bit is set to “1”, the indicator is turned on. If the bit is set to “0”, the indicator is turned off.

[Table 11-2](#) identifies the bit position for each indicator. The table also includes the weighted value of each bit. The returned value is the sum of all the weighted values for the bits that are set.

For example, assume the returned bitmap value is 34061. The binary equivalent of this value is as follows:

```
1000010100001101
```

For the above binary number, the following bits are set to “1”: 16, 11, 9, 4, 3 and 1. Using [Table 11-2](#), the following indicators are on: REL, REM, EDIT, AUTO, 4W and EDIT.

Table 11-2

**Bit identification for indicators**

|                 |       |       |      |      |      |      |      |      |
|-----------------|-------|-------|------|------|------|------|------|------|
| Bit             | 16    | 15    | 14   | 13   | 12   | 11   | 10   | 9    |
| Annunciator     | REL   | REAR  | SRQ  | LSTN | TALK | REM  | ERR  | EDIT |
| Weighted Value* | 32768 | 16384 | 8192 | 4096 | 2048 | 1024 | 512  | 256  |
| Binary Value    | 0/1   | 0/1   | 0/1  | 0/1  | 0/1  | 0/1  | 0/1  | 0/1  |
| Bit             | 8     | 7     | 6    | 5    | 4    | 3    | 2    | 1    |
| Annunciator     | SMPL  | STAR  | TRIG | ARM  | AUTO | 4W   | MATH | FILT |
| Weighted Value* | 128   | 64    | 32   | 16   | 8    | 4    | 2    | 1    |
| Binary Value    | 0/1   | 0/1   | 0/1  | 0/1  | 0/1  | 0/1  | 0/1  | 0/1  |

\* The weighted values are for bits that are set to “1.” Bits set to “0” have no value.

Note that not all of the above indicators shown in [Table 11-2](#) are used by the Series 2600A.

## LOCAL lockout

The front panel LOCAL key is used to cancel remote operation and return control to the front panel. However, the LOCAL key can be locked out to prevent a test from being interrupted. When locked, the LOCAL key becomes a NO-OP (no operation). Use the following attribute to lock or unlock the LOCAL key:

```
display.locallockout = lockout
```

where lockout is set to one of the following values:

```
0 or display.UNLOCK
```

```
1 or display.LOCK
```

**LOCAL lockout example:**

The following command locks out the LOCAL key:

```
display.locallockout = display.LOCK
```

## Load test menu

The LOAD TEST menu lists script tests (USER and FACTORY) that can be run from the front panel. Factory script tests (functions) are pre-loaded and saved in nonvolatile memory at the factory. They are available in the FACTORY TESTS submenu.

After a user script is loaded into the Series 2600A, it is not automatically added to the front panel USER TESTS submenu. A menu name and a chunk is added by the user (see [Adding USER TESTS menu entries](#)).

## Loading and saving a user script

After a user script is loaded into the Series 2600A it can be saved in nonvolatile memory. If it is not stored in nonvolatile memory, the script will be lost when the Series 2600A is turned off.

When loading a script from the Test Script Builder, the launch can be configured to save the script in nonvolatile memory (see [Using Test Script Builder](#) in [Section 13](#)).

When loading a user script from another program, `myscript.save()` is used to save the script in nonvolatile memory (see [Saving a user script](#) in [Section 12](#)).

## Adding USER TESTS menu entries

The following function can be used in two ways to add an entry into the USER TESTS submenu:

```
display.loadmenu.add(displayname, chunk)
```

```
display.loadmenu.add(displayname, chunk, memory)
```

`displayname`    Name string to add to the menu.

`chunk`            Chunk is the code to be executed.

`memory`           Save or don't save `chunk` and `displayname` in nonvolatile memory.

Set `memory` to one of the following values:

0 Or `display.DONT_SAVE`

1 Or `display.SAVE`

The default `memory` setting is `display.SAVE`.

The `chunk` can be made up of scripts, functions, variables and commands. With `memory` set to `display.SAVE`, commands are saved with the `chunk` in nonvolatile memory. Scripts, functions and variables used in the `chunk` are not saved by `display.SAVE`. Functions and variables need to be saved along with the script (see [Loading and saving a user script](#)). If the script is not saved in nonvolatile memory, it will be lost when the Series 2600A is turned off. See **Example 1** below.

### Example 1:

Assume a script with a function named “DUT1” has already been loaded into the Series 2600A, and the script has NOT been saved in nonvolatile memory.

Now assume you want to add a test named “Test” to the USER TESTS menu. You want the test to run the function named “DUT1” and sound the beeper. The following command will add “Test” to the menu, define the chunk, and then save `displayname` and `chunk` in nonvolatile memory:

```
display.loadmenu.add("Test", "DUT1() beeper.beeper(2, 500)", display.SAVE)
```

When “Test” is run from the front panel USER TESTS menu, the function named “DUT1” will execute and the beeper will beep for two seconds.

Now assume you cycle power on the Series 2600A. Since the script was not saved in nonvolatile memory, the function named “DUT1” is lost. When “Test” is again run from the front panel, the beeper will beep, but “DUT1” will not execute because it no longer exists in the chunk.

### Example 2:

The following command adds an entry called “Part1” to the front panel “USER TESTS” submenu for the chunk “testpart([[Part1]], 5.0)”, and saves it in nonvolatile memory:

```
display.loadmenu.add("Part1", "testpart([[Part1]], 5.0)", display.SAVE)
```

## Deleting USER TESTS menu entries

The following function can be used to delete an entry from the front panel USER TESTS submenu:

```
display.loadmenu.delete(displayname)
displayname Name to delete from the menu.
```

### Example:

The following command removes the entry named "Part1" from the front panel USER TESTS submenu:

```
display.loadmenu.delete("Part1")
```

## Running a test from the front panel

Front panel user tests and factory tests can be run as follows:

1. Press the LOAD key to display the LOAD TEST menu.
2. Select the USER or FACTORY menu item.
3. Position the blinking cursor on the test to be run and press ENTER or the wheel.
4. Press the RUN key to run the test.

## Key-press codes

### Sending key codes

Key codes are provided to remotely "press" a front key or the navigation wheel. There are also key codes to "rotate" the **navigation wheel** to the left or right (one click at a time). Use the `display.sendkey` function to perform these actions:

```
display.sendkey(keycode)
```

Where: `keycode` is the value of the front panel control. The key code for each control is listed alphabetically in [Table 11-3](#).

### Key press example:

Either of the following commands will press the **MENU** key:

```
display.sendkey(display.KEY_MENU)
```

```
display.sendkey(68)
```

Table 11-3  
**Key codes to send for display.sendkey**

|                           |                             |
|---------------------------|-----------------------------|
| display.KEY_AUTO or 73    | display.KEY_OUTPUTA or 88   |
| display.KEY_CONFIG or 80  | display.KEY_OUTPUTB or 96   |
| display.KEY_DIGITSA or 87 | display.KEY_RANGEDOWN or 81 |
| display.KEY_DIGITSB or 84 | display.KEY_RANGEUP or 65   |
| display.KEY_DISPLAY or 72 | display.KEY_RECALL or 85    |
| display.KEY_ENTER or 82   | display.KEY_RELA or 70      |
| display.KEY_EXIT or 75    | display.KEY_RELB or 67      |
| display.KEY_FILTERA or 77 | display.KEY_RIGHT or 103    |
| display.KEY_FILTERB or 74 | display.KEY_RUN or 71       |
| display.KEY_LEFT or 104   | display.KEY_SPEEDA or 94    |
| display.KEY_LIMITA or 93  | display.KEY_SPEEDB or 91    |
| display.KEY_LIMITB or 90  | display.KEY_SRC A or 79     |
| display.KEY_LOAD or 95    | display.KEY_SRC B or 76     |
| display.KEY_MEASA or 86   | display.KEY_STORE or 78     |
| display.KEY_MEASB or 83   | display.KEY_TRIG or 92      |
| display.KEY_MENU or 68    | display.WHEEL_ENTER or 97   |
| display.KEY_MODEA or 69   | display.WHEEL_LEFT or 107   |
| display.KEY_MODEB or 66   | display.WHEEL_RIGHT or 114  |

## Capturing key-press codes

A history of the key code for the last pressed front panel key is maintained by the Series 2600A. When the instrument is powered-on (or when transitioning from local to remote), the key code is set to 0 (`display.KEY_NONE`).

When a front panel key is pressed, the key code value for that key can be captured and returned. There are two functions associated with the capture of key-press codes: `display.getlastkey` and `display.waitkey`.

### `display.getlastkey`

The `display.getlastkey` function is used to immediately return the key code for the last pressed key:

```
key = display.getlastkey()
print(key)
```

The above code will return the key code value (see [Table 11-4](#)). Keep in mind that a value of 0 (`display.KEY_NONE`) indicates that the key code history had been cleared.

Table 11-4  
**Key code values returned for display.getlastkey**

|                            |                           |
|----------------------------|---------------------------|
| 0 (display.KEY_NONE)       | 82 (display.KEY_ENTER)    |
| 65 (display.KEY_RANGEUP)   | 83 (display.KEY_MEASB)    |
| 67 (display.KEY_RELB)      | 84 (display.KEY_DIGITSB)  |
| 68 (display.KEY_MENU)      | 85 (display.KEY_RECALL)   |
| 69 (display.KEY_MODEA)     | 86 (display.KEY_MEASA)    |
| 70 (display.KEY_RELA)      | 87 (display.KEY_DIGITSA)  |
| 71 (display.KEY_RUN)       | 90 (display.KEY_LIMITB)   |
| 72 (display.KEY_DISPLAY)   | 91 (display.KEY_SPEEDB)   |
| 73 (display.KEY_AUTO)      | 92 (display.KEY_TRIG)     |
| 74 (display.KEY_FILTERB)   | 93 (display.KEY_LIMITA)   |
| 75 (display.KEY_EXIT)      | 94 (display.KEY_SPEEDA)   |
| 76 (display.KEY_SRCB)      | 95 (display.KEY_LOAD)     |
| 77 (display.KEY_FILTERA)   | 97 (display.WHEEL_ENTER)  |
| 78 (display.KEY_STORE)     | 103 (display.KEY_RIGHT)   |
| 79 (display.KEY_SRCA)      | 104 (display.KEY_LEFT)    |
| 80 (display.KEY_CONFIG)    | 114 (display.WHEEL_RIGHT) |
| 81 (display.KEY_RANGEDOWN) |                           |

---

**NOTE** The OUTPUT ON/OFF keys for SMU A and SMU B cannot be tracked by this function.

---

### **display.waitkey**

The `display.waitkey` function captures the key code value for the next key press:

```
key = display.waitkey()
```

After sending the `display.waitkey` function, the script will pause and wait for the operator to press a front panel key. For example, if the **MEAS** key is pressed, the function will return the value 86, which is the key code for that key. The key code values are listed in [Table 11-3](#).

**Example:** The following code will prompt the user to press the **EXIT** key to abort the script, or any other key to continue it:

```
display.clear()
display.setcursor(1, 1)
display.settext("Press EXIT to Abort")
display.setcursor(2, 1)
display.settext("or any key to continue")
key = display.waitkey()
display.clear()
display.setcursor(1, 1)
if (key == 75) then
 display.settext("Test Aborted")
 exit()
else display.settext("Test Continuing")
end
```

The above code captures the key that is pressed by the operator. The key code value for the **EXIT** key is 75. If **EXIT** is pressed, the script aborts. If any other key is pressed, the script will continue.

---

## TSP Fundamentals and Script Management

### In this section:

| Topic                                                    | Page        |
|----------------------------------------------------------|-------------|
| <b>Introduction</b> .....                                | <b>12-2</b> |
| Test Script Processor (TSP) .....                        | 12-2        |
| Run-time environment .....                               | 12-2        |
| Queries .....                                            | 12-3        |
| Scripts .....                                            | 12-3        |
| Naming scripts .....                                     | 12-3        |
| Renaming Scripts .....                                   | 12-4        |
| Functions .....                                          | 12-4        |
| Scripts that create functions .....                      | 12-4        |
| <b>Programming overview</b> .....                        | <b>12-5</b> |
| What is a chunk? .....                                   | 12-5        |
| What is a script? .....                                  | 12-5        |
| Run-time environment .....                               | 12-6        |
| Nonvolatile memory .....                                 | 12-6        |
| TSP script types .....                                   | 12-7        |
| Programming model for scripts .....                      | 12-7        |
| <b>User scripts</b> .....                                | <b>12-8</b> |
| Creating a user script .....                             | 12-8        |
| Script examples .....                                    | 12-9        |
| Saving a user script .....                               | 12-11       |
| Loading scripts from the USB flash drive .....           | 12-13       |
| Running a user script .....                              | 12-14       |
| Modifying a user script .....                            | 12-15       |
| Script management .....                                  | 12-16       |
| Memory considerations for the run-time environment ..... | 12-18       |

## Introduction

Conventional instrumentation responds to command messages sent to the instrument. Each command message contains one or more commands. The instrument executes these commands in order.

To conduct a test, a computer (controller) is programmed to send sequences of commands to an instrument. The controller orchestrates the actions of the instrumentation. The controller is typically programmed to request measurement results from the instrumentation and make test sequence decisions based on those measurements.

Keithley Instruments' Test Script Processor-based instruments can operate as conventional instruments by responding to a sequence of command messages sent by a controller. They are also capable of much more.

## Test Script Processor (TSP)

**Scripting** To orchestrate a sequence of actions.

**Scripting Language** A programming language used for scripting.

The Test Script Processor (TSP) is a scripting engine that runs inside the instrument. It is capable of running code written in a scripting language called Lua ([www.lua.org](http://www.lua.org)). We will refer to Lua as the Test Script Language (TSL). The TSP runs portions of TSL code formally known as chunks. Most messages sent to the instrument are directly executed by the TSP as TSL chunks. The simplest messages sent to the instrument would be individual instrument control commands. Even though these messages are executed as TSL chunks, using them is no different than using a conventional instrument. The user sends a command message and the instrument executes that command. When sending individual command messages, it is irrelevant that the TSP is executing the message as a chunk.

Instrument control commands are implemented as a library within the TSL. The command set for a TSP-enabled instrument is referred to as the Instrument Control Library (ICL) for that instrument. Each TSP-enabled instrument will have its own ICL. Although each TSP-enabled instrument runs the same TSL, different instruments respond to different commands and the ICL for each instrument may be different.

ICL commands are very similar to the commands sent to a conventional instrument but ICL commands look like function calls or assignment statements. For example the command to set the output voltage level to one volt on Channel A is `smua.source.levelv = 1`. Similarly, the command to turn the Channel A output on is `smua.source.output = smua.OUTPUT_ON`. These commands, when sent individually as separate messages, are each a TSL chunk.

Commands do not need to be sent as separate messages. The two commands from above can be combined into one message, and thereby one chunk, by concatenating the two commands together with a space separating them. The resulting chunk would be as follows:

```
smua.source.levelv = 1 smua.source.output = smua.OUTPUT_ON
```

## Run-time environment

A feature of all scripting environments is the run-time environment. In the TSP, the run-time environment is simply a collection of global variables. A global variable can be used to remember a value as long as the unit is powered on and the variable is not assigned a new value. The command `x = smua.measure.v()` instructs the instrument to measure voltage and store the result in a global variable named "x."



A global variable can be removed from the environment by assigning it the `nil` value. For example, the command `x = nil` will remove the global variable `x` from the run-time environment. When the unit is turned off, the entire run-time environment will be lost.

## Queries

TSP-enabled instruments do not have inherent query commands. Like any other scripting environment the `print` command and other related `print` commands are used to generate output. The `print` command will create one response message.

An example of generating an output message is the following chunk (two commands) that takes a measurement and returns its value:

```
x = smua.measure.v() print(x)
```

Note that the measurement value is stored in the global variable `x` between the two commands.

## Scripts

When taking advantage of the TSP to perform more complicated sequences of commands, especially sequences utilizing advanced scripting features such as looping and branching, sending the entire sequence in one message is very cumbersome. Two special messages can be used to collect a sequence of command messages together into one chunk.

The `loadscript` message will instruct the TSP-enabled instrument to begin collecting all subsequent messages rather than executing them immediately. After sending the sequence of command messages, the `endscript` message is used to instruct the TSP-enabled instrument to compile the test sequence and make it available to run in a subsequent message. This chunk is called the “anonymous script.”

The anonymous script can be run at any time by sending the command `script.run()`. The anonymous script can be run many times without needing to re-send it. Each time the `script.run()` command is given, the anonymous script will be executed.

Sending a new script using the `loadscript` and `endscript` messages will instruct the TSP-enabled instrument to replace the anonymous script with the new script. While creating and using scripts this way is a very powerful feature of TSP-enabled instruments, only being able to access one script at a time in this way would be very limited. [Naming scripts](#) (below) describes how to use named scripts to store many scripts in the instrument at one time.

## Naming scripts

The `loadscript` message can also be used to create named scripts. When the `loadscript` message is used to create a named script, the anonymous script is not replaced with the named script. Instead, it creates an entry in the `script.user.scripts` table under the name given. In addition, a global variable with the same name in the run-time environment is created to reference the script. Because the script is referenced by a global variable, the name of the script must be a legal TSL variable name.

The name of the script can be specified by including it in the `loadscript` message. The message `loadscript MyScript` instructs the TSP-enabled instrument to begin gathering command messages that are used to create a script named `MyScript`. Upon receipt of the `endscript` message, the instrument compiles the script. If there are no errors, the script can be accessed using the global variable `MyScript`. For example, the script may be executed at any time by sending the `MyScript()` message.

If a new script is sent with the same name, the previous script becomes an unnamed script. If there are no other variables referencing the previous script, it is effectively removed. Sending new scripts with different names will not remove any previously sent scripts. By using named scripts,

any number of scripts can be made available simultaneously within the limits of the memory available to the run-time environment.

Named scripts are stored in the run-time environment which means that when the unit is powered off, they are lost. There is nonvolatile storage on the instrument that can be used to store downloaded scripts across power cycles. See [Saving a user script](#) for more information.

## Renaming Scripts

It may be useful to rename user scripts after they have already been stored. Renaming may be necessary because scripts are saved to internal nonvolatile memory by name and there can be only one script in nonvolatile storage with each given name. It may also be useful because scripts loaded from a USB memory stick will not overwrite scripts already loaded with a given name.

The name of a script can be accessed by using the `MyScript.name` command. To change the name of a script, use the following example:

```
MyScript.name = "TestScript"
```

Where: `MyScript` is the global variable and `"TestScript"` is the new name of the user script.

This command renames the script that `MyScript` was previously referencing. Changing the name of a script does not change the name of any variables that reference that script. After changing the name, the script will be found in the `script.user.scripts` table under its new name.

For example, `"TestScript"` can be run using the `script.user.scripts.TestScript()` command. It can also be run by using the command `MyScript.run()` until `MyScript` is set to `nil`.

## Functions

As previously explained, named scripts behave like TSL functions. Executing a script is just like executing a function with the same name as the script. Scripts, like functions, may return values. Unlike functions, scripts may not take any parameters. In order to pass parameters to a chunk, you must include a TSL function (referred to in this example as *function body*).

Functions are created with a message in one of the following forms:

```
MyFunction = function (parameter1, parameter2) function_body end
```

or

```
function MyFunction(parameter1, parameter2) function_body end
```

Where *function body* is a TSP chunk that will be executed when the function is called. The above function can be executed by substituting appropriate values for `parameter1` and `parameter2` and inserting them into the following message:

```
MyFunction(value_for_parameter1, value_for_parameter2)
```

Where `value_for_parameterN` represents the values to be passed to the function call for the given parameters. Note that when a function is defined, it is just another global variable in the run-time environment. Just like all global variables, functions will persist until they are removed from the run-time environment, overwritten, or the unit is turned off.

## Scripts that create functions

It is inconvenient in most cases to define a function in one message. The solution is to create a script that defines a function. The scripts will be like any other script. It will not cause any action to be performed on the instrument until it is executed. Remember that creating a function is just creating a global variable that is a function. That global variable will not exist until the chunk that

creates it is executed. In this case the chunk that creates it is a script. Therefore, the function will not exist until the script that creates it is executed. This is often confusing to first time users.

**Example:** Create the function `MyFunction` with a script named `MakeMyFunction`. The sequence of messages to do this is shown as follows:

```
loadscript MakeMyFunction
 MyFunction = function (who)
 print("Hello " .. who) -- The .. operator concatenates two strings.
 end
endscript
```

After this sequence of messages is sent, the `MakeMyFunction` script exists on the instrument in a global variable named `MakeMyFunction`. The `MyFunction` function however does not yet exist because we have not executed the `MakeMyFunction` script. Let us now send the message `MakeMyFunction()`. That message instructs the instrument to run the `MakeMyFunction` script which then creates the `MyFunction` global variable that happens to be a function.

If we now send the message `MyFunction("world")`, the instrument will execute the `MyFunction` function, which causes the instrument to generate a response message with the text "Hello world" in it.

## Programming overview

### What is a chunk?

A chunk is a single programming statement or a sequence of statements that are executed sequentially. There are non-scripted chunks and scripted chunks.

**Single statement chunk:** The following programming statement is a chunk:

```
print("This is a chunk")
```

When the above chunk is executed, it returns the following string:

```
This is a chunk
```

**Multiple statement chunk:** A chunk can also contain multiple statements. Each statement in the line of code is to be separated by white space. The following chunk contains two statements:

```
print("This is a chunk") print("that has two statements")
```

When the above chunk is executed, the two statements are executed sequentially and the following strings are returned:

```
This is a chunk
that has two statements
```

**Multiple chunks:** When sent separately, the following two lines of code are two separate chunks. The first chunk sets the source level of SMU A to 1V and the second chunk turns the output on.

```
smua.source.levelv = 1
smua.source.output = smua.OUTPUT_ON
```

**Scripted chunk:** In a script environment, the chunk is the entire listing of test programming code. If the two statements in the above example were created as a script, then those two lines of code would be considered one chunk. See the topic below, [What is a script?](#)

### What is a script?

The Series 2600A utilizes a Test Script Processor (TSP) to process and run individual chunks or programs called "scripts". A script is a collection of instrument control commands and

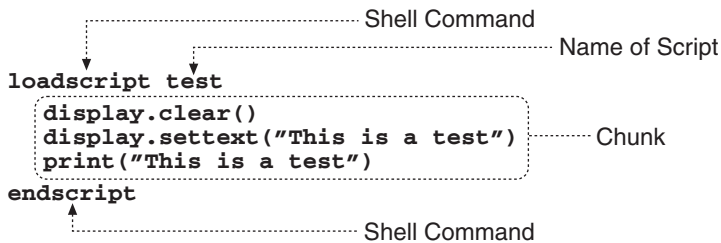
programming statements. [Figure 12-1](#) shows an example of how to create (and load) a script named “test.” When this script is run, the message “This is a test” will be displayed on the Series 2600A and sent to the PC.

As shown, a script is made up of a chunk of programming code that is framed by shell commands. The first shell command in [Figure 12-1](#) tells the instrument to start loading the script named “test.” The last shell command marks the end of the script.

The chunk in [Figure 12-1](#) consists of three lines of code. When the chunk is executed, the test messages will be sent and displayed. The following command executes the chunk: `test()`

Figure 12-1

### Script example



A script is loaded into the Series 2600A where it can be run. Running a script at the SourceMeter is faster than running a test program from the PC. The piecemeal transmission process from PC to SourceMeter instrument is eliminated by the use of a script.

Program statements control script execution and provide facilities such as variables, functions, branching, and loop control. Because scripts are programs, they are written using a programming language. This language is called the Test Script Language or TSL. TSL is an implementation of the Lua scripting language.

There are two types of scripts: Factory scripts and user scripts. A factory script was created by Keithley Instruments at the factory and stored in nonvolatile memory of the Series System 2600A SourceMeter. Factory scripts cannot be removed from nonvolatile memory. A user script can be created using your own program or the Test Script Builder integrated development environment (IDE), which is a supplied software tool (see [Using Test Script Builder](#) in [Section 13](#)). User scripts are loaded into the Series 2600A run-time environment where they can be run and/or saved to nonvolatile memory.

## Run-time environment

The run-time environment is a collection of global variables (including scripts) the user has created. After scripts are placed into the run-time environment, they are then ready to be run and/or managed. Scripts are placed in the run-time environment as follows:

- Scripts saved in [Nonvolatile memory](#) of the Series 2600A are automatically recalled into the run-time environment when the instrument is turned on
- Scripts loaded by the user since the unit was last turned on are stored in the runtime environment

## Nonvolatile memory

After a new or modified user script is loaded into the Series 2600A, it resides in the run-time environment and will be lost when the unit is turned off. To save a script after power-down, the script must be saved in the nonvolatile memory. When the Series 2600A is turned back on, all saved scripts will be loaded into the [Run-time environment](#).

Do not confuse the run-time environment with the nonvolatile memory of the Series 2600A. Making changes to a script in the run-time environment does not affect the stored version of that

script. After making changes, saving the script will overwrite the old version of the script in nonvolatile memory.

## TSP script types

Instrument Control Library (ICL) commands and TSL programming statements are used to program and control the Series 2600A System SourceMeter instruments in the test system. There are three types of scripts:

- **Factory scripts:** Scripts that are pre-loaded into the instrument by the manufacturer.
- **User scripts:** Program scripts are created and loaded into the Series 2600A, where they are executed.
- **Interactive scripts:** This type of script interacts with the operator. It provides user-defined messages on the SourceMeter instrument display to prompt the operator to enter parameters using the front panel.

## Programming model for scripts

The fundamental programming model for scripts is shown in [Figure 12-1](#). Factory scripts (created by Keithley Instruments at the factory) are permanently stored in nonvolatile memory of the Series 2600A. A user script can be created using Test Script Builder or a similar program. User-created scripts can also be stored in nonvolatile memory.

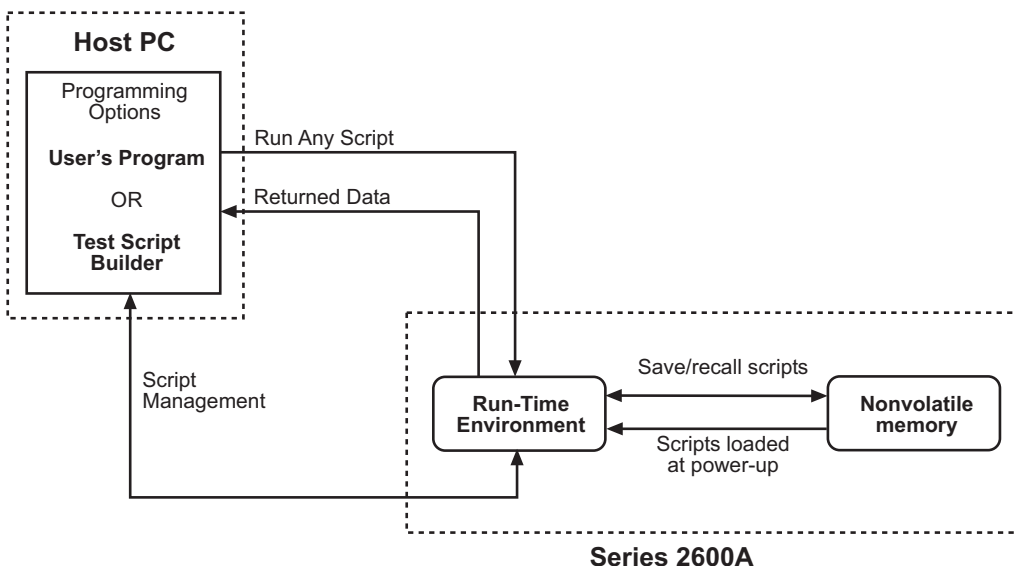
When the Series 2600A is turned on, all user scripts and factory script functions are recalled into the run-time environment from nonvolatile memory. If any user scripts have been programmed to run automatically, they will run when loaded (the `autoexec` script is the only script that will run after all scripts are loaded). Any script in the run-time environment can be run from the Test Script Builder or the user's own program.

---

**NOTE** It is common practice to say that a script is run. In actuality, it is the chunk in the script that is being run (executed).

---

Figure 12-2  
Programming model for scripts



## User scripts

User scripts can be written using your own program or the Test Script Builder. User scripts are loaded into the Series 2600A and can be saved in nonvolatile memory. Scripts not saved in nonvolatile memory will be lost when the Series 2600A is turned off.

### Creating a user script

To create a script and load it, the test program (chunk) must be framed by the following shell commands: `loadscript` or `loadandrunscript`, and `endscript`.

**Load only:** The following scripts will load only into the run-time environment of the Series 2600A. The script on the left is anonymous, while the one on the right is named (where `name` is the user-defined name):

```
loadscript loadscript name
 (chunk) (chunk)
endscript endscript
```

**Load and run:** The following scripts will load into the run-time environment and then run. Keep in mind that when a script is run, only the chunk is executed. The script on the left is anonymous, while the script on the right is named (where `name` is the user-defined name):

```
loadandrunscript loadandrunscript name
 (chunk) (chunk)
endscript endscript
```

Details on `loadscript` and `loadandrunscript` are provided as follows:

```
loadscript
loadscript name
```

where: `name` is the user-assigned name for the script.

The `loadscript` shell command loads the script into the run-time environment. The script can be assigned a name or it can be left nameless. If assigning a name that already exists for another loaded script, the old script will be overwritten with the new script.

If a script is not named when it is loaded into the run-time environment, it will be lost when another unnamed script is loaded or when the Series 2600A is turned off. After loading the anonymous script, use the `run()` or `script.run()` commands to run it.

A special name for a script is `autoexec`. After an `autoexec` script is saved in nonvolatile memory, the script will automatically run after the Series 2600A is powered on and after all other autorun scripts have been executed. For details, see [Autoexec script](#) and [Autorun scripts](#).

```
loadandrunscript
loadandrunscript name
```

where: `name` is the user-assigned name for the script.

These commands are similar to the `loadscript` commands except that the script will execute (run) after it is loaded into the run-time environment. Also, the `autorun` attribute for the script will be set to "yes" (see `myscript.autorun = "yes"`).

## Script examples

### Script using commands and statements only

The script in [Table 12-1](#) sweeps voltage (1V to 5V) and measures current at each step. The five current readings are returned to the host computer:

Table 12-1

#### Example script to sweep V and measure I

| Test Script Builder                                                                                                                                                                               | User's Program Script                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre>current = {} smua.source.output = smua.OUTPUT_ON for j = 1, 5 do   smua.source.levelv = j   current[j] = smua.measure.i()   print(current[j]) end smua.source.output = smua.OUTPUT_OFF</pre> | <pre>loadscript current = {} smua.source.output = smua.OUTPUT_ON for j = 1, 5 do   smua.source.levelv = j   current[j] = smua.measure.i()   print(current[j]) end smua.source.output = smua.OUTPUT_OFF endscript</pre> |

**NOTE** When creating a script using the Test Script Builder, only the chunk is typed in as shown above. See [Using Test Script Builder](#) in [Section 13](#) for details on creating, loading and running the script.

When creating a script using a programming language, shell commands must be included to manage interactions between the host computer and TSP. The `loadscript` command loads the script into the Series 2600A and `endscript` signifies the end of the script.

### Script using a function

TSL facilitates grouping commands and statements using the `function` keyword. Therefore, a script can also consist of one or more functions. Once a script has been RUN, the host computer can then call a function in the script directly.

The script in [Table 12-2](#) contains an ICL command to set measurement speed (NPLC) and a function (named `sourcev`). When this script is run, the measurement speed will set to 0.5 PLC and make the `sourcev` function available for calling.

Table 12-2

#### Example script using a function

| Test Script Builder                                                                                                               | User's Program Script                                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre>smua.measure.nplc = 0.5 function sourcev(v)   smua.source.levelv = v   i = smua.measure.i()   print(i)   return(i) end</pre> | <pre>loadscript smua.measure.nplc = 0.5 function sourcev(v)   smua.source.levelv = v   i = smua.measure.i()   print(i)   return(i) end endscript</pre> |

When calling the function, you must specify the source voltage in the argument for the function. For example, to set the source to 2V, call the function as follows:

```
sourcev(2)
```

Assuming SMU A output is on, it will output 2V and measure the current. The current reading is sent to the host PC and displayed.

### Interactive scripts

An interactive script prompts the operator (via the SourceMeter instrument's display) to input test parameters (via the SourceMeter instrument's front panel). The chunk fragment below uses display messages to prompt the operator to select an SMU Channel (A or B), a source function (I or V), and to input the source level. When an input prompt is displayed, the script will wait until the operator inputs the parameter and/or presses the **ENTER** key.

The `display.prompt` command in the following script prompts the user to input a source level. If a value is not entered, the default level (1mA or 1V) will be set when **ENTER** is pressed. The operator will not be able to input values that are not within the minimum (0.5mA or 0.1V) and maximum (3mA or 10V) limits.

#### Script Chunk Fragment (Test Script Builder or User's Program)

```
--Prompt operator to select channel:
chan = display.menu("Select Channel", "smua smub")
if (chan == "smua") then
 chan = smua
end
if (chan == "smub") then
 chan = smub
end

--Prompt operator to select (input) the source function:
func = display.menu("Select Function", "amps volts")
if (func == "amps") then
 chan.source.func = chan.OUTPUT_DCAMPS
else
 chan.source.func = chan.OUTPUT_DCVOLTS
end

--Prompt operator to set (input) source level:
if (func == "amps") then
 level = display.prompt("0.0E+00", " mA", "Enter I level",
 1E-3, 0.5E-3, 5E-3)
else
 level = display.prompt("00.0", " V", "Enter V level",
 1, 0.1, 10)
end

--Wait for operator to set source level:
if (func == "amps") then
 chan.source.level_i = level
else
 chan.source.level_v = level
end
```



## Saving a user script

A created and loaded script does not have to be saved in nonvolatile memory of the Series 2600A before it can be run. However, an unsaved script will be lost when the Series 2600A is turned off. The save command will save the script in nonvolatile memory.

The `myscript.save()` command saves the script under the current name of the script. If you save the script to a name that already exists in nonvolatile memory, it will be overwritten.

The `myscript.save("filename")` command is used to save the script to the USB memory stick as a file with the given file name.

---

NOTE .tsp is the default file extension for all scripts.

---

## Saving a named script

Only a named script can be saved in nonvolatile memory of the Series 2600A. After creating and loading a named script, use the following command to save it:

```
myscript.save()
```

Use the following to save a script to an external USB device:

```
myscript.save("/usb1/filename.tsp")
```

Where: `myscript` is the variable referencing the script and `filename.tsp` is a name of the file assigned by the user.

## Saving scripts to internal nonvolatile memory

Complete the following steps to save a script to nonvolatile memory:

1. Press **MENU > SCRIPT > SAVE**.
2. Turn the **navigation wheel** to select the script from the list.

---

NOTE You cannot save unnamed scripts to nonvolatile memory.

---

3. Select **INTERNAL** to save the script to internal nonvolatile memory.

Examples:

1. Assume a script named "test1" has been created and loaded. The following command saves the script in nonvolatile memory:

```
test1.save()
```

2. To save the script named "test1" under a new name ("test2") in nonvolatile memory, send the following commands:

```
test1.name = "test2"
test1.save()
```

## Saving scripts to the USB flash drive

You can transfer, load, and run scripts stored on the USB flash drive. Use the following steps to save a script to the USB flash drive from the front panel.

1. Insert the USB flash drive into the USB port.
2. Press **MENU > SCRIPT** and then select **SAVE** (see [Figure 12-3](#)).

Figure 12-3  
Saving a script



3. Turn the **navigation wheel** left or right to highlight the script to be saved. Press the **navigation wheel** or **ENTER** to select.
4. Use the **navigation wheel** to select **USB1** and press **ENTER** or the **navigation wheel**.
5. (Optional) Use the **navigation wheel** to change the last three characters of the file name.
6. Press **ENTER** to save the script to the USB flash drive.

---

NOTE The message “(overwrite)” is displayed if a file with the same name is stored on the USB flash drive (see [Figure 12-4](#)).

---

Figure 12-4  
Overwriting an existing file on the USB drive



### File numbering

The default file name for files saved from the front panel is `MyScript000.tsp`, where `MyScript` is the name of the script being saved. To change the file name, modify one or all of the last three digits. Each time you save an existing script from the front panel, the number represented by the last three digits in the file name increases by one. You can modify the last three digits to change the file name or to overwrite an existing file (see [Figure 12-4](#)).

## Loading scripts from the USB flash drive

You can use the **LOAD** feature to load a script from the USB flash drive to the run time environment. The Series 2600A validates the script before the load is completed. You can view the errors on the front panel of the Series 2600A.

Once a script is loaded from the USB flash drive, you can associate the script with the front panel's **RUN** button or save the script to internal nonvolatile memory.

**ACTIVE-FOR-RUN:** If this option is selected, the script can be executed by pressing the front panel's **RUN** button.

**SAVE-INTERNAL:** If this option is selected, the script is saved to internal nonvolatile memory.

To load a script from the USB flash drive:

1. Press **MENU > SCRIPT** and then choose **LOAD**.
2. Choose **USB1**.
3. Turn the **navigation wheel** left or right to view the files on the USB flash drive.
4. Select the desired file by highlighting it and pressing **ENTER** or the **navigation wheel**.
5. Choose one of the following:
  - (Save only) **SAVE-INTERNAL**
    - Select **YES**.
  - (Run only) **ACTIVE-FOR-RUN**.
    - Select **YES**.
6. If you chose **ACTIVE-FOR-RUN**, execute the script by pressing **EXIT** and then **RUN**.

## Working with subdirectories from the front panel

To access subdirectories while in local mode:

1. From the front panel, press **MENU > SCRIPT > LOAD > USB1**.
2. Turn the **navigation wheel** left or right to select the desired directory. The files in the subdirectory are displayed.

Figure 12-5  
Subdirectories



## Running a user script

### Running the anonymous script

There can only be one anonymous script in the run-time environment. If another anonymous script is created and loaded, the previous anonymous script will be removed from the run-time environment. Use one of the following commands to execute the chunk of the last loaded anonymous script. Both commands perform the same operation.

```
run()
script.run()
```

### Running a named script

Any variable that references a script in the run-time environment can be used to run the script using one of the following commands. Both commands perform the same operation.

```
myscript()
myscript.run()
```

Where: `myscript` is the variable that references the script. NOTE: The global variable will normally be the same as the name of the script unless the script has been renamed.

### Running scripts automatically

Scripts can be set to run automatically when the Series 2600A is turned on. One or more scripts can be set to autorun.

#### Autorun scripts

When a saved script is set to autorun, it will automatically load and run when the Series 2600A is turned on. Any number of scripts can be set for autorun. The run order for these scripts is arbitrary, so make sure the run order is not important.

To set a script for autorun, set the `autorun` attribute to "yes". Setting it to "no" disables autorun.

```
myscript.autorun = "yes"
```

where: `myscript` is the user-defined name of the script.

Make sure to save the script in nonvolatile memory after setting the `autorun` attribute.

Example:

Assume a script named "test5" is in the run-time environment. The script can be set to autorun as follows:

```
test5.autorun = "yes"
test5.save()
```

The next time the Series 2600A is turned on, the "test5" script will automatically load and run.

---

NOTE The `loadandrunscript` name command sets the `autorun` attribute for that script to "yes". To cancel autorun, set the `autorun` attribute to "no" and save the script.

---

#### Autoexec script

One script can be designated as the autoexec script. When the Series 2600A is turned on, the autoexec script will start after all the autorun scripts have run.

```
loadscript autoexec
loadandruncscript autoexec
```

An autoexec script can be formed by creating a new script and naming it `autoexec` (as shown above using `loadscript` or `loadandruncscript`). After loading the new script, send the `autoexec.save()` command to save it in nonvolatile memory. See [Creating a user script](#) (described earlier in this section) for details on creating a script.

An autoexec script can also be created by changing the name of an existing script that is saved in nonvolatile memory by using the following commands:

```
myscript.name = "autoexec"
myscript.save()
```

Where: `myscript` is the user-defined name of the script.

Example:

Assume a script named “test6” is loaded on the instrument. That script can be made into an autoexec script as follows:

```
test6.name = "autoexec"
test6.save()
```

The next time the Series 2600A is turned on, the “test6” script (which is now the `autoexec` script) will automatically load and start after all of the autorun scripts have run.

---

NOTE When the script is loaded at power-up, it will be called “autoexec” instead of “test 6.”

---

## Running a user script from the Series 2600A front panel controls

In order to run a user script from the front panel, an entry for the script needs to be added to the User menu for the LOAD key. The following commands are used to enter or delete a name into the User menu:

```
display.loadmenu.add(displayname, script)
display.loadmenu.delete(displayname)
```

Where: `displayname` is the name to be added to (or deleted from) the User menu and `script` is a string with the code that will be associated with the `displayname`.

It does not matter what order the items are added to the User menu. Menu items will be displayed in alphabetical order when the menu is selected.

Example:

Assume a user script named “Test9” has been loaded into the run-time environment. Add the name (“Test9”) to the User menu for the script as follows:

```
display.loadmenu.add("Test9", "Test9()")
```

After adding a name to the User menu, the script can then be run from the front panel as follows:

1. Press the **LOAD** key.
2. Select **USER**.
3. Select the user script to run and press the **RUN** key.

## Modifying a user script

A user script stored in nonvolatile memory can be modified by retrieving the script listing for the script. The retrieved script can then be modified, loaded, and saved in nonvolatile memory.

---

**NOTE** If using the Test Script Builder to modify a user script stored in nonvolatile memory, the script listing should be retrieved from in the Project Navigator (see [Retrieving scripts from the Series 2600A in Section 13](#)).

---

## Script management

Script management includes commands for the following operations:

- Downloading and saving scripts to nonvolatile memory.
- Retrieving scripts from the run-time environment so they can be modified.
- Deleting user scripts from nonvolatile memory.
- Restoring scripts in the run-time environment from nonvolatile memory.

### Retrieving the source code of a user script.

There are two ways to retrieve the source code for the user script:

- You can retrieve the listing of the script, that is, the source code line by line over the command interface.
- You can retrieve the entire user script source code as a single string.

The listing for a user script is the source code sent line by line over the command interface. The listed script can then be modified and saved as a user script under the same name or a new name.

The `myscript.list` command retrieves a script listing. The script chunk is returned, along with the shell keywords (`loadscript` or `loadandrunscript`, and `endscript`):

```
myscript.list()
```

Where: `myscript` is the user-defined name of the script.

Example:

Retrieve the listing for a saved script named "test7":

```
test7.list()
```

To retrieve the entire user script source code as a single string use the `myscript.source` attribute where `myscript` is the user-defined name of the script. The `loadscript` or `loadandrunscript` and `endscript` keywords are not included.

Example:

Retrieve source for a script named "test1":

```
print(test1.source)
```

### Deleting a script

**From the run-time environment:** Replacing, changing or deleting a script from the run-time environment does not remove the script from nonvolatile memory. To delete a script from the run-time environment, set its name to an empty string (" ") and remove all references to the script. To remove all references to the script, reassign the variable(s) that reference the script or set the variable(s) to the nil value.

Example:

```
-- Delete a user script name "test7" from the run-time environment
test7.name = ""
```

```
test7 = nil
```

**From nonvolatile memory:** Replacing, changing, or deleting a script from the run-time environment does not remove the script from nonvolatile memory. A script can be permanently removed from nonvolatile memory using either of the following commands:

```
script.delete("name")
script.user.delete("name")
```

Where: name is the user-defined name of the script.

Example:

```
-- Delete a user script named "test8" from nonvolatile memory:
script.delete("test8")
```

---

NOTE Removing a script from nonvolatile memory does not remove any scripts from the run-time environment.

---

## Restoring a script in the run-time environment

Once a script has been saved, you may want to remove it from the run-time environment to free up memory. The script may be restored to the run-time environment when needed. To restore the script to the run-time environment, use the one of the following commands:

```
script.restore("name")
script.user.restore("name")
```

Where: name is the user-defined name of the script to be restored.

Example:

Restore a user script named "test9" from nonvolatile memory:

```
script.restore("test9")
```

## Memory considerations for the run-time environment

The Series 2600A reserves 32MB of memory for dynamic run-time use. Of this memory, the firmware requires up to approximately 5MB for general operation. It is recommended that 1MB always be left free for the instrument's internal needs, and that 2MB be reserved for future firmware updates. That leaves approximately 24MB of memory available to the user. The run-time environment, user-created reading buffers, and active sweep configuration must fit within this 24MB of memory.

The amount of memory used by a reading buffer is approximately 15 bytes for each entry requested. There is a slight amount of overhead for a reading buffer, but this can be ignored for memory utilization calculations. For example, assume two reading buffers were created. One of them was created to store up to 1,000 readings and the other 2,500. The memory reserved for the reading buffers is calculated as follows:

$(1000 \times 15) + (2500 \times 15) = 52,500$  bytes or 52.5 kilobytes.

Note that the dedicated reading buffers do not consume memory needed by the run-time environment. Do not include them in your memory consumption calculations. Also, reading buffers for remote nodes consume memory on the remote node, not the local node. You should be sure the total reading buffer memory for any particular remote node does not exceed 24MB, but do not include that amount in your local memory consumption calculations.

The amount of memory used by a sweep configuration is based on the number of source points. The actual memory consumption can vary greatly depending on the SMU settings, but as a general rule each source point can be expected to consume at least 24 bytes.

It is possible for the memory used for these purposes to exceed 24MB. When this occurs, there is a risk that memory allocation errors will be generated and commands will not be executed as expected. If memory allocation errors are encountered, the state of the instrument cannot be guaranteed. After attempting to save off any important data, it is recommended that power to the instrument be cycled to return it to a known state. Cycling power will reset the run-time environment.

Unsaved scripts and reading buffers will be lost. The amount of memory in use can be checked using the `meminfo` function. The first value returned by `meminfo` is the number of kilobytes of memory in use.

## Checking the memory

Use the `meminfo` function to view the available free memory in the instrument (see [meminfo](#) in [Section 19](#) for more information).



---

**Test Script Builder (TSB)****In this section:**

| <b>Topic</b>                                             | <b>Page</b> |
|----------------------------------------------------------|-------------|
| <b>Installing the Test Script Builder software</b> ..... | <b>13-1</b> |
| <b>System connections</b> .....                          | <b>13-2</b> |
| <b>Using Test Script Builder</b> .....                   | <b>13-2</b> |
| Project Navigator .....                                  | 13-2        |
| Script Editor .....                                      | 13-2        |
| Programming Interaction .....                            | 13-2        |
| Starting Test Script Builder.....                        | 13-3        |
| Opening communications .....                             | 13-4        |
| Creating and modifying a script .....                    | 13-6        |
| Script launch configuration .....                        | 13-10       |
| Launching a script .....                                 | 13-14       |
| Running a TSP file.....                                  | 13-15       |
| Retrieving scripts from the Series 2600A .....           | 13-15       |
| Instrument console .....                                 | 13-16       |
| File management tasks.....                               | 13-22       |
| Displaying custom messages .....                         | 13-25       |

## Installing the Test Script Builder software

To install the TSB software, close all programs, place the CD (Keithley Instruments part number: KTS-850) into your CD-ROM drive and follow the on-screen instructions. If your web browser does not start automatically and display a screen with software installation links, open the index.html file found on the CD using your web browser.

## System connections

To connect the Series 2600A to the LAN, GPIB, or RS232 connection, see [Section 15, Communications Interfaces](#).

## Using Test Script Builder

Test Script Builder is a supplied software tool that can be used to perform the following operations:

- Send ICL commands and TSL statements
- Receive responses (data) to commands and scripts
- Run factory scripts
- Create and run user scripts

[Figure 13-1](#) shows an example of the Test Script Builder. As shown, the Workspace is divided into three window panes:

### Project Navigator

The window pane on the left side of the Workspace is where the Project Navigator resides. The navigator consists of created project folders and the script files (.tsp) created for each project. Each project folder can have one or more script files.

The navigator shown in [Figure 13-1](#) has two projects; one named “BeeperTest” and one named “SourceMeasure.” As shown, the “BeeperTest” project has one script file, and the “SourceMeasure” project has three script files.

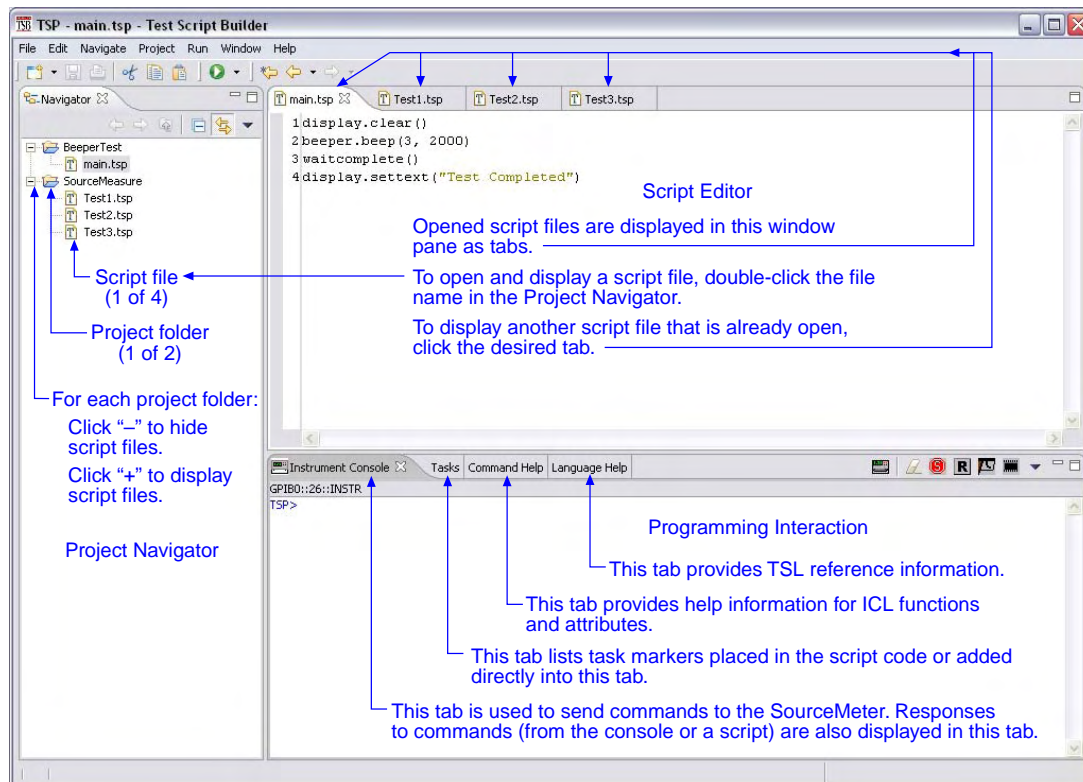
### Script Editor

The script chunk is written and/or modified in the Script Editor. Notice that there is a tab available for each opened script file. A script project is then downloaded to the SourceMeter where it can be run.

### Programming Interaction

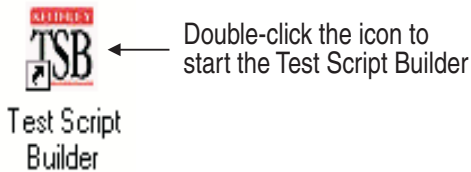
Up to seven tabs can be displayed in the lower window pane of the Workspace to provide programming interaction between the Test Script Builder and the SourceMeter. The Instrument Console (shown open in [Figure 13-1](#)) is used to send commands to the connected SourceMeter. Retrieved data (for example, readings) from commands and scripts appear in the Instrument Console. See [Programming interaction tabs](#) later in Section 2 for details on using the other tabs.

Figure 13-1  
**Test Script Builder (example)**



## Starting Test Script Builder

Make sure the SourceMeter instrument is properly connected to the PC (see [System connections](#)) and it is turned on. On the PC desktop, double-click the Test Script Builder icon to begin:

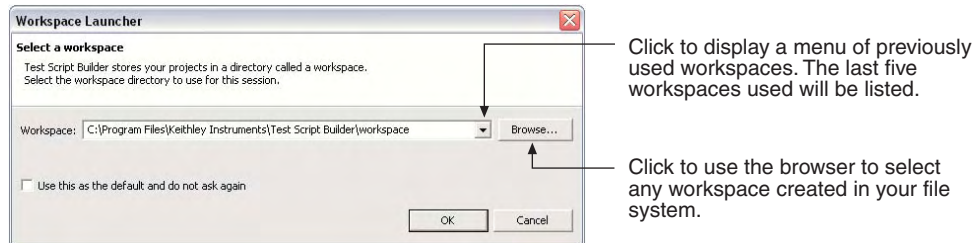


**NOTE** The Test Script Builder can also be started from the Windows Start button on the task bar. For a default installation, follow this menu path to start the Test Script Builder:

**Start > Programs > Keithley Instruments > Test Script Builder**

**Workspace Launcher:** During the initial start-up of TSB, the Workspace Launcher window will be displayed as shown below. This window will indicate the directory path for the workspace. This is

where projects and script files will be stored. If you do not wish to see this window on subsequent power-ups, select “Use this as the default and do not ask again.” Click OK to continue start-up.




---

**NOTE** See [Creating a new workspace](#) later in Section 2 to create additional workspaces.

---

**Communications** – When Test Script Builder opens, communications to the SourceMeter instrument will be closed. With communications closed, commands cannot be sent to the SourceMeter. A script can be written using the Test Script Builder, but it cannot be run. Communications with the SourceMeter instrument are established by [Opening communications](#).

## Opening communications

In order to activate communications between Test Script Builder and the SourceMeter instrument, an instrument must be opened. The toolbar on the Instrument Console tab is used to open or close communications.

[Figure 13-2](#) illustrates how to open and close communications. The following details supplement the information in the drawing:

The Select Instrument window has a drop-down menu to select the LAN, GPIB, or RS-232 interface being used by the Series 2600A.

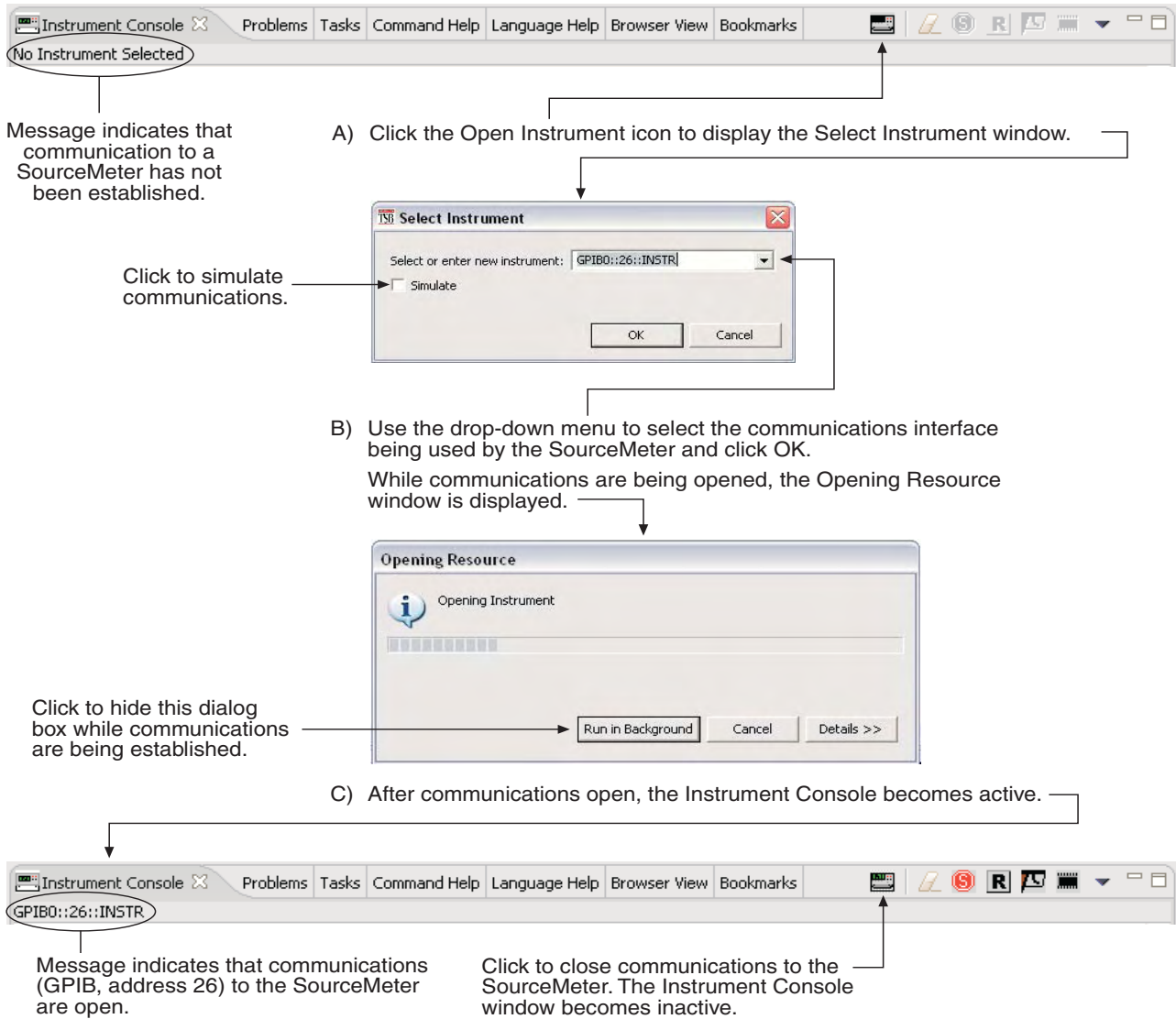
**Simulate communications:** If you select the Simulate option in the Select Instrument window, the Instrument Console will become active even though there will be no actual communication with the SourceMeter instrument. You can simulate running a script or sending a command, but the SourceMeter instrument will not respond.

---

**NOTE** The drop-down menu for the Menu icon can also be used to open or close communications between TSB and the SourceMeter instrument. See [Instrument Console icons](#) for details on using the Menu icon.

---

Figure 13-2  
**Opening and closing communications**

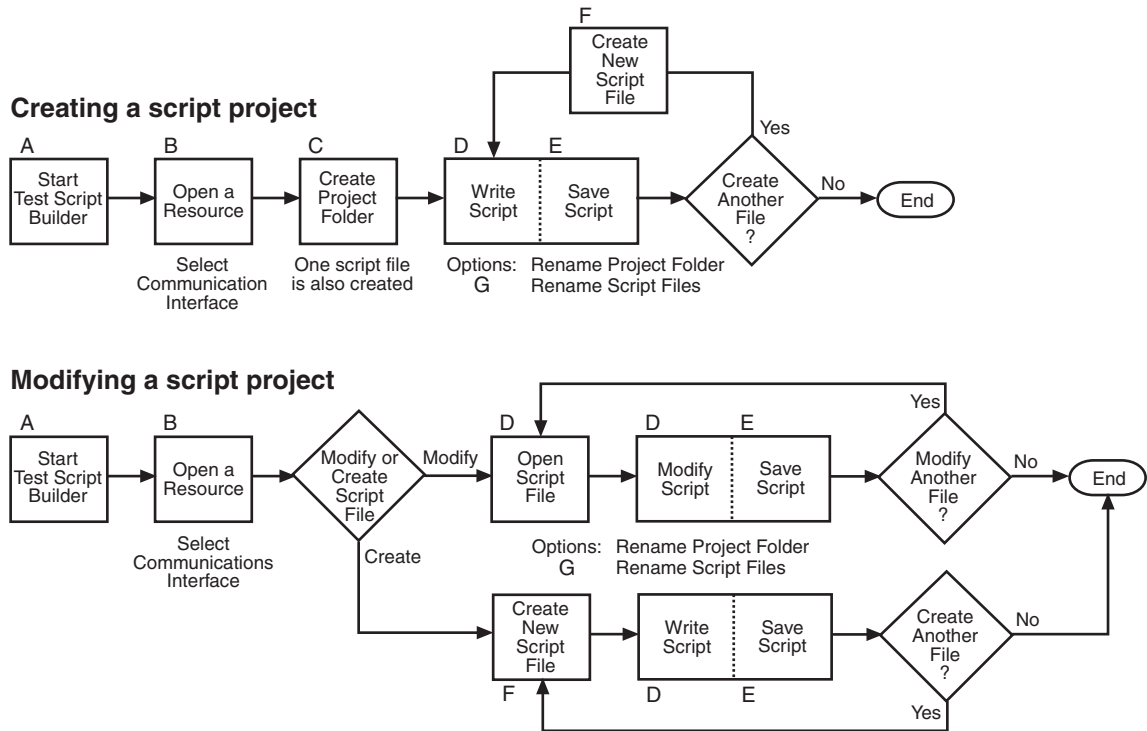


## Creating and modifying a script

The flowcharts in [Figure 13-3](#) show the basic processes to create and modify a script using the Test Script Builder. The labels (A through G) are used to identify reference links provided after the illustration.

Figure 13-3

### Creating and modifying a script using the Test Script Builder



Reference links for labels A through G shown in [Figure 13-3](#):

- A [Starting Test Script Builder](#)
- B [Opening communications](#)
- C [Creating a project folder](#)
- D [Writing or modifying a script](#)
- E [Saving a script](#)
- F [Creating new script files](#)
- G [Renaming a project folder and/or script file](#)

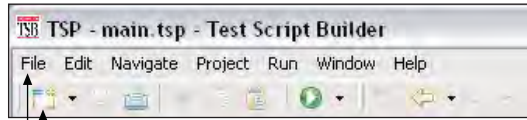
### Creating a project folder

When a project folder is created, the following actions occur:

- The project folder is added to the Project Navigator.
- A script file (named “main”) is created and placed in the project folder.
- The script file (which has no code) is opened and displayed in the Script Development area of the Test Script Builder.

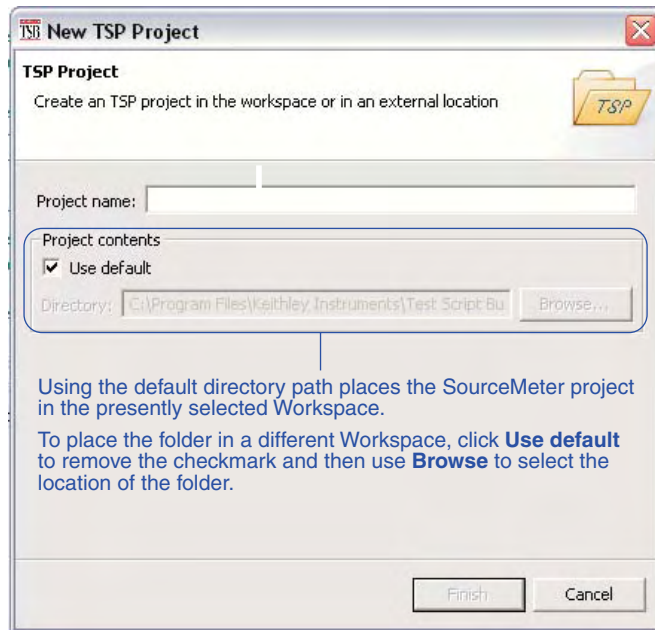
The toolbar at the top of the Test Script Builder is used to create a project folder. [Figure 13-4](#) explains how to create a project folder.

Figure 13-4  
**Creating a project folder**



- A) Open the New TSP Project dialog box as follows:  
 Click the folder icon to display the New project wizard.  
 In the wizard, select TSP Project and click Next.  
 OR  
 Click FILE to display the drop-down file menu. From the menu, click New and then click TSP Project.

- B) In the New TSP Project window, type in a Project name (e.g., SourceMeasure) and click Finish:



## Writing or modifying a script

A script is a list of ICL commands and TSL statements. [Figure 13-1](#) shows a simple example of a script. When this script is run, it performs a beeper test. After sounding the beeper for three seconds at 1kHz, the message “Test Completed” is displayed on the Series 2600A. See details on later in this section.

When a project or script file is created, the script file opens and is displayed in the Script “Editor” area of the Test Script Builder. This is where a script can be written.

To modify an existing script file, it must be open. Open script files are presented as tabs in the Script Editor. To open and display a script file, click the file name in the Project Navigator. To display a different script file that is already open, click the appropriate tab at the top of the Script Editor.

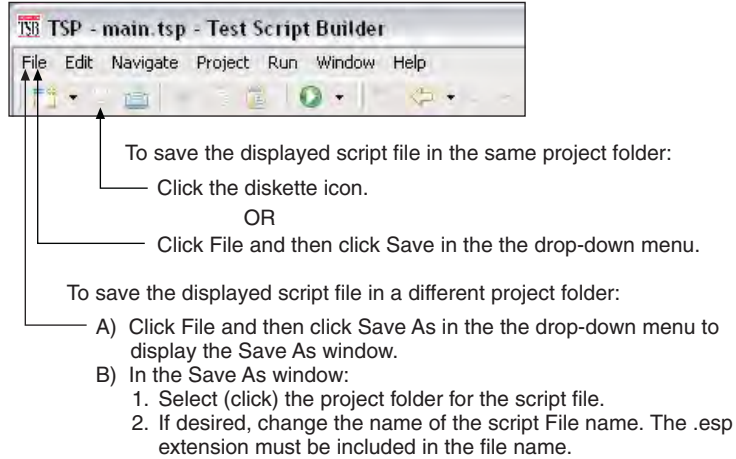
## Saving a script

It is good practice to routinely save a script file as lines of code are written or modified. The save operation performs error checking for the script. If an error occurs, an “X” will appear near the corrupt line of code, and the **Problems** tab will open to provide an explanation of the error. “X”s will also appear in the Project Navigator to indicate which project folder and which script file has the error.

The toolbar at the top of the Test Script Builder is used to save the displayed script file. As explained in [Figure 13-5](#), the script file can be saved in the same folder and/or saved in a different folder.

Figure 13-5

### Saving a script in Test Script Builder

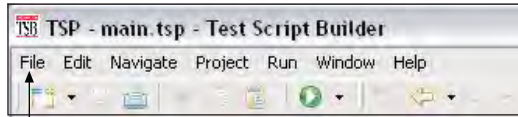


### Creating new script files

A script project can be made up of one or more script files. [Figure 13-6](#) shows how to add a script file to a project folder.



Figure 13-6

**Creating a new script file**

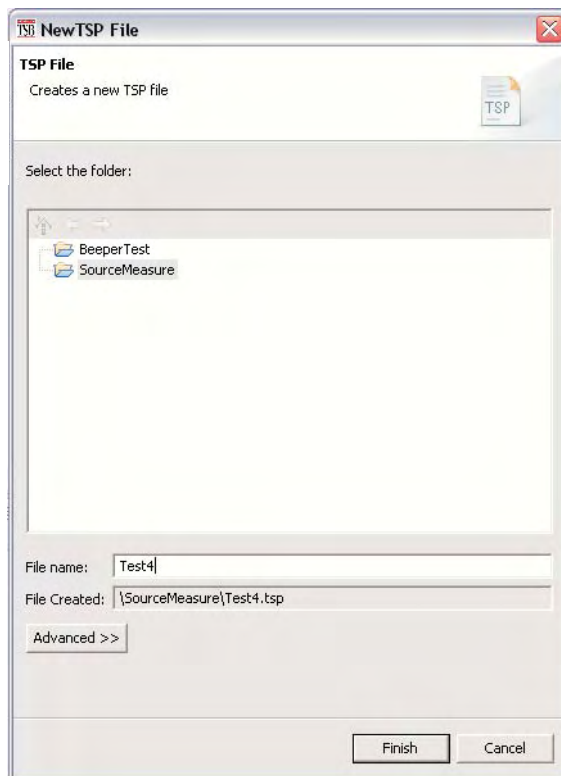
A) Open the New TSP File window as follows:

Click FILE to display the drop-down file menu. From the menu, click New and then click TSP File.

OR

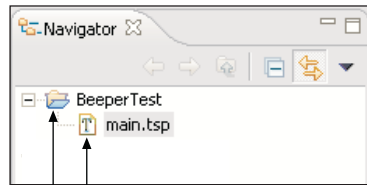
In the Project Navigator, right-click the project folder for the script file. From the drop-down menu, click New and then click TSP File.

- B) In the New TSP File window, make sure the desired project folder is selected. A folder is selected by clicking it.  
 C) Type in a file name (e.g., Test4) and click Finish:

**Renaming a project folder and/or script file**

When a new project is created, a script file (named “main”) is also created and placed in the Folder. [Figure 13-7](#) shows a project folder and script file that has been created and added to the Project Navigator. As shown, the project folder name and a script file name can be changed.

Figure 13-7  
**Renaming a project folder and/or script file**



**To change the name of a script file:**

- A) Right-click the script file, and click Rename in the drop-down menu.
- B) Type in the new name, making sure to include the .tsp extension, and then press the Enter key.

**To change the name of a project folder:**

- A) Right-click the project folder, and click Rename in the drop-down menu.
- B) Type in the new name, and then press the Enter key.

## Script launch configuration

A script is to be loaded into the Series 2600A where it will be executed (run). The launch configuration options include the following:

- Select which script files will be included in the launch.
- Set the launch order for the selected script files.
- Set the script launch to load-only, or to load-and-execute (run).
- Set script storage for the Series 2600A: volatile or nonvolatile. A script stored in volatile memory will be lost when the SourceMeter instrument's power is turned off. A script stored in nonvolatile memory will not be lost after power is turned off.

When a script project is created, the launch is configured initially as follows:

- Only the first script file ("main") is selected to be included in the launch.
- The launch type is set to load-and-execute (run).
- The script project is set to be stored in the volatile memory of the Series 2600A. The script will be lost when the Series 2600A power is turned off.

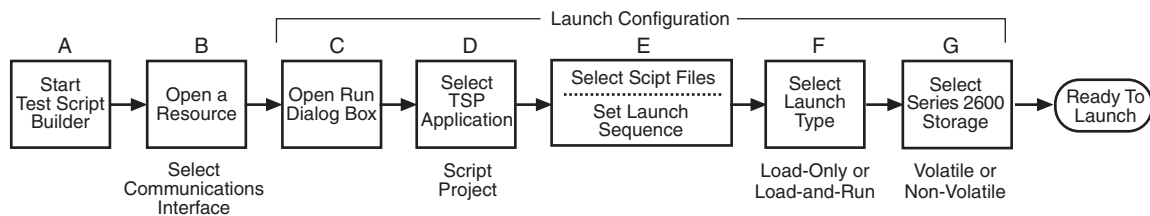
---

**NOTE** If the initial launch configuration meets your requirements, the script is ready to be launched and is explained in [Launching a script](#) later in this section.

---

The flowchart in [Figure 13-8](#) shows the basic process to change the launch configuration for a script. The labels (A through G) are used to identify reference links which follow the illustration.

Figure 13-8  
**Changing a launch configuration**



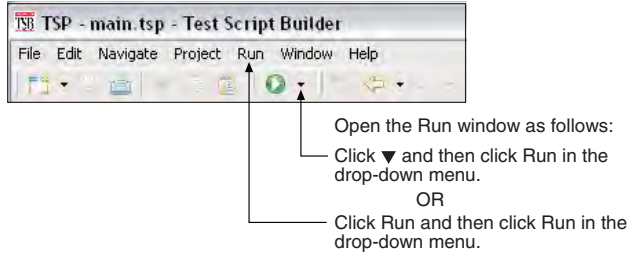
Reference links for labels A through G shown in [Figure 13-8](#):

- A [Starting Test Script Builder](#)
- B [Opening communications](#)
- C [Displaying the launch configuration window](#)
- D [Selecting a configuration](#)
- E [Selecting script files and launch order](#)
- F [Selecting the type of launch](#)
- G [Storing the script](#)

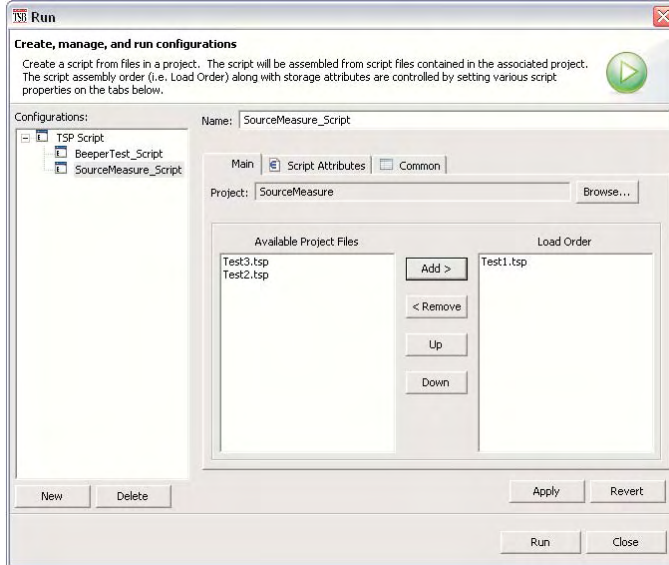
### Displaying the launch configuration window

A launch is configured from the **Run** dialog box. As shown in [Figure 13-9](#), use the toolbar at the top of the Test Script Builder to open the launch configuration window.

Figure 13-9  
**Opening the Run dialog box (launch configuration)**



Launch configuration - Main tab shown:



## Selecting a configuration

When a project is created using the Test Script Builder, a Configuration name for the launch is also created. The project name is altered to append “\_Script” to it. For example, for a project named “SourceMeasure,” the configuration will be named “SourceMeasure\_Script.”

In the Run window, the Configurations area lists the TSP Scripts. To view the launch configuration for a script, click the Configurations name. [Figure 13-9](#) shows the Main tab for “SourceMeasure\_Script.”

## Selecting script files and launch order

As shown in [Figure 13-9](#), script files for the project are shown in the Main tab of the configuration window. Script files listed on the Available Project Files side of the tab are not selected to launch. Script files on the Load Order side are selected to launch in the order that they are listed.

Make configuration changes in the Main tab as follows:

- To move a script file to the Load Order side, click the file name and then click the Add > button.
- To move a file to the Available Project Files side, click the file name then click the < Remove button.
- For script files on the Load Order side, use the Up and Down buttons in a similar manner to change the launch sequence.
- After making changes in the Main tab, click the Apply button.

## Selecting the type of launch

There are two options for the launch process:

- **Load** – The script will load into the run-time environment of the Series 2600A, but will not run. The script can be run later.
- **Load and Execute** – The script will load into the run-time environment. After the load process is completed, the script will run.
- **Auto Run** – With Load and Execute selected, Auto Run can be enabled. When enabled, the script will automatically run whenever the Series 2600A is powered on.

## Storing the script

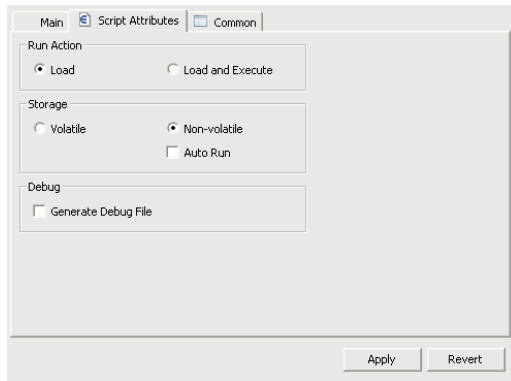
When a script is launched it can be stored in the volatile or nonvolatile memory of the Series 2600A. If stored in volatile memory, it will be lost when the SourceMeter instrument’s power is turned off. If stored in nonvolatile memory, it will not be lost when the power is turned off.

Script storage is set from the Script Attributes tab of the Run window and is shown in [Figure 13-10](#). In the Script Attributes tab, click Volatile or Non-volatile. After selecting nonvolatile memory, Auto Run can be enabled (✓) to automatically run the script whenever the SourceMeter instrument is turned on.

**Debug:** Click **Generate Debug File** to generate a read-only copy of the script. A folder named “Debug” and the debug file (.DBG) is added to the project.

After changing the storage configuration, click **Apply**.

Figure 13-10  
**Run dialog box (Script Attributes tab)**

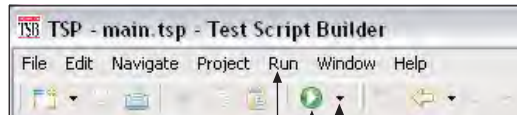


## Launching a script

After checking and/or changing a launch configuration, the script is launched from the Run dialog box by clicking the Run button shown in [Figure 13-9](#).

A script can be relaunched directly from the toolbar located at the top of the Test Script Builder. [Figure 13-11](#) explains how to relaunch a script from the toolbar.

Figure 13-11  
**Relaunching a script from the Test Script Builder toolbar**



Click Run and click Run Last Launched in the drop-down menu.

OR

Click ▶

OR

Click ▼ and then click the script in the drop-down menu.

## Running a TSP file

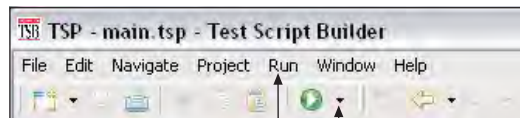
A TSP (.tsp) file does not have to be launched (loaded) into the Series 2600A in order to be run. The code for a TSP file can simply be sent to the Series 2600A and executed. The TSP file will not reside in the Series 2600A (it is not saved in volatile or nonvolatile memory). A TSP file can be run from the Project Navigator or from the toolbar at the top of Test Script Builder.

To run a TSP file from the Project Navigator, right-click the .tsp file name (for example, `main.tsp`), select Run in the mouse menu, and then click Run As TSP File in the submenu.

A TSP file can also be run from the TSB toolbar as explained in [Figure 13-12](#).

Figure 13-12

### Re-launching a script from the Test Script Builder toolbar



Click Run or ▼, select Run As in the drop-down menu, then click 1 TSP File in the submenu.

A TSP file can also be run from the Menu icon on the Instrument Console toolbar. For details, see [Instrument Console icons](#) later in this section.

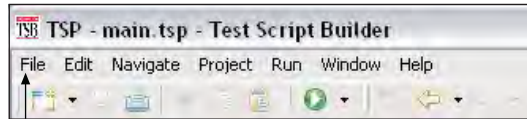
## Retrieving scripts from the Series 2600A

A user script or factory script can be retrieved from memory of the Series 2600A. The retrieved script folder will be placed in the Project Navigator with its script files opened.

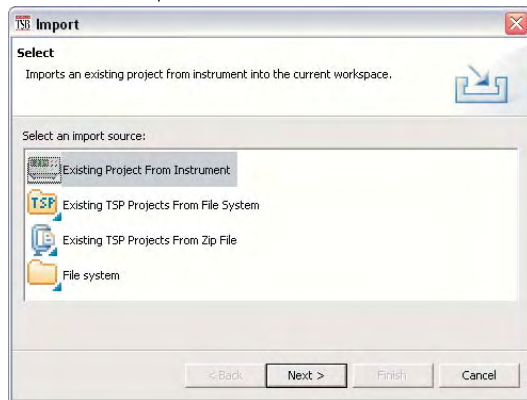
[Figure 13-13](#) explains how to import a script from the Series 2600A. It assumes that communications with the SourceMeter instrument are already open. If communications are closed, a window will appear to open communications during the import process.

A modified script can be loaded back into the Series 2600A as a user script using the same name or a new name. An imported factory script can only be loaded back into the Series 2600A as a user script.

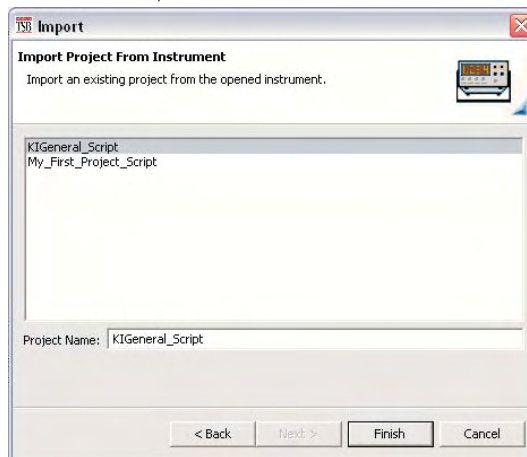
Figure 13-13  
**Importing a script from memory of the Series 2600A**



- A) Click File to display the drop-down file menu and click Import to open the Import wizard.
- B) In the Import Select box, click Existing Project From Instrument and then click Next.



- C) In the Import Project From Instrument box, click the KIGeneral\_Script project, and then click Finish.



## Instrument console

With communications established with the SourceMeter instrument, the Instrument Console is used for the following operations:

- Execute chunks, which are individual ICL commands and TSL programming statements.
- Display returned data (readings and messages).
- Display error messages caused by erroneous code sent from the Instrument Console.

The instrument console is opened by clicking the Instrument Console tab in the lower window pane of the Test Script Builder (see [Figure 13-1](#)).



An active Instrument Console displays the TSP> prompt. Type in a command after the prompt and press Enter to execute it. For example, type in the following command:

```
TSP>reset ()
```

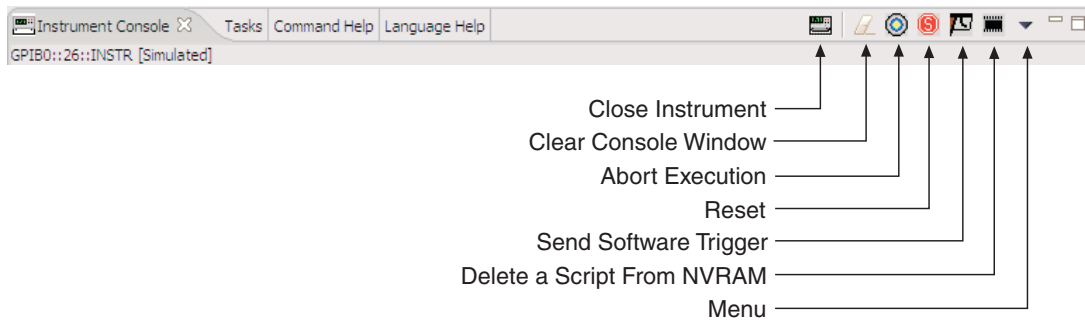
After pressing **ENTER**, the SourceMeter instrument resets to its default settings.

Code and messages in the Instrument Console can be cleared by clicking the Clear Console Window icon. It can also be cleared from the mouse menu as follows: Position the mouse pointer in the console window, right-click the mouse and then select Clear Console Window from the mouse menu.

## Instrument Console icons

After communications with the SourceMeter instrument are open, all of the icons on the Instrument Console toolbar will be active.

Figure 13-14  
Instrument Console icons



The Instrument Console icons are explained as follows:

**Close instrument:** With communications open, clicking this icon closes (disables) communications with the SourceMeter instrument.

**Clear console window:** Clicking this icon removes all code and response messages from the Instrument Console window. There are two other ways to clear the Instrument Console window:

- Place the cursor in the console window, right-click the mouse, and then select Clear Console Window from the mouse menu.
- Click the Menu icon and click the Clear Console Window item in the menu.

**Abort execution:** Clicking this icon aborts execution of a command sent from the Instrument Console.

**Reset:** Clicking this icon resets the SourceMeter instrument. It is the same as sending the `reset ( )` command.

**Send software trigger:** Clicking this icon sends a software trigger to the SourceMeter instrument (see [Section 10](#) for more information on triggering).

**Delete a script from nonvolatile memory:** Use this icon to delete a script from the nonvolatile memory of the SourceMeter instrument. After clicking this icon, select the script to be deleted from the displayed list, and click Delete.

**Menu:** Clicking this icon opens a menu with the following menu items:

- **Clear console window:** Click this menu item to clear the console window. Other ways to clear the console are explained above for the Clear Console Window icon.
- **Instrument:** Clicking this menu item opens a submenu to select items that perform the same operations as some of the other toolbar icons. Also included in the menu is the Flash

item. The Keithley Instruments Flash Programmer is used to download firmware upgrades into the Series 2600A. See [Flash programmer](#) later in this section for details on using the flash programmer.

- **Save console:** The contents (code and response messages) of the Instrument Console window can be saved as a text (.txt) file. After clicking this menu item, a browser will open to allow you to save the log. Use any text editor, such as WordPad, to open the saved text file and view the log.
- **Run:** This menu item is used to run any TSP (.tsp) file that resides in the Project Navigator or elsewhere in your computer or network (see [Running a TSP file](#) later on in this section). After selecting Run, a submenu will open with items to select Editor or Script File. Items for projects in the Project Navigator will also be listed in this submenu:
  - **Editor:** Selecting this item will open another submenu that will list all the TSP files that reside in the Project Navigator. Click a script file to run the script.
  - **Script file:** Selecting this item will open a browser that allows you to locate a TSP file stored in your computer or network. With the File Name displayed in the browser, click Open to run the TSP file.
  - **Projects:** The Run menu lists the projects that are in the Project Navigator. Select a project to display the TSP files for that project. Click a TSP file name to run the file.

The Menu icon is also displayed when the Problems, Tasks or Bookmarks tab is opened (displayed).

## Programming interaction tabs

Up to seven tabs can be displayed in the lower window pane of the Workspace to provide programming interaction between the Test Script Builder and the SourceMeter instrument.

The tabs that can be placed in the Workspace include the following: Instrument Console, Problems, Tasks, Command Help, Language Help, Browser View and Bookmarks. Tabs not presently located in the Workspace can be added by selecting them from the Window option on the toolbar at the top of the Workspace as follows:

Select **Window > Show View > Click the tab to be viewed**

A tab in the Workspace can be opened (viewed) by clicking the tab name. When a tab is opened, an “X” will appear to the right of the tab name. Clicking this “X” removes the tab from the Workspace.

### Instrument Console tab

This tab (shown in [Figure 13-1](#)) is used to send commands to the connected SourceMeter instrument. Retrieved data (for example, readings) from commands and scripts appear in the Instrument Console.

---

NOTE [Figure 13-15](#) and [Figure 13-16](#) show partial screen shots of the following tabs.

---

### Problems tab

When a script file is saved, error checking is performed. If a script error is detected, an “X” will appear in the left-hand margin of the Script Editor at or near the corrupt line of code. The Problems tab will open automatically and provide a description of the error.

If you click the problem in the Problems tab, the line code that has the “X” will be highlighted in the Script Editor. After fixing the erroneous code, the problem will clear when the script file is saved.

### Tasks tab

This tab displays user-defined tasks associated with specific files, specific lines in specific files, as well as generic tasks that are not associated with any specific file.

A task marker (✓) can be inserted for a line of code in the left-hand margin of the Script Editor. Right-click the line number for the code and select Add Task from the mouse menu. In the New Task window, type in a description of the task and click OK. The task will be added to the Task tab. If you click the task in the Tasks tab, the line of code that has the task marker will be highlighted in the Script Editor. A task can be cleared from the Script Editor by right-clicking the task marker and selecting Remove Task.

A task that is not linked to any code or file can be added to the Tasks tab. Place the mouse cursor in the Tasks tab, right-click the mouse, and then select Add Task to enter a description of the task.

### Command Help tab

This tab provides details on ICL functions and attributes (see [Section 19](#) of this manual). The first page of Command Help provides links to the major topics of the help file. Click ICL commands list to display the list of functions and attributes. Click a function or attribute to display the details.

### Language Help tab

This tab provides details on the Test Script Language (TSL); see [Test Script Language \(TSL\)](#) in [Section 19](#). The first page of Language Help provides links to the major topics of the help file.

### Browser View tab

When on-line to the internet, this tab serves as a browser for the Keithley Instruments website ([www.keithley.com](http://www.keithley.com)).

### Bookmarks tab

This tab displays bookmarks that are placed in the Script Editor by the user. A bookmark is placed for a line of code in the left-hand margin of the Script Editor. Right-click the line number for the code and select Add Bookmark from the mouse menu. In the Add Bookmark window, type in a bookmark name and click OK. The bookmark name will be added to the Bookmarks tab.

In the Bookmarks tab, clicking a bookmark displays and highlights the line of code that has the bookmark. A bookmark can be removed from the Script Editor by right-clicking the bookmark and selecting Remove Bookmark.

The Bookmarks tab in [Figure 13-16](#) shows an example of using bookmarks. Each bookmark in the tab is linked to a function for a script file that exists in the Project Navigator. When a bookmark is clicked, the first line for that function will be displayed and highlighted in the Script Editor.

Figure 13-15  
**Programming interaction tabs: Problems, Tasks, and Command Help**

**Problems tab:**

| Description             | Resource | In Folder | Location |
|-------------------------|----------|-----------|----------|
| `do' expected near `fo' | main.tsp | KIGeneral | line 47  |

**Tasks tab:**

| Description                                             | Resource | In Folder        | Location |
|---------------------------------------------------------|----------|------------------|----------|
| <input type="checkbox"/> -- TODO insert your code here. | main.tsp | My_First_Project | line 27  |

**Command Help tab:**

Forward

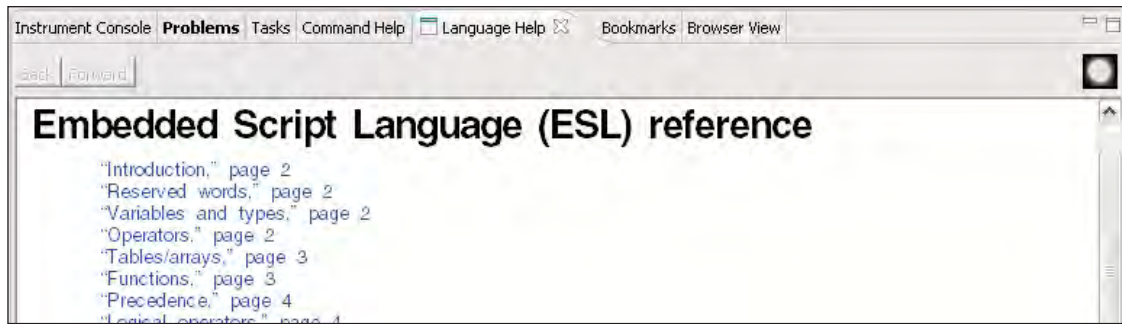
# Instrument Control Library

**Section 13 topics**

- Command programming notes, [page 13-2](#)
- Conventions, [page 13-2](#)
- Instrument command types, [page 13-3](#)
- TSPlink nodes, [page 13-4](#)
- Logical instruments, [page 13-4](#)
- Reading buffers, [page 13-5](#)
- Time and date values, [page 13-7](#)
- ICL commands list, [page 13-8](#)

Figure 13-16  
**Programming interaction tabs: Language Help, Bookmarks, Browser View**

Language Help tab:

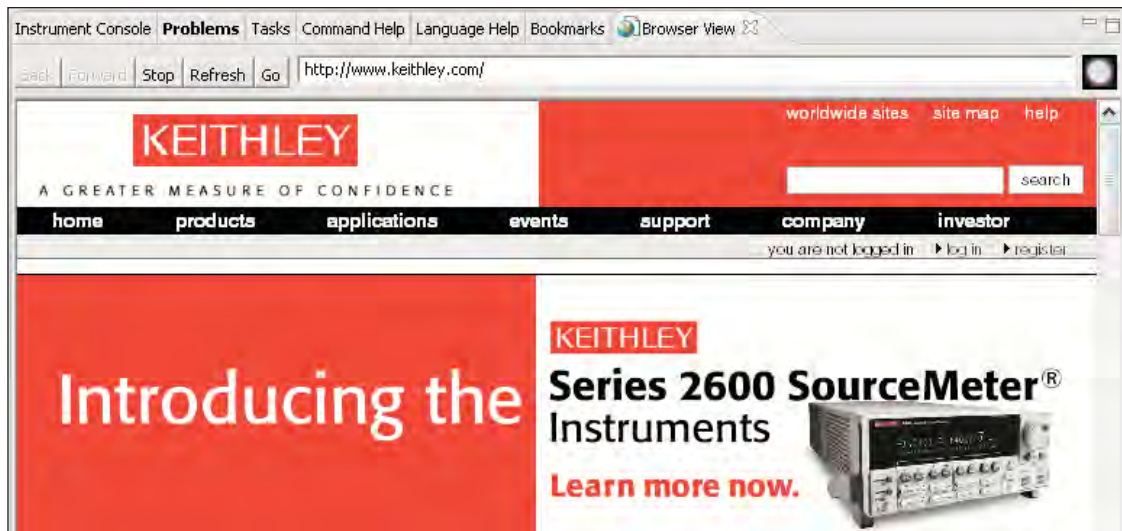


Bookmarks tab:

The screenshot shows a window titled "Bookmarks" with a tabbed interface. The active tab is "Bookmarks", and other tabs include "Instrument Console", "Problems", "Tasks", "Command Help", "Language Help", and "Browser View". Below the tabs is a navigation bar with "back", "forward", "stop", "refresh", and "go" buttons. The main content area displays a table with 8 items:

| Description        | Resource | In Folder | Location |
|--------------------|----------|-----------|----------|
| PulseIMeasureV     | main.tsp | KIGeneral | line 2   |
| PulseVMeasureI     | main.tsp | KIGeneral | line 74  |
| SweepLinMeasureV   | main.tsp | KIGeneral | line 147 |
| SweepVLinMeasureI  | main.tsp | KIGeneral | line 212 |
| SweepLogMeasureV   | main.tsp | KIGeneral | line 277 |
| SweepVLogMeasureI  | main.tsp | KIGeneral | line 342 |
| SweepListMeasureV  | main.tsp | KIGeneral | line 407 |
| SweepVListMeasureI | main.tsp | KIGeneral | line 467 |

Browser View tab:



### Flash programmer

When a firmware upgrade for the Series 2600A becomes available, it can be downloaded from the Keithley Instruments website ([www.keithley.com](http://www.keithley.com)). New or enhanced factory scripts may be included in the upgrade. The file for the firmware upgrade can then be installed in the Series 2600A using the flash programmer.

---

---

**CAUTION** *Disconnect the input/output terminals before performing a flash upgrade.*

---

---

With communications between the TSB and the SourceMeter instrument opened, the flash programmer can be accessed using the Menu icon as follows:

Menu icon > Select Instrument > Flash

Use the displayed browser to select the downloaded file and click **Open** to start the upgrade. See [Upgrading the firmware](#) in [Section 21](#) for details.

## File management tasks

A project, along with its associated files (for example, script files), resides in a workspace folder. Typical file management tasks include the creation of new projects and script files (see [Creating and modifying a script](#) for details on file management tasks). A script project can also be imported from a Series 2600A into Test Script Builder, where it can be modified (for details, see [Retrieving scripts from the Series 2600A](#)).

Other typical file management tasks include [Creating a new workspace](#), [Importing a project from another workspace](#), [Switching workspaces](#), and [Deleting projects and/or script files](#). These file management tasks are explained as follows:

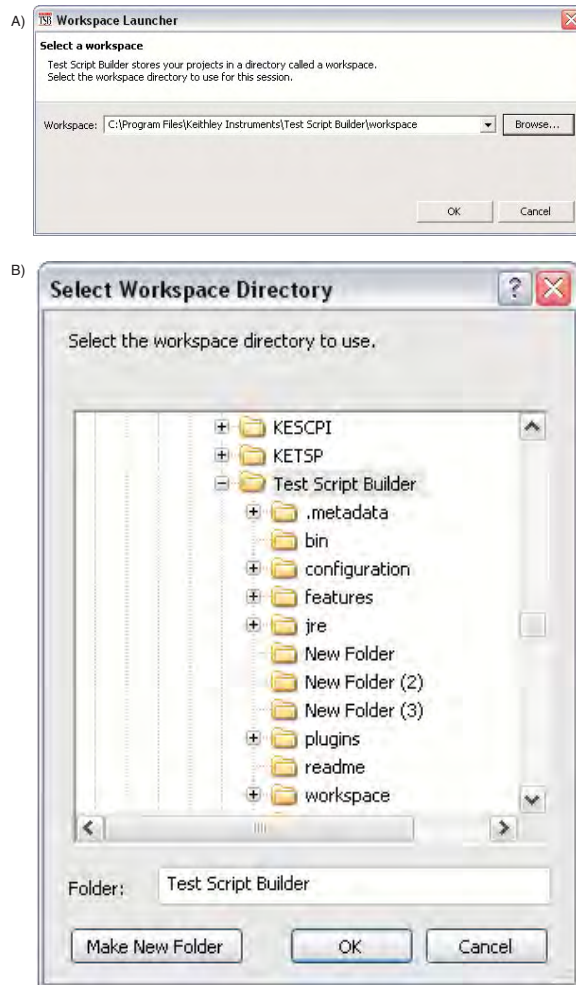
### Creating a new workspace

Additional workspaces can be created anywhere in your file system. A new workspace is simply a new folder for project files. A new folder for a workspace can be made from TSB as follows:

1. At the top of TSB, click **File** on the toolbar to open the file menu and then click **Switch Workspace** to open the Workspace Launcher ([Figure 13-17A](#)).
2. Click the **Browse** button to open the Select Workspace Directory browser and select the location for the new folder. [Figure 13-17B](#) shows the Test Script Builder folder selected as the location for the new workspace folder. Keep in mind that the workspace folder can be located anywhere in your file system.
3. In the Select Workspace Directory, click the **Make New Folder** button. A folder named New Folder will be inserted at the selected location.
4. In the browser, right-click **New Folder** and click **Rename** in the mouse menu.
5. Type in a name for the new workspace folder (for example, workspace2) and press **Enter**.
6. In the browser, click **OK**, and then click **OK** in the Workspace Launcher. Test Script Builder will close and then reopen using the new workspace.

There will not be any projects residing in the Project Navigator for the new workspace. New projects and script files can be created as explained in [Creating and modifying a script](#). A project (along with its script files) can be imported into the new workspace from another workspace folder. See [Importing a project from another workspace](#).

Figure 13-17  
**Workspace Launcher and Select Workspace Directory**

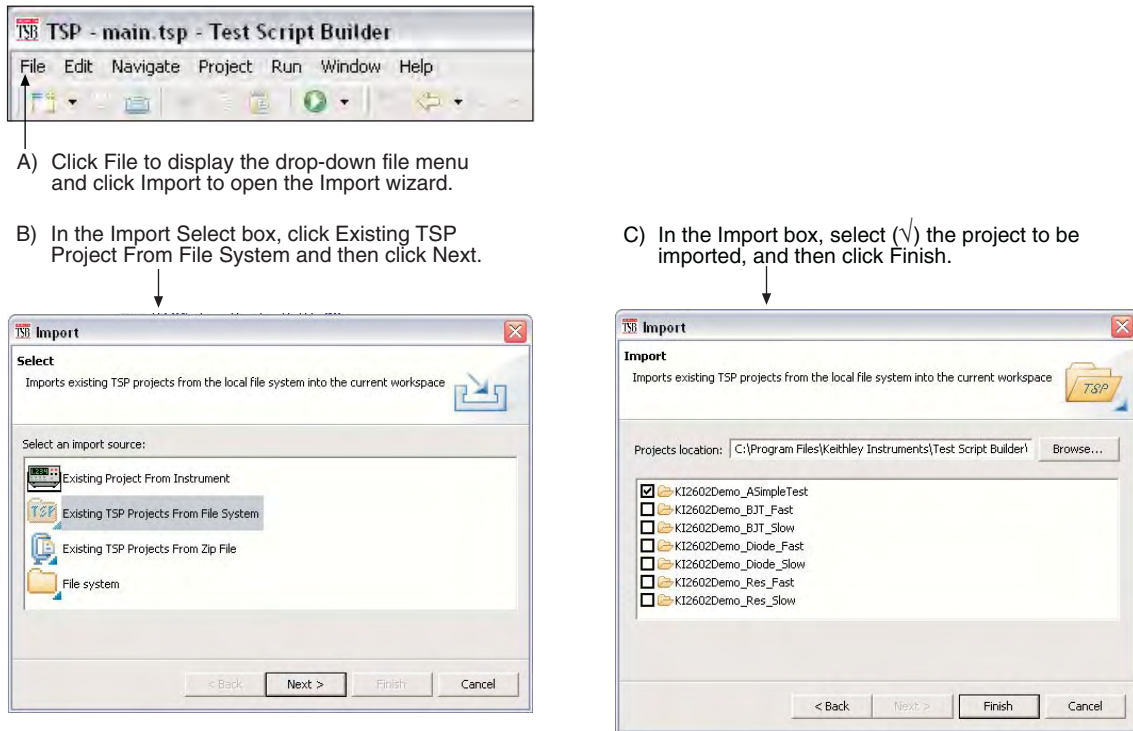


### Importing a project from another workspace

A project (along with its script files) can be imported from another workspace folder that resides in your file system. This is explained in [Figure 13-18](#), which imports a project named KI2602Demo\_ASimpleTest. In Step C, use the Browser to locate the project that you wish to import.

After clicking Finish in the Import window, the project will appear in the Project Navigator of the Test Script Builder.

Figure 13-18  
**Importing a project from another workspace folder**



## Switching workspaces

Perform the following steps to switch to another workspace:

1. At the top of TSB, click File on the toolbar to open the file menu and then click Switch Workspace to open the Workspace Launcher (Figure 13-17A).
2. Click the Browse button to open the Select Workspace Directory browser (Figure 13-17B) and select the workspace folder. TSB will shut down and then reopen using the selected workspace.

## Deleting projects and/or script files

### Deleting a project

To delete a project, right-click the project in the Project Navigator and then click Delete in the mouse menu to display the Confirm Project Delete window (see Figure 13-19).

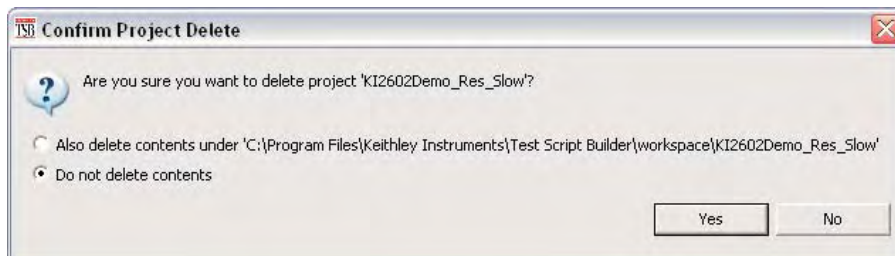
There are two project delete options:

- **Also delete contents under...** (directory path for project): This option deletes the project from the Project Navigator and also deletes the project from the workspace folder in your file system.
- **Do not delete contents:** This option deletes the project from the Project Navigator, but does not delete it from the workspace folder. The project can later be imported back into the Project Navigator (see [Importing a project from another workspace](#) described earlier in this section).

After selecting the delete option, click Yes in the Confirm Project Delete window to perform the deletion.



Figure 13-19  
**Deleting a project**



The script file will be deleted from the Project Navigator and will also be deleted from the workspace folder for the project.

### Deleting a script file

To delete a script file from a project, right-click the script file in the Project Navigator and then click Delete in the mouse menu. The script file will be deleted from the Project Navigator and will also be deleted from the workspace folder for the project.

## Displaying custom messages

You can create custom messages that display on the front panel display of the Series 2600A. Use the code below to display “Test in Process” on the front panel display:

```
display.clear() -- Clears display of messages.
display.setText("Test in Process") -- Displays message.
```

Displayed messages and input prompts are used in scripts to prompt the operator to enter parameter values from the front panel. See [Interactive scripts](#) for more information.

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---

## System Expansion (TSP-Link)

### In this section:

| Topic                                                      | Page        |
|------------------------------------------------------------|-------------|
| <b>Overview</b> .....                                      | <b>14-1</b> |
| Master and slaves .....                                    | 14-1        |
| System configurations .....                                | 14-2        |
| <b>Connections</b> .....                                   | <b>14-2</b> |
| <b>Initialization</b> .....                                | <b>14-3</b> |
| Assigning node numbers .....                               | 14-3        |
| Resetting the TSP-Link.....                                | 14-3        |
| <b>Using the expanded system</b> .....                     | <b>14-4</b> |
| Accessing nodes .....                                      | 14-4        |
| System behavior .....                                      | 14-5        |
| Triggering with TSP-Link .....                             | 14-5        |
| <b>TSP advanced features</b> .....                         | <b>14-5</b> |
| Using groups to manage nodes on the TSP-Link network ..... | 14-7        |
| Running parallel test scripts.....                         | 14-8        |
| Using the data queue for real-time communication .....     | 14-10       |
| Copying test scripts across the TSP-Link network .....     | 14-10       |
| Removing stale values from the reading buffer .....        | 14-10       |

## Overview

TSP-Link™ is an expansion interface that allows the Series 2600A instrument to communicate with other TSP-enabled instruments. The test system can be expanded to include up to 32 TSP-Link enabled instruments.

### Master and slaves

In a TSP-Link system, one of the nodes (instruments) is the Master and the other nodes are the Slaves.

The Master can control the other nodes (Slaves) in the system. When any node transitions from local operation to remote, it becomes the Master of the system; all other nodes also transition to remote operation, and become its Slaves. When any node transitions from remote operation to local, all other nodes also transition to local operation, and the Master/Slave relationship between nodes is dissolved. For more information about remote and local operations, see [Factory script information](#) in [Section 19](#).

### System configurations

A TSP-Link system can be used without a PC (stand-alone system) or as a PC-based system.

**Stand-alone system:** In a stand-alone system, scripts that control the system are executed from the front panel of one of the instruments. No PC connection is required. In [Figure 14-1](#), a script can be run from the front panel of any one of the instruments.

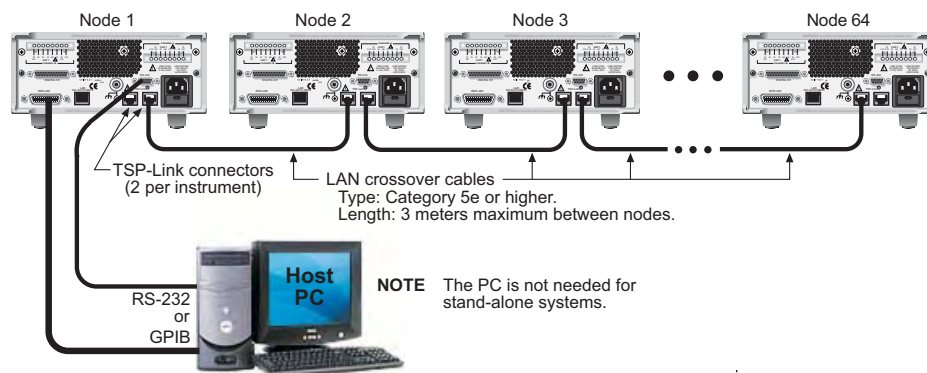
**PC-based system:** In a PC-based system, the GPIB, LAN, or RS-232 interface to any single node becomes the interface to the entire system. In [Figure 14-1](#), the system can be controlled via the GPIB, LAN or RS-232 interface of Node 1.

## Connections

Connections for an expanded system are shown in [Figure 14-1](#). As shown, one unit is optionally connected to the PC using the GPIB, LAN, or RS-232 interface. Details on these PC communication connections are covered in [Section 12](#).

As shown in [Figure 14-1](#), all the units in the system are daisy-chained together using LAN crossover cables.

Figure 14-1  
TSP-Link connections



## Initialization

Before a TSP-Link system can be used, it must be initialized. For initialization to succeed, each instrument in a TSP-Link system must be assigned a different node number.

### Assigning node numbers

At the factory, each Series 2600A instrument is assigned as Node 1. The node number for each unit is stored in its nonvolatile memory and will not be lost when the instrument is turned off.

#### Front panel operation

You can use the front panel of a instrument to assign a node number to that instrument (node). You can assign any number from 1 to 64 to the node.

Complete the following steps to assign a node number from the front panel of the instrument.

1. Press **Menu > TSPLINK > NODE**.
2. Press the **navigation wheel** and select the desired number.
3. Press **ENTER** to select the node number.

#### Remote programming

The `tsplink.node` attribute is used to set the node number for an instrument:

```
tsplink.node = N
```

Where:  $N = 1$  to  $64$

The node number of an instrument can be determined by reading the `tsplink.node` attribute as follows:

```
print(tsplink.node)
```

The above `print` command will output the node number. For example, if the node number is 1, the value `1.000000e+00` will be output.

### Resetting the TSP-Link

After all the node numbers are set, you must initialize the system by performing a TSP-Link reset. For initialization to succeed, all units must be powered on when the TSP-Link reset is performed.

---

**NOTE** If you change the system topology after initialization, you must re-initialize the system by performing a TSP-Link reset. Changes that affect the system topology include powering down or rebooting any unit in the system, or rearranging or disconnecting the LAN cable connections between units.

---

#### Front panel operation

Complete the following steps to reset the TSP-Link network from the front panel.

1. Press **Menu > TSPLINK**.
2. Press **RESET**.

## Remote programming

The commands associated with TSP-Link reset are listed in [Table 14-1](#).

Table 14-1

### TSP-Link reset commands

| Command                      | Description                                                                                               |
|------------------------------|-----------------------------------------------------------------------------------------------------------|
| <code>tsplink.reset()</code> | Initializes the TSP-Link network.                                                                         |
| <code>tsplink.state</code>   | Returns “online” if the most recent TSP-Link reset was successful. Returns “offline” if the reset failed. |

An attempted TSP-Link reset will fail if any of the following conditions are true:

- Two or more instruments in the system have the same node number.
- There are no other instruments connected to the unit performing the reset (only if the expected number of nodes was not provided in the reset call).
- One or more of the units in the system is not powered on.
- If the actual number of nodes is less than the expected number.

Example: The following code will reset the TSP-Link and output its state:

```
tsplink.reset()
print(tsplink.state)
```

If the reset is successful, `online` will be returned to indicate that communications with all nodes have been established.

## Using the expanded system

### Accessing nodes

A TSP-Link reset populates the node table. Each unit in the system corresponds to an entry in this table. Each entry is indexed by the node number of the unit. The variable `node[N]` (where `N` is the node number) is used to access any node in the system. For example, node 1 is represented in the node table as entry `node[1]`.

Each of these entries is, in turn, a table, holding all of the logical instruments (and associated ICL commands) shared by the corresponding unit (see [Logical instruments](#) for more details). SMU A on node 1, therefore, could be accessed as `node[1].smua`.

The variable `localnode` is an alias for `node[N]`, where `N` is the node number of the node on which the code is running. For example, if node 1 is running the code, `localnode` can be used instead of `node[1]`.

**Programming examples:** The following examples show how to access instruments in the TSP-Link system shown in [Figure 14-1](#):

- Any of the following three commands can be used to reset SMU A of node 1 (which, in this example, is the Master). The other nodes in the system are not affected.

```
smua.reset()
localnode.smua.reset()
node[1].smua.reset()
```

- The following command will reset the SMU A of node 4, which is a Slave. The other nodes are not affected.

```
node[4].smua.reset()
```

## System behavior

### Using the `reset()` command

While most TSP-Link operations target a single node in the system, the `reset()` command affects the system as a whole. The `reset()` command, by definition, resets all nodes to their default settings:

```
-- Resets all nodes in a TSP-Link system.
reset()
```

`node[N]` and `localnode` can be used with `reset` to reset only one of the nodes. The other nodes are not affected. Examples:

```
-- Resets node 1 only.
node[1].reset()
-- Resets node 1 only.
localnode.reset()
-- Resets node 4 only.
node[4].reset()
```

### Abort

An `abort` will terminate an executing script and return all nodes to local operation (REM indicators turn off), dissolving the Master/Slave relationships between nodes. An abort is invoked by either issuing an `abort` command to the Master or pressing the **EXIT** key on any node in the system.

An abort can also be performed by pressing the **OUTPUT ON/OFF** key on any node. The results are the same as above, with the addition that all SMU outputs in the system are turned off.

## Triggering with TSP-Link

TSP-Link has three synchronization lines that function similar to the Digio synchronization lines. See [Section 8](#) and [Section 10](#) for more information.

## TSP advanced features

Use the TSP advanced features to run test scripts in parallel, to manage resources allocated to test scripts running in parallel, and to use the data queue to facilitate real-time communication between nodes on the TSP-Link network.

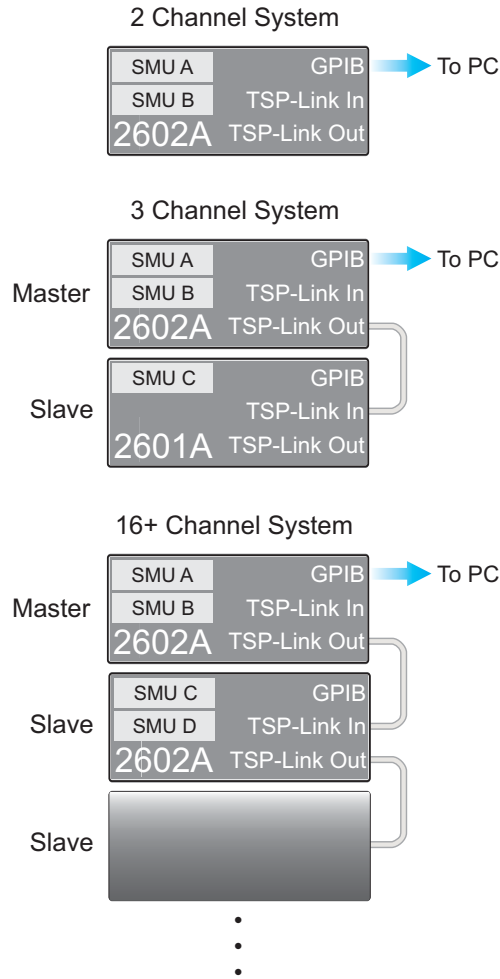
Running test scripts in parallel improves functional testing, provides higher throughput, and expands system flexibility.

There are two methods you can use to run test scripts in parallel:

- Create multiple TSP-Link networks
- Use a single TSP-Link network with groups

[Figure 14-2](#) displays the first method, which consists of multiple TSP-Link networks. Each TSP-Link network has a master node and a GPIB connection to the PC.

Figure 14-2  
**Multiple TSP-Link networks**



The second method to run parallel test scripts is to use groups with a single TSP-Link network. A group consists of one or more nodes with the same group number. Each group on the TSP-Link network can run different test scripts at the same time (in parallel).

*Figure 14-3* displays a single TSP-Link network with groups. This method requires one TSP-Link network and a single GPIB connection to the PC.



**Figure 14-3**  
Single TSP-Link network with groups

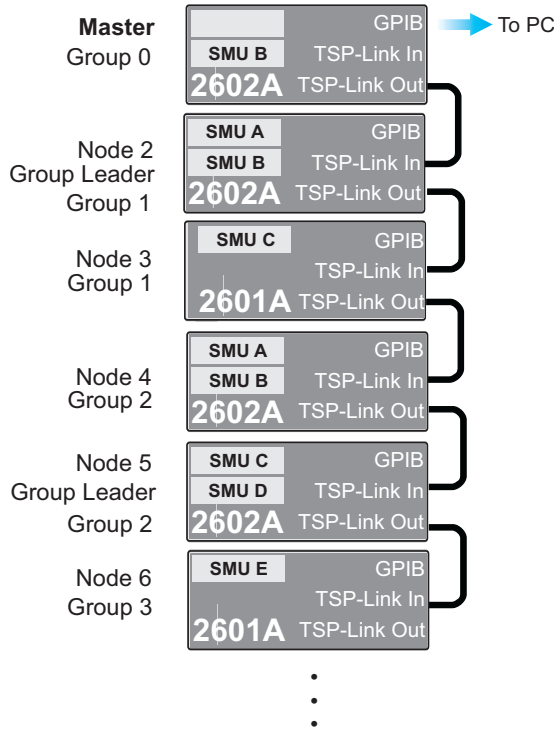


Table 14-2 describes the functions of a single TSP-Link network. Each group in this example runs multiple test scripts at the same time or in parallel.

Table 14-2  
TSP-Link network group functions

| Group number | Group members          | Current function                                                                                                                       |
|--------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| 0            | Master node            | Initiates and runs a test script on Node 2<br>Initiates and runs a test script on Node 5<br>Initiates and runs a test script on Node 6 |
| 1            | Group leader<br>Node 2 | Runs the test script initiated by the master node<br>Initiates remote operations on Node 3                                             |
|              | Node 3                 | Performs remote operations initiated by Node 2                                                                                         |
| 2            | Group leader<br>Node 5 | Runs the test script initiated by the master node<br>Initiates remote operations on Node 4                                             |
|              | Node 4                 | Performs remote operations initiated by Node 5                                                                                         |
| 3            | Group leader<br>Node 6 | Runs the test script initiated by the master node                                                                                      |

## Using groups to manage nodes on the TSP-Link network

The primary reason to use a group is to assign each node to run different test scripts at the same time (in parallel). Each node must belong to a group; a group can consist of one or more nodes on the TSP-Link network. Group numbers are not assigned automatically; you must use the Instrument Control Library (ICL) commands to assign each node to a group.

### Master node overview

The master node is always the node that coordinates activity on the TSP-Link network. All nodes assigned to group 0 belong to the same group as the master node.

The following list describes the functionality of the master node:

- The only node that can issue the `execute` command to a remote node
- Cannot initiate remote operations on any node in a remote group if any node in that remote group is performing an overlapped operation
- Can use the `waitcomplete` command to wait for all overlapped operations running on the local group that the master node belongs to, and to wait for all overlapped operations running on a remote group, or to wait for all overlapped operations running on the TSP-Link network to complete

### Group leader overview

Each group has a dynamic group leader. The last node in a group running any operation initiated by the master node is the group leader.

The following list describes the functionality of the group leader:

- Runs operations initiated by the master node
- Initiates remote operations on any node with the same group number
- Cannot initiate remote operations on any node with a different group number
- Can use the `waitcomplete` command without a parameter to wait for all overlapped operations running on nodes in the same group

### Assigning groups

Group numbers can range from 0 (zero) to 64. The default group number is 0. You can change the group number at any time.

Use the following code to dynamically assign nodes to a group.

Note the following:

- Replace N with the node number
- N represents the node number that runs the test scripts and the TSL code
- Each time the node powers off, the group number for that node changes to 0
- Replace G with the group number

```
-- Assigns the node to a group.
node[N].tsplink.group = G
```

### Reassigning groups

Use the following code to change group assignment. You can add or remove a node to a group at anytime.

```
-- Assigns the node to a different group.
node[N].tsplink.group = G
```

## Running parallel test scripts

You can issue the `execute` command from the master node to initiate test script and TSL code on a remote node. The `execute` command places the remote node in the overlapped operation state. As a test script runs on the remote node, the master node continues to process other commands in parallel.

Note the following:

- Use the following code to send the `execute` command on a remote node
- N represents the node number that runs the test script

- Replace N with the node number

**To set the global variable on Node N equal to 2.5:**

```
node[N].execute("setpoint = 2.5")
```

The following code is an example of how to run a test script on a remote node.

---

NOTE For this example, `myscript` is defined on the local node.

---

**To run myscript on Node N:**

```
node[N].execute(myscript.source)
```

The following code demonstrates how to run a test script defined on a remote node.

---

NOTE For this example, `myscript` is defined on the remote node.

---

**To execute a script defined on the remote node:**

```
node[N].execute("myscript()")
```

It is recommended that you copy large scripts to a remote node to improve system performance (see [Copying test scripts across the TSP-Link network](#) for more information).

**Coordinating overlapped operations in remote groups**

Errors occur if you send a command to a node in a remote group running an overlapped operation. All nodes in a group must be in the overlapped idle state before the master node can send a command to the group.

Use the `waitcomplete` command to:

- **Group leader and master node:** To wait for all overlapped operations running in the local group to complete.
- **Master node only:** To wait for all overlapped operations running on a remote group to complete.
- **Master node only:** To wait for all groups to complete overlapped operations.

For additional information, refer to [Section 19](#) and the `waitcomplete` command.

The following code is an example on how to issue the `waitcomplete` command from the master node:

```
-- Waits for each node in group G to complete all overlapped operations.
waitcomplete(G)
-- Waits for all groups on the TSP-Link network to complete overlapped
-- operations.
waitcomplete(0)
```

The group leader can issue the `waitcomplete` command to wait for the local group to complete all overlapped operations.

The following code is an example of how to issue the `waitcomplete` command:

```
-- Waits for all nodes in a local group to complete the overlapped
-- operations.
waitcomplete()
```

## Using the data queue for real-time communication

You cannot access the reading buffers or global variables from any node in a remote group while a node in that group is performing an overlapped operation. You can use the data queue to retrieve data from any node in a group performing an overlapped operation. In addition, the master node and the group leaders can use the data queue as a way to coordinate activities.

The data queue uses the first-in, first-out (FIFO) structure to store data. Nodes running test scripts in parallel can store data in the data queue for real-time communication. Each Series 2600A has an internal data queue. You can access the data queue from any node at any time.

You can use the data queue to post numeric values, strings, and tables. Tables in the data queue consume one entry. A new copy of the table is created when the table is retrieved from the data queue. The copy of the table does not contain any references to the original table or any subtables.

To add or retrieve values from the data queue and to view the capacity, see [Section 19](#).

## Copying test scripts across the TSP-Link network

To run a large script on a remote node, it is highly recommend that you copy the test script to the remote node to increase the speed of test script initiation.

Use the code below to copy test scripts across the TSP-Link network. This example creates a copy of a script on the remote node.

Note the following:

- The copy of the test script has the same name as the source
- Replace N with the number of the node that receives a copy of the script
- Replace `myscript` with the name of the script that you want to copy from the local node

```
-- Adds the source code from myscript to the data queue.
node[N].dataqueue.add(myscript.source)

-- Creates a new script on the remote node using the source code from
-- myscript.
node[N].execute(myscript.name.." = script.new(dataqueue.next(),
[["..myscript.name.."]])")
```

## Removing stale values from the reading buffer

The node that acquires the data stores the data for the reading buffer. To optimize data access, all nodes can cache data from the node that stores the reading buffer data.

Running TSL code remotely can cause values in the reading buffer cache to become stale. If the values in the reading buffer change while the TSL code runs remotely, another node can hold stale values. Use the `clearcache` command to clear the cache.

The following code demonstrates how stale values occur and how to use the `clearcache` command to clear the reading buffer cache.

Note the following:

- Replace N with the node number
- Replace G with the group number

```
-- Creates a reading buffer on a node in a remote group.
node[N].tsplink.group = G
node[N].execute("rbremote = smua.makebuffer(20) " ..
 "smua.measure.count = 20 " ..
 "smua.measure.overlappedv(rbremote)")
waitcomplete(G)

-- Creates a variable on the local node to access the reading buffer.
rblocal = node[N].getglobal("rbremote")

-- Access data from the reading buffer.
print(rblocal[1])

-- Runs code on the remote node that updates the reading buffer.
node[N].execute("smua.measure.overlappedv(rbremote)")

-- Use the clearcache command if the reading buffer contains cached data.
rblocal.clearcache()

-- If you do not use the clearcache command, the data buffer values do
--not update. The same data buffer values will print each time the
-- print command is issued.
print(rblocal[1])
```

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---

## Communications Interfaces

### In this section:

| Topic                                      | Page         |
|--------------------------------------------|--------------|
| <b>Overview</b> .....                      | <b>15-2</b>  |
| <b>Selecting an interface</b> .....        | <b>15-2</b>  |
| <b>Output queue</b> .....                  | <b>15-2</b>  |
| <b>GPIB operation</b> .....                | <b>15-3</b>  |
| GPIB standards .....                       | 15-3         |
| GPIB connections .....                     | 15-3         |
| Primary address .....                      | 15-4         |
| Terminator .....                           | 15-5         |
| <b>General bus commands</b> .....          | <b>15-5</b>  |
| REN (remote enable) .....                  | 15-6         |
| IFC (interface clear) .....                | 15-6         |
| LLO (local lockout) .....                  | 15-6         |
| GTL (go to local) .....                    | 15-6         |
| DCL (device clear) .....                   | 15-6         |
| SDC (selective device clear) .....         | 15-6         |
| GET (group execute trigger) .....          | 15-6         |
| SPE, SPD (serial polling) .....            | 15-7         |
| <b>Front panel GPIB operation</b> .....    | <b>15-7</b>  |
| Error and status messages .....            | 15-7         |
| GPIB status indicators .....               | 15-7         |
| LOCAL key .....                            | 15-8         |
| <b>RS-232 interface operation</b> .....    | <b>15-8</b>  |
| Setting RS-232 interface parameters .....  | 15-8         |
| Sending and receiving data .....           | 15-9         |
| Terminator .....                           | 15-9         |
| Baud rate .....                            | 15-9         |
| Data bits and parity .....                 | 15-9         |
| Flow control (signal handshaking) .....    | 15-9         |
| RS-232 connections .....                   | 15-10        |
| Error messages .....                       | 15-11        |
| <b>Ethernet communications</b> .....       | <b>15-11</b> |
| Ethernet cable connection .....            | 15-11        |
| Using the LAN with remote operations ..... | 15-12        |

## Overview

This section provides information on:

- [Selecting an interface](#)
- [GPIB operation](#)
- [General bus commands](#)
- [Front panel GPIB operation](#)
- [RS-232 interface operation](#)
- Ethernet communications

## Selecting an interface

The Keithley Instruments Series 2600A System SourceMeter® instrument supports three remote interfaces:

- GPIB (General Purpose Interface Bus)
- RS-232
- LAN

---

NOTE See [Section 12](#) for more information on the GPIB and RS-232 communications interfaces. See [Section 16](#) for more information on LAN interfaces.

---

The Series 2600A can only be controlled from one remote interface at a time. The unit will remote to the first interface on which it receives a message. It will ignore the other interface until the unit is taken back to local operation.

## Output queue

All interfaces share the same output queue. The output queue sets the MAV bits in the status model. The data in the output queue clears if the mode changes to local mode.

---

NOTE You must save the data from the output queue while the instrument is communicating with the remote command interface. All data in the output queue is cleared when the instrument returns to local mode.

---



## GPIB operation

This section contains information about GPIB standards, bus connections, and primary address selection.

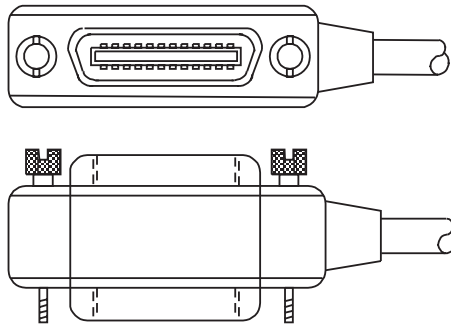
### GPIB standards

The GPIB is the IEEE-488 instrumentation data bus with hardware and programming standards originally adopted by the IEEE (Institute of Electrical and Electronic Engineers) in 1975. The Series 2600A is IEEE-488.1 compliant and supports IEEE-488.2 common commands and status model topology.

### GPIB connections

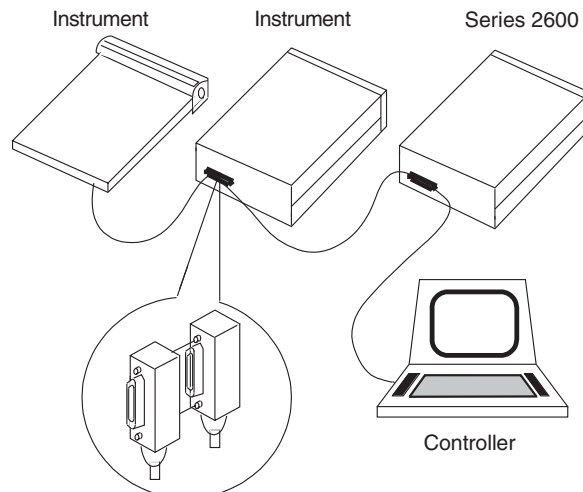
To connect the Series 2600A to the GPIB bus, use a cable equipped with standard IEEE-488 connectors, as shown in [Figure 15-1](#).

Figure 15-1  
IEEE-488 connector



To allow many parallel connections to one instrument, stack the connectors. Two screws are located on each connector to ensure that connections remain secure. [Figure 15-2](#) shows a typical connection scheme for a multi-unit test system.

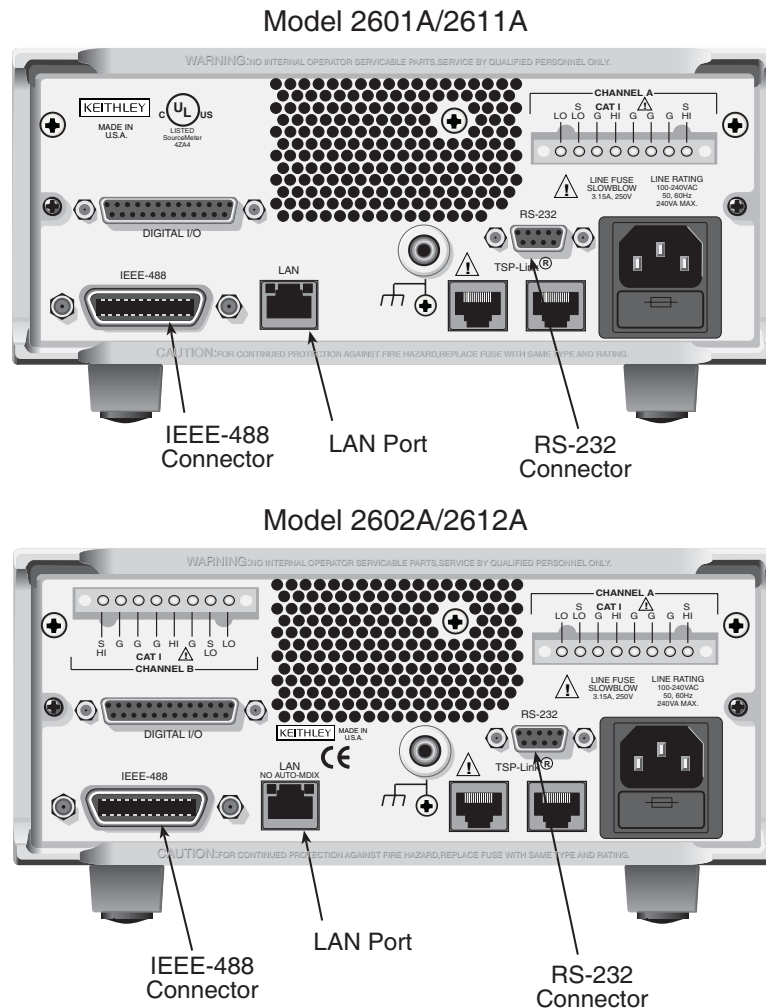
Figure 15-2  
IEEE-488 connections



To avoid possible mechanical damage, stack no more than three connectors on any one unit. To minimize interference caused by electromagnetic radiation, use only shielded IEEE-488 cables. Available shielded cables from Keithley Instruments are listed in [Options and accessories](#) in Section 1.

To connect the Series 2600A to the IEEE-488 bus, line up the cable connector with the connector located on the rear panel. Install and tighten the screws securely, making sure not to overtighten them ([Figure 15-3](#) shows the location of the connections).

Figure 15-3  
IEEE-488, RS-232, and LAN connection



Connect any additional connectors from other instruments as required for your application. Make sure the other end of the cable is properly connected to the controller. You can only have 15 devices connected to an IEEE-488 bus, including the controller. The maximum cable length is either 20 meters or two meters multiplied by the number of devices, whichever is less. Not observing these limits may cause erratic bus operation.

## Primary address

The Series 2600A ships from the factory with a GPIB primary address of 26. If the GPIB interface is enabled, it momentarily displays the primary address on power-up. You can set the address to a

value from 0 to 30, but do not assign the same address to another device or to a controller that is on the same GPIB bus (controller addresses are usually 0 or 21).

### Front panel primary address

To set or check the primary address:

1. Press **MENU** > **GPIB**, then press **ENTER** or the **navigation wheel**.
2. Set the primary address to the desired value, then press **ENTER** or the **navigation wheel**.
3. Press **EXIT** to back out of the menu structure.

### Remote primary address

Use the following command to set the primary address by remote:

```
gpib.address = address
```

For example, the following command sets the address to 20:

```
gpib.address = 20
```

Note that changing the GPIB address takes effect when the command is processed. Any response messages generated after processing this command will be sent with the new settings. If command messages are being queued (sent before this command has executed), the new settings may take effect in the middle of a subsequent command message, so care should be exercised when setting this attribute from the GPIB interface.

## Terminator

When receiving data over the GPIB, the Series 2600A terminates on any line feed character or any data byte with EOI asserted (line feed with EOI asserted is also valid). When sending data, it will append a line feed character to all outgoing messages. The EOI line will be asserted with the terminating line feed character.

## General bus commands

General commands are those commands, such as DCL, that have the same general meaning regardless of the instrument. [Table 15-1](#) lists the general bus commands.

Table 15-1

**General bus commands**

| Command  | Effect on Series 2600A                                     |
|----------|------------------------------------------------------------|
| REN      | Goes into remote when next addressed to listen.            |
| IFC      | Goes into talker and listener idle states.                 |
| LLO      | LOCAL key locked out.                                      |
| GTL      | Cancel remote; restore Series 2600A front panel operation. |
| DCL      | Returns all devices to known conditions.                   |
| SDC      | Returns Series 2600A to known conditions.                  |
| GET      | Initiates a trigger.                                       |
| SPE, SPD | Serial polls the Series 2600A.                             |

## REN (remote enable)

The remote enable command is sent to the Series 2600A by the controller to set up the instrument for remote operation. Generally, the instrument should be placed in the remote mode before you attempt to program it over the bus. Setting REN true does not place the instrument in the remote state. You must address the instrument to listen after setting REN true before it goes into remote.

## IFC (interface clear)

The IFC command is sent by the controller to place the Series 2600A in the local, talker, or listener idle states. The unit responds to the IFC command by cancelling front panel TALK or LSTN lights, if the instrument was previously placed in one of these states.

Transfer of command messages to the instrument and transfer of response messages from the instrument are not interrupted by IFC. If a response message was suspended by IFC, transfer of the message will resume when the unit is addressed to talk. If a command message transfer was suspended by IFC, the rest of the message can be sent when the unit is addressed to listen.

## LLO (local lockout)

When the unit is in remote operation, all front panel controls are disabled except the **LOCAL** and **OUTPUT OFF** keys (and of course the POWER switch). The LLO command disables the **LOCAL** key, but it does not affect **OUTPUT OFF**, which cannot be disabled.

## GTL (go to local)

Use the GTL command to put a remote-mode instrument into local mode. Leaving the remote state also restores operation of all front panel controls.

## DCL (device clear)

Use the DCL command to clear the GPIB interface and return it to a known state. Note that the DCL command is not an addressed command, so all instruments equipped to implement DCL will do so simultaneously.

When the Series 2600A receives a DCL command, it clears the Input Buffer and Output Queue, cancels deferred commands, and clears any command that prevents the processing of any other device command. A DCL does not affect instrument settings and stored data.

## SDC (selective device clear)

The SDC command is an addressed command that performs essentially the same function as the DCL command. However, since each device must be individually addressed, the SDC command provides a method to clear only selected instruments instead of clearing all instruments simultaneously, as is the case with DCL.

## GET (group execute trigger)

GET is a GPIB trigger that is used to trigger the instrument to take readings from a remote interface.

## SPE, SPD (serial polling)

Use the serial polling sequence to obtain the Series 2600A serial poll byte. The serial poll byte contains important information about internal functions. (See [Appendix C](#).) Generally, the serial polling sequence is used by the controller to determine which of several instruments has requested service with the SRQ line. The serial polling sequence may be performed at any time to obtain the status byte from the Series 2600A.

## Front panel GPIB operation

This section describes aspects of the front panel that are part of GPIB operation, including messages, status indicators, and the **LOCAL** key.

### Error and status messages

See [Appendix A](#) for a list of status and error messages associated with IEEE-488 programming. The instrument can be programmed to generate an SRQ, and command queries can be performed to check for specific error conditions.

### GPIB status indicators

The REM (remote), TALK (talk), LSTN (listen), and SRQ (service request) indicators show the GPIB bus status. Each of these indicators is described below.

#### REM

This indicator shows when the instrument is in the remote state. When the instrument is in remote, all front panel keys, except for the **LOCAL** and **OUTPUT OFF** keys, are locked out. When REM is turned off, the instrument is in the local state, and front panel operation is restored.

#### TALK

This indicator is on when the instrument is in the talker active state. Place the unit in the talk state by addressing it to talk with the correct talk command. TALK is off when the unit is in the talker idle state. Place the unit in the talker idle state by sending a UNT (Untalk) command, addressing it to listen, or sending the IFC (Interface Clear) command.

#### LSTN

This indicator is on when the Series 2600A is in the listener active state, which is activated by addressing the instrument to listen with the correct listen command. LSTN is off when the unit is in the listener idle state. Place the unit in the listener idle state by sending UNL (Unlisten), addressing it to talk, or sending IFC (Interface Clear) command over the bus.

#### SRQ

You can program the instrument to generate a service request (SRQ) when one or more errors or conditions occur. When this indicator is on, a service request has been generated. This indicator stays on until the serial poll byte is read or all the conditions that caused SRQ have been cleared.

## LOCAL key

The **LOCAL (EXIT)** key cancels the remote state and restores local operation of the instrument. Pressing the **LOCAL** key also turns off the REM indicator and returns the display to normal if a user-defined message was displayed.

If the LLO (Local Lockout) command is in effect, the **LOCAL** key is also inoperative. For safety reasons, the **OUTPUT OFF** key can be used to turn the output off while in LLO. Note that pressing **LOCAL** or **OUTPUT OFF** will also abort any commands or scripts that are being processed.

## RS-232 interface operation

### Setting RS-232 interface parameters

#### Front panel RS-232 parameters

To set interface parameters:

1. Press **MENU > RS232** and then press **ENTER** the **navigation wheel**.
2. Select and enter the following interface parameters:
  - Baud rate
  - Number of bits
  - Parity
  - Flow control  
(See the following section for details)
3. Press **EXIT** as needed to back out of the menu structure.

#### Remote RS-232 parameters

Commands to set RS-232 parameters are listed in [Table 15-2](#). See [Section 19](#) for more information.

Table 15-2

**RS-232 interface commands**

| Command                                | Description                                                                                                                                                |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>serial.baud = baud</code>        | Set baud rate (300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200)                                                                           |
| <code>serial.databits = bits</code>    | Set number of bits (7 or 8)                                                                                                                                |
| <code>serial.flowcontrol = flow</code> | Set flow control:<br><code>serial.FLOW_NONE</code> (no flow control)<br><code>serial.FLOW_HARDWARE</code> (hardware flow control)                          |
| <code>serial.parity = parity</code>    | Set parity:<br><code>serial.PARITY_NONE</code> (no parity)<br><code>serial.PARITY_EVEN</code> (even parity)<br><code>serial.PARITY_ODD</code> (odd parity) |

Note that changing the serial port settings take effect when the command is processed. Any response messages generated after processing these commands will be sent with the new settings. If command messages are being queued (sent before these commands have executed), the new settings may take effect in the middle of a subsequent command message, so care should be exercised when setting these attributes from the RS-232 interface.

## RS-232 programming example

Send the following commands to set the baud rate to 9600 with no flow control:

```
serial.baud = 9600
serial.flowcontrol = serial.FLOW_NONE
```

## Sending and receiving data

The RS-232 interface transfers data using 7 or 8 data bits, 1 stop bit, and no, even, or odd parity. Make sure the device you connect to the Series 2600A also uses the same settings.

## Terminator

When receiving data over the RS-232 interface the command interface terminates on line feeds. A line feed is appended to all output messages when the RS-232 interface is being used as a command interface.

Sending data using the `serial.write` function does not append a terminator. Be sure to append the appropriate terminator to the message before sending it.

## Baud rate

The baud rate is the rate at which the Series 2600A and the programming terminal communicate. Choose one of the following available rates:

- 115200
- 57600
- 38400
- 19200
- 9600
- 4800
- 2400
- 1200
- 600
- 300

The factory-selected baud rate is 9600.

Both the Series 2600A and the other device must be configured for the same baud rate. Make sure the device connected to the Series 2600A RS-232 port can support the selected baud rate.

## Data bits and parity

The RS-232 interface can be configured to send/receive data that is 7 or 8 bits long using even, odd, or no parity.

## Flow control (signal handshaking)

Signal handshaking between the controller and the instrument allows the two devices to communicate to each other regarding being ready or not ready to receive data.

The RS-232 interface provides two control lines (RTS and CTS) for this purpose (see [Figure 15-4](#) and [Table 15-3](#)). When the Series 2600A is ready to send (RTS) data, it will transmit when it receives the clear to send (CTS) signal from the computer.

Figure 15-4  
**RS-232 interface connector**

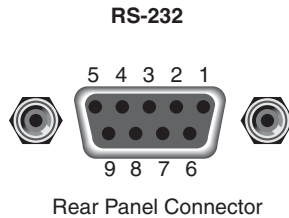


Table 15-3  
**RS-232 connector pinout**

| Pin number | Description        |
|------------|--------------------|
| 1          | Not used           |
| 2          | TXD, transmit data |
| 3          | RXD, receive data  |
| 4          | Not used           |
| 5          | GND, signal ground |
| 6          | Not used           |
| 7          | RTS, ready to send |
| 8          | CTS, clear to send |
| 9          | Not used           |

To enable or disable flow control, use the RS-232 configuration menu. Select **HARDWARE** to enable flow control, or **NONE** to disable it.

## RS-232 connections

The RS-232 serial port is connected to the serial port of a computer using a straight-through RS-232 cable terminated with DB-9 connectors. Do not use a null modem cable. The serial port uses the transmit (TXD), receive (RXD), CTS and RTS (if flow control is enabled), and signal ground (GND) lines of the RS-232 standard. [Figure 15-4](#) shows the rear panel connector for the RS-232 interface, and [Table 15-3](#) shows the pinout for the connector. The connector location is shown in [Figure 15-3](#).

If your computer uses a DB-25 connector for the RS-232 interface, you will need a standard cable or adapter with a DB-25 connector on one end and a DB-9 connector on the other. An available RS-232 cable from Keithley Instruments is listed in [Options and accessories](#) in Section 1.

[Table 15-4](#) provides pinout identification for the 9-pin (DB-9) or 25-pin (DB-25) serial port connector on the computer (PC).



Table 15-4  
**PC serial port pinout**

| Signal*                  | DB-9 pin number | DB-25 pin number |
|--------------------------|-----------------|------------------|
| DCD, data carrier detect | 1               | 8                |
| RXD, receive data        | 2               | 3                |
| TXD, transmit data       | 3               | 2                |
| DTR, data terminal ready | 4               | 20               |
| GND, signal ground       | 5               | 7                |
| DSR, data set ready      | 6               | 6                |
| RTS, request to send     | 7               | 4                |
| CTS, clear to send       | 8               | 5                |
| RI, ring indicator       | 9               | 22               |

\* The Series 2600A does not use all RS-232 signals. See [Table 15-3](#).

## Error messages

See [Appendix A](#) for RS-232 error messages.

## Ethernet communications

Ethernet provides the flexibility to build scalable and functional test or data acquisition systems with a large degree of flexibility. The Series 2600A is a Class C LXI-compliant instrument that supports TCP/IP and complies with the IEE 802.3 standard. There is one Ethernet port, (located on the back of the instrument), and supports full connectivity on a 10 Mbps or 100 Mbps network.

### Ethernet cable connection

The Series 2600A includes 2 x CA-180-3A cables. Use one cable for TSP-Link and use the other cable for LAN (for a direct instrument to PC connection).

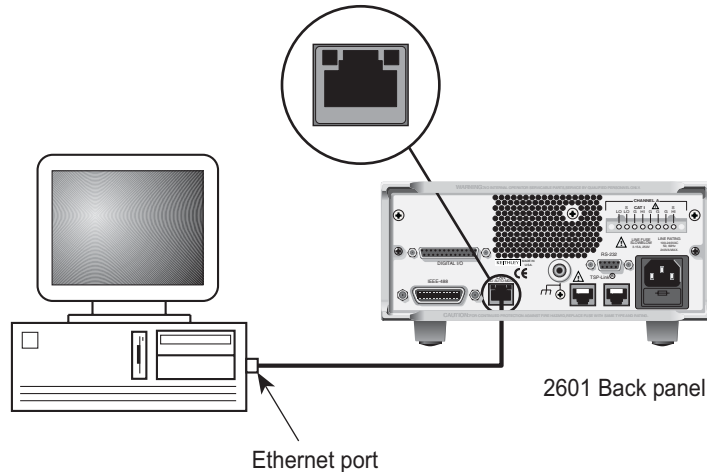
---

NOTE Do not use the cable supplied to connect with a router or hub unless the router or hub supports Auto-MDIX.

---

1. Insert the LAN cable into the LAN port located on the back of the instrument. See [Figure 15-5](#).

Figure 15-5  
**Ethernet connection**



2. Insert the category 5 cable into the Ethernet port located on the host PC.

To configure the LAN settings, see [Connecting to the LAN](#).

## Using the LAN with remote operations

[Table 15-5](#) provides the functions available from the remote interface:

Table 15-5  
**LAN functions**

| Port Number | Function                     |
|-------------|------------------------------|
| 23          | Telnet                       |
| 1024        | VXI-11                       |
| 5025        | Raw socket                   |
| 5027        | Dead socket termination port |

---

**NOTE** You can only use one remote interface at a time. Although multiple ethernet connections to the instrument can be opened, only one can be used to control the instrument at any given time.

---

**Raw socket:** Raw socket is a basic ethernet connection that communicates similarly to RS-232 without explicit message boundaries. The instrument will always terminate messages with a line feed, but because binary data may include bytes that resemble line feed characters, it may be difficult to distinguish between data and line feed characters.

**VXI-11:** VXI-11 is similar to GPIB and supports message boundaries as well as service requests (SRQs). A VXI-11 driver or VISA software is required. Test Script Builder (TSB) uses VISA and can be used with the VXI-11 interface.

**Telnet:** Telnet is similar to raw socket and is used when the user needs to interact directly with the instrument, typically for debugging and troubleshooting. Telnet requires a separate telnet program.

**Dead socket termination port:** The dead socket termination port is used to terminate all existing ethernet connections. A dead socket is one which is held open by the instrument because it has not been properly closed. This most often happens when the PC is turned off or reboots without first closing the socket. This port cannot be used for command and control functions.

### Monitoring the LAN

The `lan.autoconnect` command configures the instrument to monitor the LAN for lost connections. All Ethernet connections are disconnected if the LAN link is disconnected for longer than the time-out value specified in the `lan.linktimeout` attribute.

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---

## LAN Concepts and Settings

### In this section:

| Topic                                                    | Page         |
|----------------------------------------------------------|--------------|
| <b>Overview</b> .....                                    | <b>16-2</b>  |
| <b>Establishing a point-to-point connection</b> .....    | <b>16-2</b>  |
| LAN troubleshooting suggestions .....                    | 16-7         |
| <b>Connecting to the LAN</b> .....                       | <b>16-8</b>  |
| Setting the method .....                                 | 16-8         |
| Assigning the Method.....                                | 16-9         |
| Setting the IP address.....                              | 16-9         |
| Setting the subnet mask.....                             | 16-9         |
| Understanding the domain name system.....                | 16-9         |
| Verify menu overview .....                               | 16-10        |
| <b>Understanding LAN speeds</b> .....                    | <b>16-10</b> |
| Configuring the LAN speed .....                          | 16-10        |
| <b>Duplex mode</b> .....                                 | <b>16-11</b> |
| Configuring the duplex mode .....                        | 16-11        |
| <b>Configuring the network settings</b> .....            | <b>16-11</b> |
| CONFIG/FAULT .....                                       | 16-11        |
| <b>Viewing LAN status messages</b> .....                 | <b>16-11</b> |
| <b>Viewing the network settings</b> .....                | <b>16-12</b> |
| Confirming the active speed and duplex negotiation ..... | 16-12        |
| Confirming port numbers.....                             | 16-12        |
| <b>Selecting a remote command interface</b> .....        | <b>16-13</b> |
| <b>Configuring a telnet connection</b> .....             | <b>16-13</b> |

## Overview

Keithley Instruments Series 2600A System SourceMeter® instruments are class C LXI version 1.2 compliant. The Series 2600A is a scalable test system with a direct connection to a host PC or interact with a DHCP or DNS server, and other LXI compliant instruments on a local area network (LAN).

The Series 2600A is compliant with the IEEE standard 802.3 and supports full connectivity on a 10Mbps or 100Mbps network. The LAN interface is an alternative solution to GPIB that can be used to build test systems with a large degree of flexibility and includes web accessibility.

---

**NOTE** Please read this entire chapter before you connect the Series 2600A to the LAN.

---

## Establishing a point-to-point connection

A one-to-one LAN connection to set up a static IP address between the PC and the instrument enables the use of the instrument's internal web page and TSP™ Express.

Use the instructions below to configure the instrument's IP address based on the present IP address of the host PC. Whenever there is an existing IP address configured for the network interface card's network settings, the IP address for the ethernet instruments should be configured so they are compatible.

---

---

**CAUTION** Record all network configurations before modifying any existing network configuration information on the network interface card. Once the network configuration settings are updated, the older information is lost. This may cause a problem reconnecting the PC to a corporate network if DHCP Enabled = NO (DHCP is disabled).

Be sure to return all settings to their original configuration prior to reconnecting the PC to a corporate network. Failure to do this could result in damage to the equipment and loss of data. Contact your system administrator for more information.

---

---

### Step 1: Identify and record the PC's existing IP configuration Information

1. Open the command prompt to see the existing IP configuration information:
  - In Windows 2000/XP:
    - a. Click the **Start** button and select **Run**.
    - b. Type `cmd` in the **Open** field and click **OK**.
  - In Windows Vista:
    - a. Click the **Start** button.
    - b. Select **All Programs**.
    - c. Select **Accessories**.
    - d. Select **Command Prompt**.
2. At the command prompt, type `ipconfig/all` and click **Enter** (see [Figure 16-1](#)).
  - a. If the information for the ethernet adapter displays **Media Disconnected** then close the command prompt and skip to [Step 2: Disable DHCP to use the computer's existing IP address](#).

- b. When the information is displayed, record the DHCP mode, IP address, subnet mask, default gateway, and DNS servers.

---

**CAUTION** `ipconfig/all` displays the configuration of all network connections. Be sure to record the information for the proper network card.

---

Figure 16-1  
Computer configuration using the command prompt

```

c:\ Command Prompt

C:\WINDOWS>ipconfig/all

Windows IP Configuration

 Host Name : mycomputer
 Primary Dns Suffix :
 Node Type : Hybrid
 IP Routing Enabled. : No
 WINS Proxy Enabled. : No
 DNS Suffix Search List. : mycompany.com

Ethernet adapter Wireless Network Connection:

 Connection-specific DNS Suffix . . . :
 Description : Intel(R) Wireless WiFi Link 4965AG
 Physical Address. : 00-01-02-03-04-05
 Dhcp Enabled. : Yes
 IP Address. : 1.2.3.87
 Subnet Mask : 255.255.255.0
 Default Gateway : 1.2.3.1
 DNS Servers : 1.2.3.2

Ethernet adapter Local Area Connection:

 Connection-specific DNS Suffix . . . :
 Description : Intel(R) 82566MM Gigabit Network Connection
 Physical Address. : 00-02-03-04-05-06
 Dhcp Enabled. : No
 IP Address. : 192.168.1.100
 Subnet Mask : 255.255.255.0
 Default Gateway : 192.168.1.1
 DNS Servers :

C:\WINDOWS>

```

3. Verify DHCP or Static IP status.
  - To determine the next step, check the DHCP Enabled setting in the IP configuration screen or in the settings recorded earlier.
    - a. If DHCP Enabled = **Yes**, proceed to [Step 2: Disable DHCP to use the computer's existing IP address.](#)
    - b. If DHCP Enabled = **No**, proceed to [Step 3: Configure the Instrument's LAN settings.](#)

---

**NOTE** When DHCP Enabled = Yes, the IP address of the PC is assigned automatically upon power up. However, if DHCP Enabled = No, the network will not recognize the PC if the original settings are changed. If at any time you are unsure how to proceed, contact your system administrator.

---

4. To exit the IP configuration screen, type `exit` at the command prompt and press **ENTER**.

---

**Step 2: Disable DHCP to use the computer's existing IP address**

---

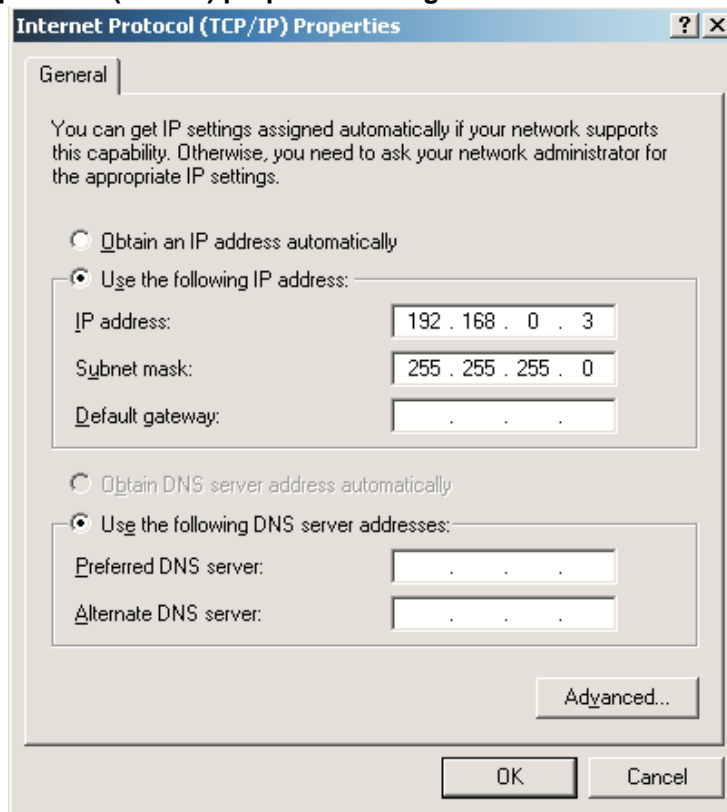
**NOTE** Do not change the IP address at any time without talking to your system administrator first. Entering an incorrect IP address can prevent your PC from connecting to your corporate network.

---

1. Open the Internet Protocol Properties dialog box
  - In Windows 2000:
    - a. Click the **Start** button, select **Settings**, and open the **Control Panel**.
    - b. Open **Network and Dial-up Connections**.
    - c. Right-click **Local Area Connection** and select **Properties**. The Local Area Connection Properties dialog box is displayed.
    - d. Double-click **Internet Protocol (TCP/IP)** in the items list. The Internet Protocol (TCP/IP) Properties dialog box is displayed (see [Figure 16-2](#)).
  - In Windows XP:
    - a. Click the **Start** button and open the **Control Panel**.
    - b. Open **Network Connections**.
    - c. Right-click **Local Area Connection** and select **Properties**. The Local Area Connection Properties dialog box is displayed.
    - d. Double-click **Internet Protocol (TCP/IP)** in the items list. The Internet Protocol (TCP/IP) Properties dialog box is displayed (see [Figure 16-2](#)).
  - In Windows Vista:
    - a. Click the **Start** button and open the **Control Panel**.
    - b. Open **Network & Sharing Center**.
    - c. In the list, click **View Status** next to Connection. The Wireless Network Connection Status dialog box is displayed.
    - d. Click **Properties**. Windows displays a permissions message.
    - e. If you are logged in as administrator, click **Continue**. If you are not logged in as administrator, enter the administrator's password to continue.
    - f. The Network Connection Properties dialog box is displayed.
    - g. Double-click **Internet Protocol Version 6 (TCP/IPv6)** in the items list. The Internet Protocol Version 6 (TCP/IPv6) Properties dialog box is displayed (see [Figure 16-2](#)).
2. Select **Use the following IP address**. The option for **Use the following DNS server** addresses is automatically selected.
3. Set the IP Address
  - a. Are the IP address and subnet mask fields populated?
    - Yes: If populated, record the address, subnet mask, default gateway, and DNS servers to use in [Step 3: Configure the Instrument's LAN settings](#).
    - No: If blank, enter the IP address 192.168.0.3 in the IP address field and 255.255.255.0 in the subnet mask field. These will be used to configure the instrument's LAN settings.
  - b. After recording or entering the IP address, click **OK** to close the Internet Protocol (TCP/IP) Properties dialog box.
4. Close the Network Connections window.



Figure 16-2  
**Internet protocol (TCP/IP) properties dialog box**



### Step 3: Configure the Instrument's LAN settings

To configure the Series 2600A using the front panel:

1. Press the **MENU** key to display the MAIN MENU. Use the **navigation wheel** to select **LAN** to display the LAN MENU.
2. Change the IP address assignment method:
  - a. Select **CONFIG > METHOD > MANUAL**, then press the **ENTER** key.
  - b. Press the **EXIT** key once to return to the LAN MENU.
  - c. Select **APPLY\_SETTINGS > YES**, then press the **ENTER** key.
3. Enter the IP address using the LAN MENU:
  - a. Select **CONFIG > IP-ADDRESS**.
  - b. Refer to the recorded computer's IP address. A portion of the computer's IP address will be used as a base for the instrument's unique ID. Only the last three numbers (after the last decimal point) will be different between the PC and instrument. The last three digits may be anything from 1-255 for a subnet mask of 255.255.255.0.

For example, the Internet Protocol (TCP/IP) Properties dialog box in [Figure 16-1](#) shows that the computer's IP address is 192.168.1.1. A unique address for the instrument is 192.168.001.101.

---

NOTE The instrument's IP address can have leading zeros, but the computer's cannot.

---

- c. Use the **navigation wheel** to select and enter an appropriate IP address for the instrument. Be sure to record the instrument's IP address to use in [Step 5: Access the instrument's internal web page](#).
  - d. Push the **ENTER** key or **navigation wheel** to confirm the changes.
  - e. Press the **EXIT** key to return to the LAN MENU.
  - f. From the LAN MENU, select **APPLY\_SETTINGS > YES**, then press the **ENTER** key.
4. Change the subnet mask from within the LAN MENU:
- a. Select **CONFIG > SUBNETMASK**, then press the **ENTER** key. The SUBNETMASK menu item is to the right of **GATEWAY**. Use the **navigation wheel** to scroll through the options.
  - b. Modify the SUBNETMASK to match the PC settings recorded earlier or 255.255.255.000 if DHCP Enabled = YES.
  - c. Push the **ENTER** key or the **navigation wheel** when finished changing all the characters.
  - d. Press the **EXIT** key to return to the LAN MENU.
  - e. From the LAN MENU, select **APPLY\_SETTINGS > YES**, then press the **ENTER** key.

---

NOTE **APPLY\_SETTINGS** must be used before changes to the IP address or subnet mask are applied.

---

#### **Step 4: Connect the crossover cable from the instrument to the PC network interface card**

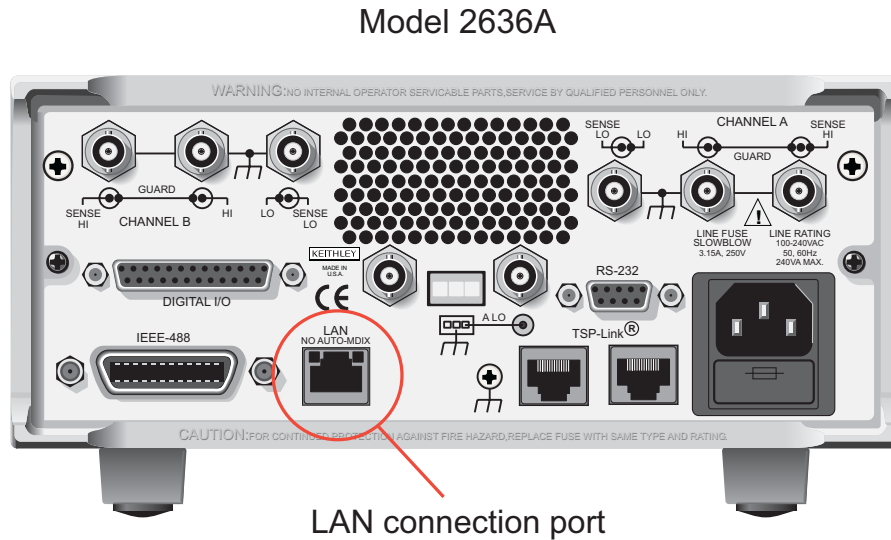
Connect the supplied crossover cable between the computer's NIC card and the ethernet connector on the instrument's rear panel. There are multiple connectors on the Series 2600A rear panel. Be sure to connect to the LAN connection port (see [Figure 16-3](#)).

---

NOTE Connect the crossover cable into the same PC ethernet port that was used during the configuration of the instrument. This will ensure that the system is using the correct network card.

---

Figure 16-3  
LAN connection



#### Step 5: Access the instrument's internal web page

1. Open a web browser on the host PC.
2. Enter the instrument's IP address in the browser's address box. For example, if the instrument's IP address is 192.168.0.3, enter 192.168.0.3 in the browser's address box.
3. Press **ENTER** on the PC keyboard to open the instrument's web page.

---

**NOTE** If the web page does not open in the browser, see [LAN troubleshooting suggestions](#).

---

## LAN troubleshooting suggestions

If you are unable to connect to the instrument's internal web page, check the following items:

- Verify that the crossover cable is in the correct port on the instrument. Do not connect to one of the TSP-Link® ports.
- Verify that the crossover cable is in the correct port on the PC. The side ethernet port of a laptop may be disabled while the unit is in a docking station.
- Verify that the correct ethernet card's configuration information was used during the setup procedure.
- Verify that the computer's network card is enabled.
- Verify the instrument IP address is compatible with the IP address on the computer.
- Verify the instrument Subnet mask address is the same as the computer's subnet mask address.
- Cycle the power on the instrument.
- Reboot the computer.
- Contact your system administrator for assistance.

## Connecting to the LAN

Each device on the LAN (corporate or private) requires a unique IP address. Contact your IT department for details on obtaining an IP address before you deploy the Series 2600A on a corporate or private network.

---

---

**WARNING** *It is highly recommended that you contact your corporate IT (Information Technology) department for permission before you connect the Series 2600A to a corporate network.*

---

---

There are two indicators on the LAN jack:

**ACT indicator.** The light flashes green which indicates the instrument is receiving LAN packets.

**LINK indicator.** A solid light indicates the instrument is connected to the LAN.

The following interfaces may be used to configure the LAN settings:

- Front panel
- Telnet
- RS232
- GPIB
- Virtual front panel

---

**NOTE** Reference [Section 19](#) for the Instrument Control Library (ICL) commands to configure the LAN from a remote interface.

---

It is highly recommended that the front panel be used to configure the LAN. The connection to the virtual front panel is lost if the IP address, subnet mask, or gateway is changed.

## Setting the method

There are two methods used to configure the LAN.

**Auto:** Use the Auto setting to allow the DHCP server to automatically set the LAN settings.

You do not need to set the LAN options manually. The DHCP server automatically configures the IP address, subnet mask and the default gateway. A DHCP server must be available on the LAN in order to use this option.

**Manual:** Use the Manual setting to manually configure the communication parameters.

The manual setting requires you to configure the following:

- IP Address
- Gateway
- Subnet mask

## Assigning the Method

Complete the following steps to select a method:

1. From the front panel, press **MENU > LAN > CONFIG > METHOD**.
2. Select one of the following methods and then push the **navigation wheel** to enter the desired method:
  - Press **AUTO**.
  - Press **MANUAL**. The LAN CONFIG menu is shown.
3. (Optional) Press **Exit** to return to the LAN CONFIG menu. CONFIG blinks on the front panel.
4. Turn the navigation wheel one click to the left and then push-in to select **APPLY\_SETTINGS**.
5. Select **YES**.

## Setting the IP address

Note the following:

- Contact your IT department to secure a valid IP address for the instrument when placing the instrument on a corporate network.
- The IP address does not need to be manually set if the method is set to AUTO.

A direct connection to the PC can also be configured. See [Establishing a point-to-point connection](#) for more information.

## Setting the subnet mask

Note the following:

- Contact your IT department to secure a valid subnet mask for the instrument when placing the instrument on a corporate network.
- The subnet mask does not need to be manually set if the method is set to AUTO.

A direct connection to the PC can also be configured. See [Establishing a point-to-point connection](#) for more information.

## Understanding the domain name system

The Domain Name System (DNS) lets you type a domain name in the address bar to connect to the instrument. The DNS removes the requirement to memorize the IP address, instead you only need to know the domain name.

### Example:

Series2600A.yourcompany.com

Contact your IT department to learn more about DNS.

---

**NOTE** If a DNS server is not part of the LAN infrastructure, then this setting is not used.

---

## Verify menu overview

You can use the options on the verify menu to do the following:

- **Verify:** Enables or disables the DNS feature.
- **Dynamic:** (DHCP) The Series 2600A attempts to assign a host name to the DNS server.

To configure the DNS:

1. From the front panel press, **MENU > LAN > CONFIG > DNS**. **VERIFY** flashes.
2. Push the **navigation wheel** to select the **VERIFY** option.
3. Choose one of the following:
  - **ENABLE**
  - **DISABLE**
4. Push the **navigation wheel** to return to the DNS menu.
5. Use the **navigation wheel** to select **DYNAMIC** and press the **ENTER** key or the **navigation wheel**.
6. Choose one of the following:
  - **ENABLE**
  - **DISABLE**
7. Select **DNS-ADDRESS-1** and then do the following:
  - Turn the **navigation wheel** to select the desired digit.
  - Push the **navigation wheel** and then use it to change the value.
  - Push the **ENTER** key or the **navigation wheel** to accept the value.
8. Repeat step 7 to configure **DNS-ADDRESS-2**.
9. Press **Exit** to return to the LAN CONFIG menu. **CONFIG** blinks on the front panel.
10. Turn the navigation wheel one click to the left and select **APPLY\_SETTINGS**.
11. Select **YES** and press the **ENTER** key or the **navigation wheel**.

## Understanding LAN speeds

Another characteristic of the LAN is speed. The Series 2600A negotiates with the host PC and other LXI compliant devices on the LAN to transmit data at the highest speed possible. LAN speeds must be configured to match the speed of the other instruments on the network.

## Configuring the LAN speed

To configure the LAN speed, complete the following steps:

1. From the LAN menu, turn the navigation wheel to the right and then select **SPEED** and then choose one of the following:
  - **10MBPS**
  - **100MBPS**
2. Press **Exit** to return to the LAN CONFIG menu. **CONFIG** blinks on the front panel.
3. Turn the navigation wheel one click to the left and then push-in to select **APPLY\_SETTINGS**.
4. Select **YES**.

## Duplex mode

The duplex mode is based on the LAN configuration. There are two settings:

**Half.** Only one direction is active at a time.

**Full.** Permits communications in both directions simultaneously.

### Configuring the duplex mode

Complete the following steps to configure the duplex mode:

1. Push the **navigation wheel** to return to the LAN menu.
2. Select **DUPLEX** and then choose one of the following:
  - **HALF**
  - **FULL**
3. Press the **navigation wheel** to return to the LAN CONFIG menu. DUPLEX blinks on the front panel.
4. Turn the **navigation wheel** one click to the left and then push to select **APPLY\_SETTINGS**.
5. Select **YES**.

Use the status menu to confirm the LAN configuration, communication settings, to retrieve error messages, and to change the password.

## Configuring the network settings

### CONFIG/FAULT

Use the CONFIG and FAULT menus to retrieve LAN faults and configuration messages.

There are two types of messages:

- **LAN faults:** Communicates issues related to physical connectivity.
- **LAN configurations:** Communicates issue related to configuration.

Table 16-1 displays possible fault and configuration messages.

Table 16-1

#### CONFIG/fault messages

| LAN message       | Notes                                                                                                                                |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| LAN fault         | <ul style="list-style-type: none"> <li>• Could not acquire IP address</li> <li>• Duplicate IP address detected</li> </ul>            |
| LAN configuration | <ul style="list-style-type: none"> <li>• LAN configuration closed</li> <li>• Manual Configuration started on 10.10.10.105</li> </ul> |

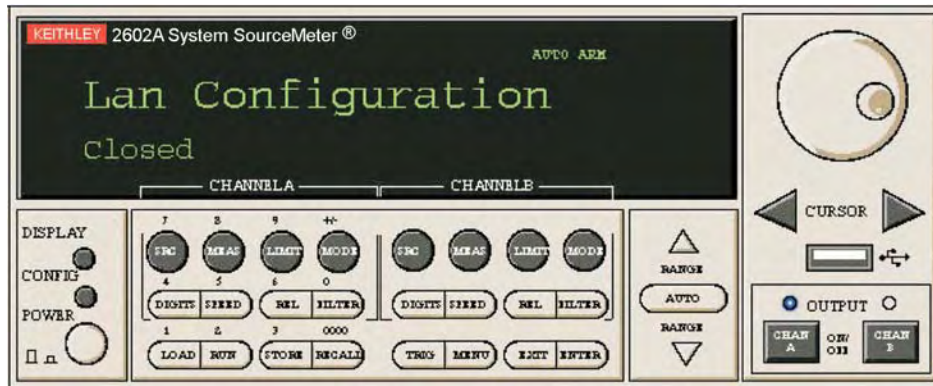
## Viewing LAN status messages

To view the LAN status messages, complete the following steps:

From the front panel or the virtual front panel, complete the following steps:

- Select **MENU > LAN > STATUS > CONFIG/FAULT**.  
Figure 16-4 shows a LAN status message.

Figure 16-4  
LAN CONFIG/FAULT



## Viewing the network settings

You can use the Status menu to view the active network settings.

Complete the following steps to view the active network settings.

1. From the front panel press, **MENU > LAN > STATUS**.
2. Turn the navigation wheel to the right or to the left to view one of the following network settings:
  - IP address
  - Gateway
  - Subnet-mask
  - Method
  - DNS
  - MAC address
3. Push the **navigation wheel** to view the status.
4. Press **ENTER** to return to the STATUS menu.

## Confirming the active speed and duplex negotiation

The Series 2600A automatically detects the speed and duplex negotiation active on the LAN. Once the speed and duplex negotiation is detected, the instrument automatically adjusts to match the LAN settings.

## Confirming port numbers

Use the port menu to view the ports numbers assigned to each protocol. [Table 16-2](#) displays the command interface and the required port number.

Table 16-2  
Port number

| Command Interface | Port number |
|-------------------|-------------|
| Raw socket        | 5025        |
| Telnet            | 23          |
| VXI-11            | 1024        |
| DST               | 1030        |



Complete the following steps to check the port number:

1. Select **MENU > LAN > STATUS > PORT**.
2. choose one of the following:
  - **RAW-SOCKET**
  - **TELNET**
  - **VXI-11**
  - **DST**

The port number is displayed on the front panel.

## Selecting a remote command interface

This section provides the details of how to use a remote command interface to connect to the Series 2600A.

### VXI - 11

This command interfaces provides message boundaries, supports serial poll, and serial request (SRQ). You can expect a slower connection with this protocol.

### Raw socket

Use as an alternative to VXI -11. Raw socket offers a faster connection than VXI-11. However, raw socket does not support serial poll and serial request message boundaries.

### Dead socket connection

Use the dead socket connection to manually disconnect a dead session on any open socket. This forces the connection to close when the dead socket connection is closed.

## Configuring a telnet connection

The Series 2600A supports the telnet protocol that you can use over a TCP/IP connection to issue commands to the instrument. You can use a telnet connection to interact with scripts or issue commands in real-time.

---

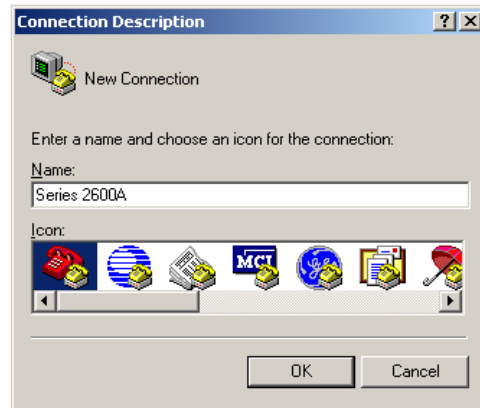
**NOTE** This example uses HyperTerminal available with Microsoft Windows XP. Consult the help system for your version of Microsoft Windows to identify a compatible tool.

---

To connect with the Series 2600A using HyperTerminal on a Windows XP system, complete the following steps:

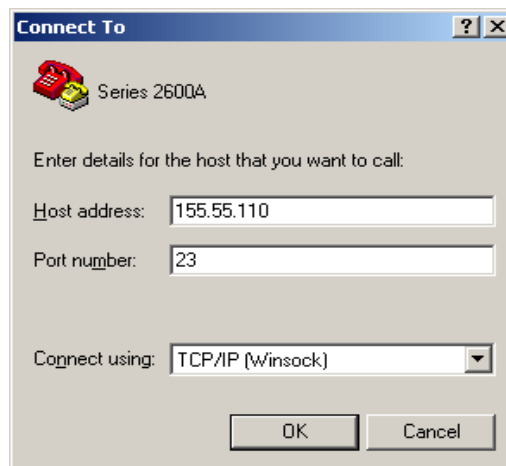
1. On the host PC, click **Start > Accessories > Communications > HyperTerminal**. A dialog box similar to the one shown in [Figure 16-5](#) should open.

Figure 16-5  
**Connection description**



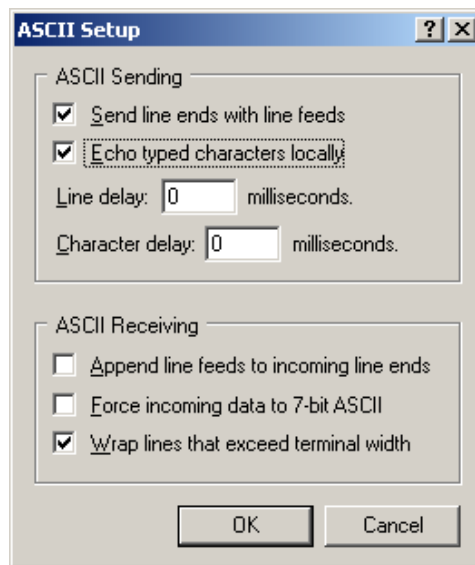
2. Type a name to identify the connection and then click **OK**.
3. Click the **Connect using** drop-down list and then select **TCP/IP (Winsock)** (see [Figure 16-6](#)).

Figure 16-6  
**Connect To dialog box**



4. In the **Host address** field, type the IP address.
5. Type **23** in the **Port number** field and then click **OK**.  
The HyperTerminal program window displays.
6. From the HyperTerminal program window, click **File > Properties**.
7. Choose the **Settings** tab and then click the **ASCII Setup** button.

Figure 16-7  
ASCII Setup window



8. Select the following options:
  - Send line ends with line feeds
  - Echo typed characters locally
9. Click **OK**  
The Properties window displays.
10. Click **OK**.

This page left blank intentionally.

---

## Web Interface and TSB Embedded

### In this section:

| Topic                                            | Page        |
|--------------------------------------------------|-------------|
| <b>Working with the web interface</b> .....      | <b>17-1</b> |
| Web browser requirements .....                   | 17-2        |
| Accessing the web interface .....                | 17-2        |
| Configuring IP addressing .....                  | 17-3        |
| <b>Password management</b> .....                 | <b>17-6</b> |
| Password overview .....                          | 17-6        |
| Accessing the virtual front panel .....          | 17-7        |
| Device identification indicator .....            | 17-8        |
| <b>Working with TSB Embedded</b> .....           | <b>17-9</b> |
| Using the Instrument Control Library (ICL) ..... | 17-9        |

## Working with the web interface

The Series 2600A has a web interface that you can use to access the following:

- Connection string
- LXI class
- Firmware version number
- MAC address
- Instrument model
- Connection string
- Virtual front panel
- TSB embedded

### Web browser requirements

The web interface uses different technologies to display information. If you cannot view the virtual front panel or other topics on the page, make sure your web browser meets the minimum requirements.

[Table 17-1](#) displays the web browsers and the version tested with the Series 2600A.

Table 17-1

#### Web Browser Requirements

| Web browser                              | Version number |
|------------------------------------------|----------------|
| Microsoft Internet Explorer              | 6.0 or higher  |
| Mozilla Firefox                          | 1.5 or higher  |
| Java Platform Standard Edition (Java SE) | 6.0 or higher  |

### Welcome page overview

You can use the welcome web page to view the following information in read-only format:

- IP configuration
- Serial number
- LXI Class
- MAC address
- Host name
- Firmware revision number

### Accessing the web interface

Complete the following steps to log in to the web interface.

1. Open a web browser.
2. In the address bar, type the IP address for the instrument.

[Figure 17-1](#) displays LXI welcome page.

Figure 17-1  
LXI Welcome page

**LXI Web Interface - Welcome Page**

|                            |                                                                                                                                      |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Instrument Model:          | 2635A System SourceMeter®                                                                                                            |
| Manufacturer:              | Keithley Instruments                                                                                                                 |
| Firmware Revision:         | X.X.X                                                                                                                                |
| Serial Number:             | 1175561                                                                                                                              |
| Description:               | Keithley Instruments SMU 2636A - 1175561                                                                                             |
| LXI Class:                 | C                                                                                                                                    |
| LXI Version:               | 1.2                                                                                                                                  |
| MAC Address:               | 00:60:1A:99:15:E2                                                                                                                    |
| TCP/IP Address:            | 192.168.0.11                                                                                                                         |
| Gateway:                   | 0.0.0.0                                                                                                                              |
| Subnetmask:                | 255.255.255.0                                                                                                                        |
| Lan Connection:            | 100Mbs, Full Duplex                                                                                                                  |
| Host Name (FQDN):          | 192.168.0.11                                                                                                                         |
| DNS Servers:               | 0.0.0.0<br>0.0.0.0<br>0.0.0.0                                                                                                        |
| Ports:                     | DST: 5030<br>Raw Socket: 5025<br>Telnet: 23<br>VXI-11 Core: 1024                                                                     |
| Instrument Address String: | TCPIP[board]::192.168.0.11::5025::SOCKET<br>GPIB[board]::26::INSTR<br>ASRL[board]::INSTR<br>TCPIP[board]::192.168.0.11::inst0::INSTR |
| Smu A Calibration Date:    | Sat Jan 01 13:00:48 2005                                                                                                             |
| Smu A Calibration Due:     | Sat Jan 01 13:00:48 2005                                                                                                             |

You can use the LXI welcome page to retrieve the following information:

- LXI class
- Serial number
- Host name
- Port Number
- Instrument Address String
- IP, DNS, and gateway address
- Calibration dates

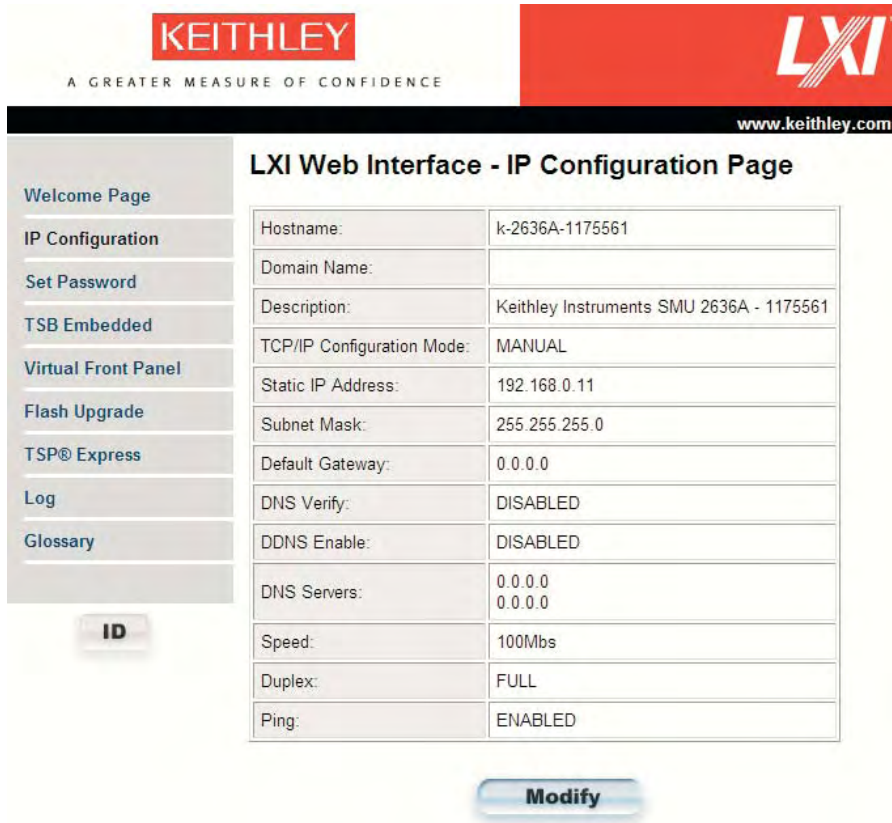
## Configuring IP addressing

Use the IP configuration page to review and to configure the Internet Protocol (IP) settings.

To modify the IP settings, complete the following steps.

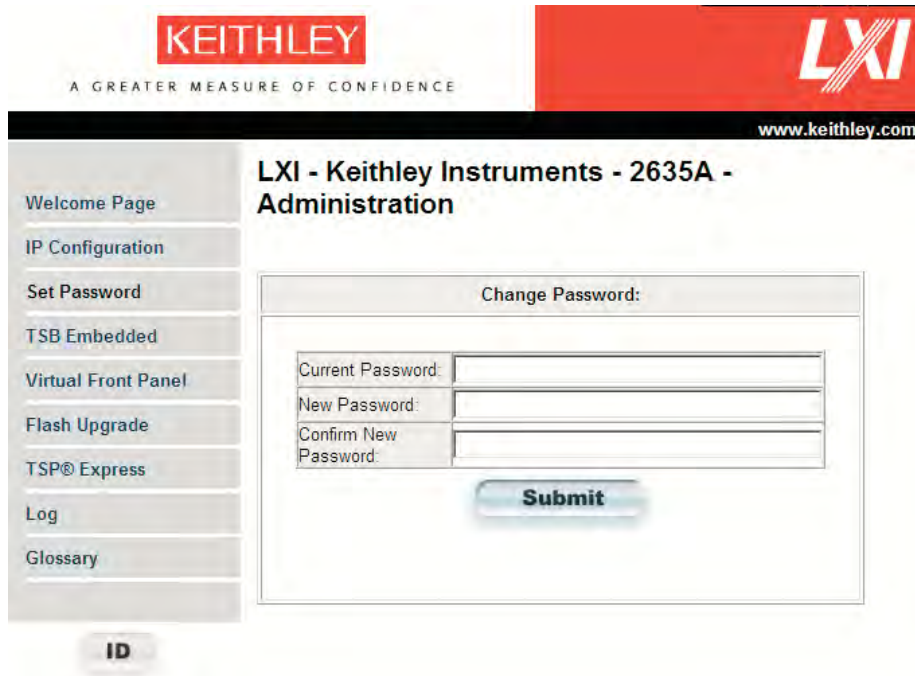
1. From the Welcome page, from the main menu click **IP Configuration**.

Figure 17-2  
IP configuration page



2. Click **Modify**.

Figure 17-3  
Password administration page





- If the unit has a password enabled, type the **Password** type the password and then click **Submit**. If password is not enabled, this page will not appear.

Figure 17-4

**Modify IP configuration page**

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**LXI - Keithley Instruments - 2635A - Modify IP Configuration**

|                            |                                                                              |
|----------------------------|------------------------------------------------------------------------------|
| Host Name:                 | <input type="text" value="k-2636A-1175561"/>                                 |
| Description:               | <input type="text" value="Keithley Instruments SMU 2636A - 1175561"/>        |
| TCP/IP Configuration Mode: | <input type="radio"/> Automatic<br><input checked="" type="radio"/> Manual   |
| Static IP Address:         | <input type="text" value="192.168.0.11"/>                                    |
| Subnet Mask:               | <input type="text" value="255.255.255.0"/>                                   |
| Default Gateway:           | <input type="text" value="0.0.0.0"/>                                         |
| DNS Verify:                | <input type="radio"/> Enabled<br><input checked="" type="radio"/> Disabled   |
| DDNS Enable:               | <input type="radio"/> Enabled<br><input checked="" type="radio"/> Disabled   |
| DNS Servers:               | <input type="text" value="0.0.0.0"/><br><input type="text" value="0.0.0.0"/> |
| Domain Name:               | <input type="text"/>                                                         |
| Speed:                     | <input checked="" type="radio"/> 100 Mbs<br><input type="radio"/> 10 Mbs     |
| Duplex:                    | <input checked="" type="radio"/> Full<br><input type="radio"/> Half          |

**Submit**

- Modify the desired field(s) and then click **Submit**.

---

**NOTE** You must reload the page if you change the gateway or subnet mask from the Modify IP configuration page.

---



---

**CAUTION** If you change the IP address, you must type the new IP address in the address bar before you can use the web interface.

---

## Password management

The Series 2600A has unique password capabilities that lets you decide how to password protect the instrument. You can enable password policies to lock the instrument which prevents unauthorized access to any remote interface and reserves the instrument exclusively for your use.

### Password overview

You can set the password to limit access to the web page and the command interface while you are away from your test area.

---

NOTE To reset the password, see ["Resetting the password"](#).

---

### Setting the password

---

NOTE Passwords can contain up to 255 characters.

---

If the password feature is enabled, a password is required to view and modify the following pages:

- IP configuration
- Set password
- TSB Embedded
- Virtual front panel
- Web page flash upgrade

Complete the following steps to set the password.

1. From the web interface, click **Set Password**.  
The LXI - Keithley Instruments -2602 - Administration page displays.
2. In the **Current Password** field, type the existing password.
3. In the **New Password** field, type the new password.
4. Retype the new password in the **Confirm Password** field.
5. Click **Submit**.  
The LXI Welcome page displays.

### Setting the password from a command interface

The attribute `localnode.passwordmode` enables passwords and sets the mode. The password mode identifies which interface to password protect.

Use one of the following attributes to set the password mode.

`localnode.PASSWORD_WEB`. Passwords are only required for the web interface.

`localnode.PASSWORD_LAN`. Enables passwords on all Ethernet and web interfaces.

`localnode.PASSWORD_ALL`. Protects the LAN, all command and web interfaces.

`localnode.PASSWORD_NONE`. Disables all passwords.

The password lock feature on Series 2600A is similar to the lock feature on your PC.

To enable the password feature, type the following from the command line:

```
localnode.password
```

---

**NOTE** You must enable passwords to use this feature.

---

To lock the instrument when you are away from the testing area, type the following command:

```
password
```

The remote interface locks. The Series 2600A does not respond to commands issued from the command line until you unlock the interface. This reserves the instrument and protects the test script running on the instrument.

### Unlocking the remote interface

If the remote interface is locked, you must enter the password before the Series 2600A responds to any command issued over a remote interface.

---

**NOTE** The password for the example below is Keithley.

---

To unlock the remote interface, type the following command

```
password Keithley
```

The Series 2600A unlocks and communicates with any remote interface.

### Resetting the password

If you forget the password, you can reset the password from the front panel. Once you enable the password feature, the Series 2600A stores this password until the LAN configuration is reset or you reset the password.

Complete the following steps to reset the password:

- From the front panel, press **MENU > RESET-PASSWORD**.

---

**NOTE** If you reset the LAN settings, you must re-enable the password feature.

---

## Accessing the virtual front panel

If the Series 2600A instrument is stored in a remote location, you can use the virtual front panel to access the features available from the front panel.

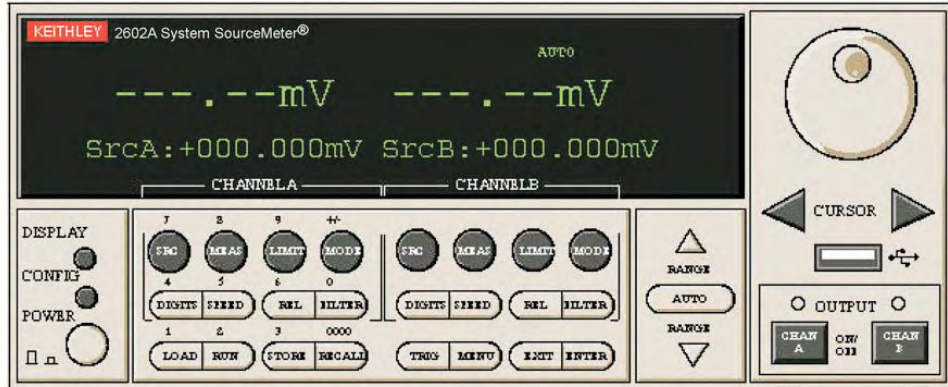
You can use the same features and functions that are available from the front panel with the exception of the following:

- Power button

Complete the following steps to access the virtual front panel.

1. From the web interface, click **Virtual Front Panel**.
2. (Optional) In the **Password** field, type the password and then click **Submit**.  
The virtual front panel displays.

Figure 17-5  
**Virtual front panel**



## Device identification indicator

You can use the ID button to physically locate the instrument that you are communicating with from the web interface. With this identification indicator enabled, the message LAN STATUS INDICATOR displays on the front panel of the instrument.


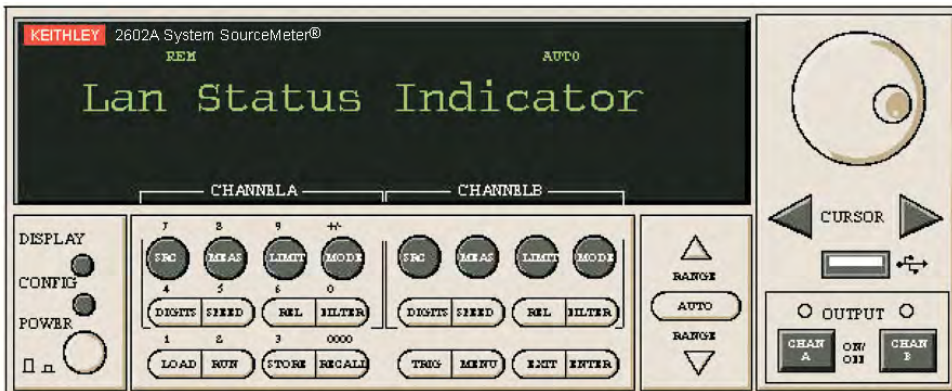
1. From the web interface, click  .  
The ID button illuminates, see [Figure 17-6](#).

Figure 17-6  
**ID Illuminated**



2. The front panel displays the LAN Status Indicator message.

Figure 17-7  
**LAN status indicator**



## Turning off the Device identification indicator

To turn off the ID indicator, Click **ID**.

The message LAN STATUS INDICATOR does not display on the front panel of the instrument.

## Working with TSB Embedded

TSB Embedded is an option to a full version of Test Script Builder (TSB) Suite. The capabilities of TSB Embedded are very similar to TSB. TSB Embedded includes a command line interface that you can use to issue ICL commands, create, modify, and save test scripts to the instrument.

### Using the Instrument Control Library (ICL)

The response from the instrument appears in the instrument output window.

Complete the following steps to issues commands from the command line.

1. To issue a ICL Command, type the command in the console and then click **Enter**.
2. (Optional) Click Clear to clear the Instrument output window.

### Creating scripts

Complete the following steps to create a new script:

1. Click in the script editor window and then type the first line of your script and then use the **Enter** key advance to line 2.
2. In the TSP Script line, type the name of the script and then click **Save script**.  
The instrument validates the syntax and then saves the script to the nonvolatile memory.

### Clearing the script editor window

- To remove the code from the script editor, click **Clear**.

### Running scripts

- To run a script, select the desired script from the User script window and then click **Run**.

### Stopping scripts

To stop a running script, click **Abort script**.

### Deleting scripts

To delete a script from TSB embedded, complete the following steps:

---

NOTE You cannot retrieve a deleted scripts

---

- Select the desired script from the user script window and then click **Delete**.

### Modifying scripts

Complete the following steps to modify a script:

1. Select the desired script from the User script window and then modify the desired code in the script editor.
2. Click **Save script** to validate the syntax and save the script.
3. The message, Script clearing will be overwritten displays, do one of the following:

- To overwrite the script, click **OK**.
- To save the script with a new name, click Cancel and then type the name of the script in the name field.

### Exporting Scripts

You can export a script to save to an external drive or to store as a back-up on your PC.

1. To export a script, click on the name of the script in the user script window and then click **Export**.  
The **Save** dialogue box displays.
2. Use the drop-down arrow to change folders, and navigate to the desired file or directory.
3. In the **File name** field, type the name of the file and then click **Save**.

**In this section:**

| <b>Topic</b>                                                | <b>Page</b> |
|-------------------------------------------------------------|-------------|
| <b>Overview .....</b>                                       | <b>18-2</b> |
| <b>TSP-Net capabilities.....</b>                            | <b>18-2</b> |
| <b>Using TSP-Net with any Ethernet-enabled device .....</b> | <b>18-2</b> |
| <b>Example script .....</b>                                 | <b>18-3</b> |
| <b>Using TSP-Net vs. TSP-Link for communication .....</b>   | <b>18-3</b> |

## Overview

TSP-Net™ allows the Series 2600A to control Ethernet-enabled devices directly through its LAN port. This enables the Series 2600A to communicate directly with a non-TSP™-enabled device without the use of a controlling computer.

## TSP-Net capabilities

For both TSP™ and non-TSP devices, the TSP-Net library permits the Series 2600A to control a remote device through the LAN port. Using TSP-Net methods, you can transfer string data to and from a remote device, transfer and format data into Lua variables, and clear input buffers. TSP-Net is only accessible using ICL commands from a remote command interface and is not available from the front panel.

You can use TSP-Net to communicate with any Ethernet-enabled device. However, specific TSP-Net commands exist for TSP-enabled devices to allow for support of features unique to TSP. These features include script downloads, reading buffer access, wait completion, and handling of TSP prompts.

Using TSP-Net with TSP-enabled instruments, a Series 2600A can download a script to another TSP-enabled device and have both devices run scripts independently. The Series 2600A can read the data from the remote device and either manipulate the data or send the data to a different remote device on the LAN. You can simultaneously connect to a maximum of 32 devices using standard TCP/IP networking techniques through the LAN port of the Series 2600A.

## Using TSP-Net with any Ethernet-enabled device

---

NOTE Refer to [Section 19](#) for more details on the commands presented in this section.

---

To communicate to a remote Ethernet-enabled device from the Series 2600A, perform the following steps:

1. Connect to the remote device through the LAN port.

Use an Ethernet crossover cable to connect directly from the Series 2600A to an Ethernet-enabled device.

Use a straight-through Ethernet cable and a hub to connect the Series 2600A to any other device on the LAN.

2. Establish a new connection to a remote device at a specific IP address using `tspnet.connect`. For non-TSP™-enabled devices, you must also provide the port number, or the Series 2600A assumes the remote device to be TSP-capable and enables TSP prompts and error handling.

If the Series 2600A is not able to make a connection to the remote device, it generates a timeout error. Use `tspnet.timeout` to set the timeout value. The default timeout value is 20 seconds.



---

NOTE Set `tspnet.tsp.abortonconnect` to `TRUE` to abort any script currently running on a remote TSP device.

---

3. Use `tspnet.write` or `tspnet.execute` to send strings to a remote device. Using `tspnet.write` sends strings to the device exactly as indicated, and you must supply any needed termination characters or other lines. Use `tspnet.termination` to specify the termination character. If you use `tspnet.execute` instead, the Series 2600A appends termination characters to all strings sent to the command.
4. Retrieve responses from the remote device using `tspnet.read`. The Series 2600A suspends operation until data is available or a timeout error is generated. You can check if data is available from the remote device using `tspnet.readavailable`.

Disconnect from the remote device using `tspnet.disconnect`. Terminate all remote connections using `tspnet.reset`.

## Example script

The following example demonstrates how to connect to a remote non-TSP™-enabled device, and send and receive data from this device:

```
-- Disconnect all existing TSP-Net connections.
tspnet.reset()
-- Set tspnet timeout to 5 seconds.
tspnet.timeout = 5
-- Establish connection to another device with IP address 192.168.1.51
-- at port 1394.
id_instr = tspnet.connect("192.168.1.51",1394, "*rst\r\n")
-- Print the device ID from connect string.
print("ID is: ", id_instr)
-- Set termination character to CRLF. You must do this on a per
-- connection basis after connection has been made.
tspnet.termination(id_instr, tspnet.TERM_CRLF)
-- Send the command string to the connected device.
tspnet.write(id_instr,"*idn?" .. "\r\n")
-- Read the data available, then print it.
print("instrument write/read returns:: " , tspnet.read(id_instr))
-- Disconnect all existing TSP-Net sessions.
tspnet.reset()
```

## Using TSP-Net vs. TSP-Link for communication

TSP Link is the preferred communication method when communicating between the Series 2600A and another TSP™-enabled instrument. Using TSP Link has certain advantages over using TSP-Net, including:

- **Error checking:** When connected to a TSP-enabled device, all errors that occur on the remote device are transferred to the error queue of the Series 2600A. The Series 2600A indicates errors from the remote device by prefacing these errors with "Remote Error".
- **Digital I/O Triggering:** TSP Link connections have three TSP synchronization lines that are available to each device on the TSP Link network. You can use any one of the TSP synchronization lines to perform hardware triggering between devices on the TSP Link network.

These advantages make using TSP Link to control another TSP-enabled device the best choice for most applications. However, if the distance between the Series 2600A and the TSP-enabled device is longer than 15 feet, use TSP-Net.

To establish a remote TSP-Net connection with a TSP-enabled device, use `tspnet.connect` without specifying a port number. The Series 2600A enables TSP prompt and error handling for the remote device, which allows you to successfully use the `tspnet.tsp` set of commands to load and run scripts and retrieve reading buffers.

Abort any operation on the remote TSP-enabled device using `abort()`.

---

## Remote Commands

### In this section:

| Topic                                       | Page             |
|---------------------------------------------|------------------|
| <b>Test Script Language (TSL)</b> .....     | <b>19-3</b>      |
| Introduction .....                          | 19-3             |
| Reserved words .....                        | 19-3             |
| Variables and types .....                   | 19-3             |
| Operators .....                             | 19-4             |
| Functions .....                             | 19-4             |
| Tables/arrays .....                         | 19-5             |
| Precedence .....                            | 19-6             |
| Logical operators .....                     | 19-6             |
| Concatenation .....                         | 19-7             |
| Branching .....                             | 19-7             |
| Loop control .....                          | 19-8             |
| <br><b>Command programming notes</b> .....  | <br><b>19-9</b>  |
| Conventions .....                           | 19-9             |
| Functions and attributes .....              | 19-10            |
| TSP-Link nodes .....                        | 19-12            |
| Logical instruments .....                   | 19-12            |
| Reading buffers .....                       | 19-13            |
| Time and date values .....                  | 19-14            |
| Remote versus local state .....             | 19-14            |
| <br><b>Standard libraries</b> .....         | <br><b>19-15</b> |
| String library functions .....              | 19-16            |
| Math library functions .....                | 19-17            |
| <br><b>File I/O</b> .....                   | <br><b>19-18</b> |
| <br><b>Instrument Control Library</b> ..... | <br><b>19-18</b> |
| beeper .....                                | 19-23            |
| bit .....                                   | 19-23            |
| data queue .....                            | 19-29            |
| delay .....                                 | 19-31            |
| digio .....                                 | 19-31            |
| display .....                               | 19-38            |
| errorqueue .....                            | 19-54            |
| event log .....                             | 19-56            |
| exit .....                                  | 19-58            |
| file I/O .....                              | 19-58            |
| format .....                                | 19-61            |
| file system .....                           | 19-62            |
| gpib .....                                  | 19-65            |

|                                         |               |
|-----------------------------------------|---------------|
| io .....                                | 19-65         |
| LAN .....                               | 19-69         |
| localnode .....                         | 19-85         |
| makegetter and makesetter .....         | 19-93         |
| meminfo .....                           | 19-94         |
| opc .....                               | 19-94         |
| printbuffer and printnumber .....       | 19-95         |
| reset .....                             | 19-96         |
| script .....                            | 19-97         |
| serial .....                            | 19-98         |
| setup .....                             | 19-101        |
| smuX .....                              | 19-103        |
| Status register sets .....              | 19-150        |
| timer .....                             | 19-203        |
| trigger .....                           | 19-205        |
| tsplink .....                           | 19-212        |
| tspnet .....                            | 19-221        |
| userstring .....                        | 19-234        |
| waitcomplete .....                      | 19-236        |
| <b>Standard libraries .....</b>         | <b>19-236</b> |
| String library functions .....          | 19-237        |
| Math library functions .....            | 19-238        |
| <b>Factory scripts .....</b>            | <b>19-238</b> |
| Introduction .....                      | 19-238        |
| Running a factory script .....          | 19-239        |
| Modifying a factory script .....        | 19-239        |
| <b>Factory script information .....</b> | <b>19-240</b> |
| KISweep .....                           | 19-240        |
| KIPulse .....                           | 19-248        |
| KIHighC .....                           | 19-271        |
| KIParlib .....                          | 19-273        |
| KISavebuffer .....                      | 19-274        |

# Test Script Language (TSL)

## Introduction

A script is a program that the Test Script Processor (TSP) executes. A script is written using the Test Script Language (TSL). TSL is an efficient language, with simple syntax and extensible semantics. TSL is an implementation of the Lua programming language, Copyright © 1994-2004 Tecgraf, PUC-Rio. See <http://www.lua.org>, the official website for the Lua Programming Language, for more information. Also, <http://lua-users.org> internet site is created for and by users of the Lua programming language and is another source of useful information.

## Reserved words

|        |          |        |
|--------|----------|--------|
| and    | function | return |
| elseif | nil      | until  |
| for    | repeat   | else   |
| local  | true     | false  |
| then   | do       | in     |
| break  | if       | or     |
| end    | not      | while  |

## Variables and types

TSL has six basic types; nil, Boolean, number, string, function, and table. TSL is a dynamically typed language, which means variables do not need to be declared as a specific type. Instead, variables assume a type when a value is assigned to them. Therefore, each value carries its own type. If a variable has not been assigned a value, the variable defaults to the type nil. All numbers are real numbers. There is no distinction between integers and floating-point numbers in TSL.

```
-- var is nil.
var = nil
-- var is now a number.
var = 1.0
-- var is still a number.
var = 0.3E-12
-- var is still a number.
var = 7
-- var is now a string.
var = "Hello world!"
-- var is still a string.
var = "I said, Hello world!"
-- var is now a function that adds two numbers.
var = function(a, b) return(a+b) end
-- var is now a table (array) with three initialized members.
var = {1, 2., 3.00e0}
```

Nil is a type with a single value, nil, whose main property is to be different from any other value. Global variables have a nil value by default—before a first assignment—and you can assign nil to a global variable to delete it. TSL uses nil as a kind of non-value to represent the absence of a useful value.

## Operators

| Arithmetic Operators: | Relational Operators:      | Logical Operators: |
|-----------------------|----------------------------|--------------------|
| + (addition)          | < (less than)              | and                |
| - (subtraction)       | > (greater than)           | or                 |
| * (multiplication)    | <= (less than or equal)    | not                |
| / (division)          | >= (greater than or equal) |                    |
| - (negation)          | ~= (not equal)             |                    |
|                       | == (equal)                 |                    |

## Functions

TSL allows you to define functions. A function can take a predefined number of parameters and return multiple parameters if desired.

Here is an example of how to define a function and call it:

```
function add_two(parameter1, parameter2)
 return(parameter1 + parameter2)
end
print(add_two(3, 4))
```

Below is an alternate syntax for defining a function. Functions are first-class values in TSL, which means functions can be stored in variables, passed as arguments, and returned as results if desired.

```
add_three = function(parameter1, parameter2, parameter3)
 return(parameter1 + parameter2 + parameter3)
end
print(add_three(3, 4, 5))
```

Here is a function that returns multiple parameters; sum, difference, and ratio of the two numbers passed to it:

```
function sum_diff_ratio(parameter1, parameter2)
 psum = parameter1 + parameter2
 pdif = parameter1 - parameter2
 prat = parameter1 / parameter2
 return psum, pdif, prat
end
sum, diff, ratio = sum_diff_ratio(2,3)
print(sum)
print(diff)
print(ratio)
```

Output of code above:

```
7
12
5
-1
0.66666
```

## Tables/arrays

TSL makes extensive use of the data type “table,” which is essentially a very flexible array-like data type.

Define a table:

```
atable = {1, 2, 3, 4}
```

Print it:

```
-- Tables are indexed starting at one, NOT zero.
i = 1
-- atable[index] is true if there is an element at that index; nil is returned
-- otherwise. 0 does NOT evaluate to false - only nil does.
while atable[i] do
 -- Index into table using a number.
 print(atable[i])
 i = i + 1
end
```

Output of code above:

```
1
2
3
4
```

Tables can be indexed using element names instead of numeric indices. Since functions are first-class variables, tables can be used to create “pseudo-classes.” Classes are often used in object-oriented programming.

Below is a table used to create a circle pseudo-class. It has 3 elements:

clr: A string containing the color of the circle.

diam: A number containing the diameter of the circle.

setdiam: A function, or method, used to change the diameter.

```
circle = {clr = "red", diam = 1, setdiam = function(d)
 circle["diam"] = d end}
-- Index using a string; print the clr property.
print(circle["clr"])
-- Index using a string; print the diam property.
print(circle["diam"])
-- Change the diam element by calling setdiam method.
circle["setdiam"](2)
-- circle["diam"] is the same as circle.diam; simpler syntax.
print(circle.diam)
-- Change the diameter of the circle again.
circle.setdiam(3)
-- Print diam property again using simple syntax.
print(circle.diam)
```

Output of code above:

```
red
1
2
3
```

## Precedence

Operator precedence in TSL follows the table below, from higher to lower priority:

```

^
not- (unary)
* /
+ -
.. (concatenation)
< > <=>=~===
and
or

```

All operators are left associative, except for '^' (exponentiation) and '.', which are right associative. Therefore, the following expressions on the left are equivalent to those on the right:

```

a+i < b/2+1 (a+i) < ((b/2)+1)
5+x^2*8 5+((x^2)*8)
a < y and y <= z (a < y) and (y <= z)
-x^2 -(x^2)
x^y^z x^(y^z)

```

## Logical operators

The logical operators are `and`, `or`, and `not`. Like control structures, all logical operators consider `false` and `nil` as false and anything else as true. The operator `and` returns its first argument if it is false, otherwise it returns its second argument. The operator `or` returns its first argument if it is not false; otherwise it returns its second argument:

```

print(4 and 5)
print(nil and 13)
print(false and 13)
print(4 or 5)
print(false or 5)

```

Output of code above:

```

5
nil
false
4
5

```

Both `and` and `or` use short-cut evaluation, that is, they evaluate their second operand only when necessary. A useful TSL construct is `x = x or v`, which is equivalent to:

```

if not x then x = v end

```

For example, it sets `x` to a default value `v` when `x` is not set (provided that `x` is not set to `false`).

To select the maximum of two numbers `x` and `y`, use the following statement (note the `and` operator has a higher precedence than `or`):

```

max = (x > y) and x or y

```

When `x > y` is true, the first expression of the `and` is true, so the `and` results in its second argument `x` (which is also true, because it is a number), and then the `or` expression, results in the value of its first expression, `x`. When `x > y` is false, the `and` expression is false and so are the `or` results in its second expression, `y`.

The operator `not` always returns `true` or `false`:



```
print(not nil)
print(not false)
print(not 0)
print(not not nil)
```

Output of code above:

```
true
true
false
false
```

## Concatenation

TSL denotes the string concatenation operator by “.” (two dots). If any of its operands is a number, TSL converts that number to a string:

```
print("Hello " .. "World")
print(0 .. 1)
```

Output of code above:

```
Hello World
01
```

## Branching

TSL uses the “if” keyword to do conditional branching.

```
--
----- IF blocks -----
--
-- Zero IS true! This is a contrast to C where 0 evaluates false. In TSL,
-- both "nil" and false are false and everything else is true.
if 0 then
 print("Zero is true!")
else
 print("Zero is false.")
end

x = 1
y = 2
if (x and y) then
 print("' if ' expression 2 was not false.")
end

if (x or y) then
 print("' if ' expression 3 was not false.")
end

if (not x) then
 print("' if ' expression 4 was not false.")
else
 print("' if ' expression 4 was false.")
end

if x == 10 then
 print("x = 10")
elseif y > 2 then
 print("y > 2")
else
```

```
 print("x is not equal to 10, and y is not less than 2.")
end
```

Output of code above:

```
Zero is true!
' if ' expression 2 was not false.
' if ' expression 3 was not false.
' if ' expression 4 was false.
x is not equal to 10, and y is not less than 2.
```

## Loop control

TSL has familiar constructs for doing things repetitively and/or until an expression evaluates to false.

```
-- Something to iterate
list = {"One", "Two", "Three", "Four", "Five", "Six"}
--
----- FOR loop -----
--
print("Counting from one to three:")
for element = 1, 3 do
 print(element, list[element])
end
print("Counting from one to four,")
print("in steps of two:")
for element = 1, 4, 2 do
 print(element, list[element])
end
--
----- WHILE loop -----
--
print("Count elements in list")
print("on numeric index")
element = 1
-- Will exit when list[element] = nil
while list[element] do
 print(element, list[element])
 element = element + 1
end
--
----- REPEAT loop -----
--
print("Count elements in list")
print("using repeat")
element = 1
repeat
 print(element, list[element])
 element = element + 1
until not list[element]
```

Output of code above:

```
Counting from one to three:
1 One
```

```
2 Two
3 Three
Counting from one to four,
in steps of two:
1 One
3 Three
Counting elements in list
on numeric index
1 One
2 Two
3 Three
4 Four
5 Five
6 Six
Counting elements in list
using repeat
1 One
2 Two
3 Three
4 Four
5 Five
6 Six
```

## Command programming notes

### Conventions

For the following command reference, it is necessary to understand the following conventions:

#### Wild characters

Many source-measure unit (SMU) commands are expressed in a generic form using wild characters. A wild character indicates a SMU channel, function, or array index. Keep in mind that wild characters used in the generic form are NOT to be included in the command sent to the instrument.

#### X and Y

The `x` character is used for functions and attributes to indicate the SMU channel (`a` or `b`) and `y` is used to indicate the SMU function (`v`, `i`, `r`, or `p`). For example, the attribute for the source output setting is generically expressed as follows:

```
smuX.source.levelY
```

To program SMU Channel A to 5 Volts, the following command statement is to be sent to the instrument:

```
smua.source.levelv = 5.0
```

To program SMU channel B to 1 mA, the following command statement is to be sent to the instrument:

```
smub.source.leveli = 0.001
```

---

**NOTE** The wild characters *x* and/or *y* are NEVER sent to the instrument. They are used in this command reference for notational convenience only.

---

### [M] and [N]

The M and N characters, enclosed by brackets ([ ]), are used in functions and attributes anywhere an index is used in the command set.

Commands that use [M] include:

- `trigger.blender` commands use [M] for the 4 stimulus attributes.

Commands that use [N] include:

- TSP-Link lines
- Timers
- Event blenders

For example, the function to assert an output trigger is generically expressed as follows:

```
digio.trigger[N].assert
```

Where: [N] is the trigger number.

To program the Series 2600A to assert an output trigger on trigger line 5, the following command statement is sent to the instrument.

```
digio.trigger[5].assert()
```

---

**NOTE** The wild characters M and N should NOT to be sent to the instrument. However, the brackets ([ ]) must be included in the command.

---

## Functions and attributes

Commands can be function-based or attribute-based.

### Functions

Function based commands are used to control actions or activities. For example, performing a voltage measurement is a function (action) of a SMU. A function-based command is not necessarily directly related to a Series 2600A operation. For example, the `bit.bitand` function will logically AND two numbers.

Each function consists of a function name followed by a set of parenthesis (()). If the function does not have a parameter, the parenthesis set is left empty. Examples:

|                                   |                                            |
|-----------------------------------|--------------------------------------------|
| <code>digio.writeport(15)</code>  | Sets digital I/O lines 1, 2, 3 and 4 high. |
| <code>digio.writebit(3, 0)</code> | Sets line 3 low (0).                       |
| <code>smua.reset()</code>         | Returns SMU A to its default settings.     |
| <code>digio.readport()</code>     | Reads the digital I/O port.                |

The results of a function call are used by assigning the return values to variables and accessing those variables. The following code will measure SMU A voltage and return the reading:

```
reading = smua.measure.v()
```

```
print(reading)
```

```
Output: 2.360000e+00
```

The above output indicates that the voltage reading is 2.36V.

For a function that returns one value, the function call can be used in an expression. For example:

```
if smua.measure.v() > 5 then
 ...
end
```

## Attributes

An attribute is a characteristic of an instrument feature or operation. For example, some characteristics of a SMU source include the source function, range and output level.

### Assigning a value to an attribute

An attribute-based command can be used to assign a new value to an attribute. For many attributes, the value can be in the form of a discrete number or a predefined identifier. For example, filter type is an attribute. The moving average filter is selected by assigning either of the following values to the attribute:

```
0 OR smuX.FILTER_MOVING_AVG
```

Either of the following command messages will configure SMU A for the moving average filter:

```
smua.measure.filter.type = 0
```

```
smua.measure.filter.type = smua.FILTER_MOVING_AVG
```

Some attributes can take any numeric value that is within a valid range. For example, the Model 2601A/2602A voltage source can be set from -40.4V to +40.4V, while the Model 2611A/2612A voltage source can be set from -202V to +202V. The following command message sets the SMU A source level to 1.53V:

```
smua.source.levelv = 1.53
```

### Reading an attribute

Reading an attribute is accomplished by passing it to a function call as a parameter or by assigning it to another variable.

**Parameter passing example:** The following command reads the filter type for SMU A by passing the attribute to the `print` function, which outputs a value:

```
print(smua.measure.filter.type)
```

```
Output: 0.000000e+00
```

The above output indicates that the moving average filter is selected.

**Variable assignment example:** The following command reads the filter type by assigning the attribute to a variable named `filtertype`:

```
filtertype = smua.measure.filter.type
```

## Syntax rules

- Commands for functions and attributes are case sensitive. As a general rule, all function and attribute names must be in lower case, while parameters use a combination of lower and upper case characters. Upper case characters are required for attribute constants. Example:

```
smua.source.func = smua.OUTPUT_DCVOLTS
```

In the above command to select the volts source function, `OUTPUT_DCVOLTS` is the attribute constant.

- Whitespace in a function is not required. The function to set digital I/O line 3 low can be sent with or without whitespaces as follows:
 

```
digio.writebit(3,0) -- Whitespaces NOT used in string.
digio.writebit (3, 0) -- Whitespaces used in string.
```
- Some commands require multiple parameters. Multiple parameters must be separated by commas (,), as shown above for the `digio.writebit` function.

## TSP-Link nodes

Each instrument or enclosure attached to the TSP-Link bus must be uniquely identified. This identification is called a TSP-Link node number, and the enclosures are called nodes. Each node must be assigned a unique node number.

From a test script program point of view, nodes look like tables. There is one global table named `node` that contains all the actual nodes that are themselves tables. An individual node is accessed as `node[N]` where `N` is the node number assigned to the node. Each node has certain attributes that can be accessed as elements of its associated table. These are listed as follows:

- `model`            The product model number string of the node.
- `revision`        The product revision string of the node.
- `serialno`        The product serial number string of the node.

There is also an entry for each logical instrument on the node (see [Logical instruments](#)).

It is not necessary to know the node number of the node running a script. The variable `localnode` is an alias for the node entry the script is running on. For example, if a script is running on node 5, the global variable `localnode` will be an alias for `node[5]`.

## Logical instruments

You would normally refer to all instrumentation within one enclosure or node as a single instrument. For TSP and the Instrument Control Library (ICL), it is useful to think of individual SMUs as instruments. To avoid confusion, SMUs and other subdivisions of the instrumentation within an enclosure will be referred to as “logical instruments.”

Each logical instrument is given a unique identifier in a system. These identifiers are used as part of all ICL function calls that control a given logical instrument. The Series 2600A SMU has the following logical instruments in each enclosure:

|                        |                         |                     |                      |
|------------------------|-------------------------|---------------------|----------------------|
| <code>beeper</code>    | <code>errorqueue</code> | <code>serial</code> | <code>timer</code>   |
| <code>dataqueue</code> | <code>eventlog</code>   | <code>smua</code>   | <code>trigger</code> |
| <code>digio</code>     | <code>gpib</code>       | <code>smub</code>   | <code>tsplink</code> |
| <code>display</code>   | <code>lan</code>        | <code>status</code> | <code>tspnet</code>  |

Logical instruments also look like TSP tables. Each logical instrument has an element for each command that it supports. These commands are documented in this section. Note that `smua` and `smub` support the same command set and are documented jointly as `smuX`.

On any given node, the logical instrument identifiers from that node are also global variables. They can be accessed as elements of the node they belong or directly if running on that node. For example, to execute the `measure.v` command on `smua` on `node[5]`, one could use `node[5].smua.measure.v()`. If the command is being issued (executed) on `node[5]`, then `smua.measure.v()` is sufficient. Only be concerned with node numbers when controlling multiple units via the TSP-Link.

## Reading buffers

Readings can be obtained in multiple ways. Reading acquisition can be synchronous or overlapped. Furthermore, the routines that make single point measurements can be configured to make multiple measurements where only one would ordinarily be made. Also, consider that the measured value is not the only component of a reading. The measurement status (for example “In Compliance” or “Over ranged”) is also data associated with a particular reading.

All routines that return measurements can return them in reading buffers. Overlapped measurements are always returned in a reading buffer. Synchronous measurements return a single value or both a single value and a reading buffer. The more advanced user can use the reading buffer to access the additional information stored in the reading buffer.

A reading buffer is based on a TSL table. The measurements themselves are accessed by ordinary array access. If `rb` is a reading buffer, the first measurement is accessed as `rb[1]` and the 9<sup>th</sup> measurement as `rb[9]`, etc. The additional information in the table is accessed as additional members of the table. The following values are all available per reading buffer, i.e., `rb.appendmode`:

|                                  |                                                                                                                                                                                                                                                                  |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>appendmode</code>          | Off or on. If off, a new measurement to this buffer will overwrite the previous contents. If on, the first new measurement will be stored at what was formerly <code>rb[n+1]</code> . This attribute is initialized to off when the buffer is created.           |
| <code>basetimestamp</code>       | The time stamp of when the reading at <code>rb[1]</code> was stored, in seconds, since 12:00 am January 1, 1970 (UTC).                                                                                                                                           |
| <code>capacity</code>            | The total number of readings that can be stored in the reading buffer.                                                                                                                                                                                           |
| <code>collectsourcevalues</code> | When on, source values will be stored with readings in the buffer. This requires four extra bytes of storage per reading. This value, off or on, can only be changed when the buffer is empty. When the buffer is created, this attribute is initialized to off. |

The following values are available per reading, i.e., `rb.measurefunctions[3]`, as enabled. Each is actually a nested table. Related entries are stored at the same index as the relevant measurement.

|                                  |                                                                                                                                                                                                                                                                |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>collecttimestamps</code>   | When on, time stamps will be stored with readings in the buffer. This requires four extra bytes of storage per reading. This value, off or on, can only be changed when the buffer is empty. When the buffer is created, this attribute is initialized to off. |
| <code>n</code>                   | The number of readings in the reading buffer.                                                                                                                                                                                                                  |
| <code>timestampresolution</code> | The time stamp resolution, in seconds. When the buffer is created, its initial resolution is 0.000001 seconds. At this resolution, the reading buffer can store unique time stamps for up to 71 minutes. This value can be increased for very long tests.      |
| <code>measurefunctions</code>    | An array (TSL table) of strings indicating the function measured for the reading (Current, Voltage, Ohms or Watts).                                                                                                                                            |
| <code>measureranges</code>       | An array (TSL table) of full-scale range values for the measure range used when the measurement was made.                                                                                                                                                      |
| <code>readings</code>            | An array (TSL table) of the readings stored in the reading buffer. This array holds the same data that is returned when the reading buffer is accessed directly, i.e., <code>rb[2]</code> and <code>rb.readings[2]</code> are the same value.                  |
| <code>sourcefunctions</code>     | An array (TSL table) of strings indicating the source function at the time of the measurement (Current or Voltage).                                                                                                                                            |

|                                 |                                                                                                                                                                                                                                               |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>sourceoutputstates</code> | An array (TSL table) of strings indicating the state of the source (Off or On).                                                                                                                                                               |
| <code>sourceranges</code>       | An array (TSL table) of full-scale range values for the source range used when the measurement was made.                                                                                                                                      |
| <code>sourcevalues</code>       | If enabled (see <code>collectsourcevalues</code> above), an array (TSL table) of the sourced value in effect at the time of the reading.                                                                                                      |
| <code>statuses</code>           | An array (TSL table) of status values for all of the readings in the buffer. The status values are floating-point numbers that encode the status value into a floating-point value.                                                           |
| <code>timestamps</code>         | An array (TSL table) of time stamps, in seconds, between when the reading was acquired and when the first reading in the buffer was acquired. Adding this value to the base timestamp will give the actual time the measurement was acquired. |

For example, the number of readings the reading buffer can store is accessed as `rb.capacity`.

## Time and date values

Time and date values are represented as a number of seconds since some base. Representing time as a number of seconds is referred to as “standard time format.” There are three time bases:

1. UTC 12:00 am Jan 1, 1970. Reading buffer base timestamps, calibration dates, and the value returned by `os.time()` are all examples of UTC time.
2. When the Series 2600A is powered on. The value returned by `os.clock()` is referenced to the power-on time.
3. Time referenced to an event, such as the first reading stored in a reading buffer.

## Remote versus local state

The Series 2600A can be in either the local state or the remote state. When in the local state (REM indicator off), the instrument is operated using the front panel controls. When in the remote state (REM indicator on), instrument operation is being controlled by the PC. When the instrument is powered-on, it will be in the local state.

### Remote state

The following actions will place the instrument in the remote state:

- Sending a command from the PC to the instrument.
- Running a script (FACTORY or USER test) from the front panel. After the test is completed, the instrument will return to the local mode.
- Opening communications between the instrument and Test Script Builder.

While in the remote state, front panel controls are disabled. However, the **LOCAL** key will be active if it has not been locked out. When an interactive script is running, the front panel controls will be active to allow the operator to input parameter values.

### Local state

The following actions will cancel the remote state and return the instrument to the local state:

- Cycling power for the instrument.
- Pressing front panel **LOCAL** key (if it is not locked out).
- Sending the `abort` command from the PC.
- Clicking the Abort Execution icon on the toolbar of the Instrument Console for Test Script Builder.



- After a front panel script (FACTORY or USER test) is completed, the instrument will return to the local state.

### TSP-Link system

A test system can be expanded to include up to 32 TSP-Linked enabled instruments. The system can be stand-alone or PC-based. Details on system expansion using the TSP-Link are provided in [Section 14](#).

**Stand-alone system:** A script can be run from the front panel of any node (instrument) in the system. When a script is run, all nodes in the system go into remote operation (REM indicators turn on). The node running the script becomes the Master and can control all of the other nodes, which become its Slaves. When the script is finished running, all the nodes in the system return to local operation (REM indicators turn off), and the Master/Slave relationship between nodes is dissolved.

**PC-based system:** When using a PC, the LAN, GPIB, or RS-232 interface to any single node becomes the interface to the entire system. When a command is sent via one of these interfaces, all nodes go into remote operation (REM indicators turn on).

The node that receives the command becomes the Master and can control all of the other nodes, which become its Slaves. In a PC-based system, the Master/Slave relationship between nodes can only be dissolved by performing an abort.

## Standard libraries

In addition to the standard programming constructs above, TSL includes standard libraries that contain useful functions for string manipulation, mathematics and related functions. TSL also includes instrument control extension libraries. These libraries provide programming interfaces to the instrumentation accessible by the TSP. These libraries are automatically loaded when the TSP starts and do not need to be managed by the programmer.

Table 19-1  
Base library functions

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>print(x)</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Prints the argument <code>x</code> to the active host interface, using the <code>toString()</code> function to convert <code>x</code> to a string (note that numbers are converted to scientific notation using <code>format.asciiprecision</code> ).                                                                                                                                                                                                                                                                                                                                                            |
| <code>collectgarbage([limit])</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Sets the garbage-collection threshold to the given limit (in Kbytes) and checks it against the byte counter. If the new threshold is smaller than the byte counter, then TSL immediately runs the garbage collector. If the limit parameter is absent, it defaults to 0 (thus forcing a garbage-collection cycle). See <b>Note</b> for more information.                                                                                                                                                                                                                                                         |
| <code>gcinfo()</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Returns the number of Kbytes of dynamic memory that TSP is using.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <code>tonumber(x [,base])</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Returns <code>x</code> converted to a number. If <code>x</code> is already a number, or a convertible string, then the number is returned; otherwise, it returns <code>nil</code> .<br>An optional argument specifies the base to interpret the numeral. The base may be any integer between 2 and 36, inclusive. In bases above 10, the letter 'A' (in either upper or lower case) represents 10, 'B' represents 11, and so forth, with 'Z' representing 35. In base 10, the default, the number may have a decimal part, as well as an optional exponent. In other bases, only unsigned integers are accepted. |
| <code>toString(x)</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Receives an argument of any type and converts it to a string in a reasonable format.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <code>type(v)</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Returns the type of its only argument, coded as a string. The possible results of this function are: <code>nil</code> , <code>number</code> , <code>Boolean</code> , <code>table</code> , or <code>function</code> .                                                                                                                                                                                                                                                                                                                                                                                             |
| <p><b>NOTE:</b> TSL does automatic memory management. That means that you do not have to worry about allocating memory for new objects and freeing it when the objects are no longer needed. TSL manages memory automatically by running a garbage collector from time to time to collect all dead objects (that is, those objects that are no longer accessible from TSL). All objects in TSL are subject to automatic management: tables, variables, functions, threads, and strings. TSL uses two numbers to control its garbage-collection cycles. One number counts how many bytes of dynamic memory TSL is using; the other is a threshold. When the number of bytes crosses the threshold, TSL runs the garbage collector, which reclaims the memory of all dead objects. The byte counter is adjusted, and then the threshold is reset to twice the new value of the byte counter.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

## String library functions

This library provides generic functions for string manipulation, such as finding and extracting substrings. When indexing a string in TSL, the first character is at position 1 (not 0 as in ANSI C). Indices may be negative and are interpreted as indexing backwards, from the end of the string. Thus, the last character is at position 1, and so on.

|                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>string.byte(s [,i])</code>            | Returns the internal numerical code of the <code>i</code> -th character of string <code>s</code> , or <code>nil</code> if the index is out of range.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <code>string.char(i1, i1, ...)</code>       | Receives 0 or more integers. Returns a string with length equal to the number of arguments, in which each character has the internal numerical code equal to its corresponding argument.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <code>string.format(fs, e1, e2, ...)</code> | Returns a formatted version of its variable number of arguments following the description given in its first argument, which must be a string. The format string follows the same rules as the print family of ANSI C functions. The only differences are that the options/modifiers <code>*</code> , <code>l</code> , <code>L</code> , <code>n</code> , <code>p</code> , and <code>h</code> are not supported. The options <code>c</code> , <code>d</code> , <code>E</code> , <code>e</code> , <code>f</code> , <code>g</code> , <code>G</code> , <code>l</code> , <code>o</code> , <code>u</code> , <code>X</code> , and <code>x</code> all expect a numeric argument, where <code>s</code> expects a string argument. String values to be formatted with <code>%s</code> cannot contain embedded zeros. |
| <code>string.len(s)</code>                  | Returns the length of the strings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <code>string.lower(s)</code>                | Returns a copy of the string <code>s</code> with all uppercase letters changed to lowercase.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <code>string.rep(s, n)</code>               | Returns a string that is the concatenation of <code>n</code> copies of the string <code>s</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

|                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>string.sub(s, i [,j])</code> | Returns the substring of <code>s</code> that starts at <code>i</code> and continues until <code>j</code> . <code>i</code> and <code>j</code> may be negative. If <code>j</code> is absent, then it is assumed to be equal to <code>-1</code> , which is the same as the string length. In particular, the call <code>string.sub(s,1,j)</code> returns a prefix <code>s</code> with length <code>j</code> , and <code>string.sub(s,-i)</code> returns a suffix <code>s</code> with length <code>i</code> . |
| <code>string.upper(s)</code>       | Returns a copy of the string <code>s</code> with all lowercase letters changed to uppercase.                                                                                                                                                                                                                                                                                                                                                                                                              |

## Math library functions

This library is an interface to most of the functions of the ANSI C math library. All trigonometric functions work in radians. The functions `math.deg()` and `math.rad()` convert between radians and degrees.

|                                   |                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>math.abs(x)</code>          | Returns the absolute value of the argument <code>x</code> .                                                                                                                                                                                                                                                                                                     |
| <code>math.acos(x)</code>         | Returns the principal value of the trigonometric arc cosine function of <code>x</code> .                                                                                                                                                                                                                                                                        |
| <code>math.asin(x)</code>         | Returns the principal value of the trigonometric arc sine function of <code>x</code> .                                                                                                                                                                                                                                                                          |
| <code>math.atan(x)</code>         | Returns the principal value of the trigonometric arc tangent function of <code>x</code> .                                                                                                                                                                                                                                                                       |
| <code>math.atan2(y,x)</code>      | Returns the principal value of the trigonometric arc tangent function of <code>y/x</code> .                                                                                                                                                                                                                                                                     |
| <code>math.ceil(x)</code>         | Returns the smallest floating-point number not less than <code>x</code> whose value is an exact mathematical integer.                                                                                                                                                                                                                                           |
| <code>math.cos(x)</code>          | Returns the trigonometric cosine function of <code>x</code> .                                                                                                                                                                                                                                                                                                   |
| <code>math.deg(x)</code>          | Returns the value of <code>x</code> in degrees, where <code>x</code> is in radians.                                                                                                                                                                                                                                                                             |
| <code>math.exp(x)</code>          | Returns the exponential function of <code>x</code> ; that is, $e^x$ , where $e$ is the base of the natural logarithms.                                                                                                                                                                                                                                          |
| <code>math.floor(x)</code>        | Returns the largest floating-point number not greater than <code>x</code> whose value is an exact mathematical integer.                                                                                                                                                                                                                                         |
| <code>math.log(x)</code>          | Returns the natural logarithm function of <code>x</code> .                                                                                                                                                                                                                                                                                                      |
| <code>math.log10(x)</code>        | Returns the base-10 logarithm function of <code>x</code> .                                                                                                                                                                                                                                                                                                      |
| <code>math.max(x, y, ...)</code>  | Returns the maximum value of its numeric argument(s).                                                                                                                                                                                                                                                                                                           |
| <code>math.min(x, y, ...)</code>  | Returns the minimum value of its argument(s).                                                                                                                                                                                                                                                                                                                   |
| <code>math.mod(x, y)</code>       | Returns an approximation to the mathematical value <code>f</code> such that <code>f</code> has the same sign as <code>x</code> , the absolute value of <code>f</code> is less than the absolute value of <code>y</code> , and there exists an integer <code>k</code> such that $k*y+f = x$ .                                                                    |
| <code>math.pi</code>              | Variable containing the value of $\pi$ (3.141592654).                                                                                                                                                                                                                                                                                                           |
| <code>math.pow(x, y)</code>       | Returns $x^y$ .                                                                                                                                                                                                                                                                                                                                                 |
| <code>math.rad(x)</code>          | Returns the value of <code>x</code> in radians, where <code>x</code> is in degrees.                                                                                                                                                                                                                                                                             |
| <code>math.sin(x)</code>          | Returns the trigonometric sine function of <code>x</code> .                                                                                                                                                                                                                                                                                                     |
| <code>math.sqrt(x)</code>         | Returns the non-negative square root of <code>x</code> .                                                                                                                                                                                                                                                                                                        |
| <code>math.tan(x)</code>          | Returns the trigonometric tangent function of <code>x</code> .                                                                                                                                                                                                                                                                                                  |
| <code>math.frexp()</code>         | Splits <code>x</code> into a fraction <code>f</code> and exponent <code>n</code> , such that <code>f</code> is 0.0 or $0.5 \leq  f  < 1.0$ , and $f * 2^n$ is equal to <code>x</code> . Both <code>f</code> and <code>n</code> are returned; <code>f, n = math.frexp(x)</code> .                                                                                |
| <code>math.ldexp(x, n)</code>     | Returns the inverse of the <code>math.frexp()</code> function; it computes the value $x * 2^n$ .                                                                                                                                                                                                                                                                |
| <code>math.random([x],[y])</code> | When called without an argument, returns a pseudo-random real number in the range <code>[0, 1)</code> .<br>When called with number <code>x</code> , returns a pseudo-random integer in the range <code>[1,n]</code> .<br>When called with two arguments, <code>x</code> and <code>y</code> , returns a pseudo-random integer in the range <code>[x, y]</code> . |
| <code>math.randomseed(x)</code>   | Sets a "seed" for the pseudo-random generator. Equal seeds produce equal sequences of numbers.                                                                                                                                                                                                                                                                  |

## File I/O

Lua supports file I/O with its `io` library commands. A subset of these commands is supported for use with Series 2600A instruments. As with Lua `fs`, these commands are encapsulated as an `io` logical instrument so that the files on any given node are accessible to the entire TSP-Link system.

Lua organizes its file I/O commands into two groups:

1. Commands that reside in the `io` table, for example: `io.open`, `io.close`, `io.input`, and `io.output`. These commands are responsible for opening and closing file descriptors and performing basic I/O operations on a pair of default files, one input and one output.
2. Commands that reside in the file descriptors themselves (for example: `file.seek`, `file.write`, and `file.read`) operate exclusively on the file with which they are associated.

The following Lua I/O commands, which support basic file I/O, are included for your reference:

```
file:close
file:flush
file:read
file:seek
file:write
io.close
io.flush
io.input
io.open
io.output
io.read
io.write
io.type
```

The following standard I/O commands are not supported at this time:

```
file:lines
file:setvbuf
io.lines
io.popen
io.tmpfile
```

---

**NOTE** File descriptor commands for file I/O use a colon (:) to separate the command parts rather than a period like the `io` commands.

Note that file descriptors cannot be passed between nodes in a TSP-Link system; as such, the `io.open` command is not accessible via the TSP-Link. However, the default input and output files mentioned above allow for the execution of many file I/O operations without any reference to a file descriptor.

---

## Instrument Control Library

### B

beeper.beep  
 beeper.enable  
 bit.bitand  
 bit.bitor  
 bit.bitxor  
 bit.clear  
 bit.get  
 bit.getfield  
 bit.set  
 bit.setfield  
 bit.test  
 bit.toggle

### D

dataqueue.add  
 dataqueue.CAPACITY  
 dataqueue.clear  
 dataqueue.count  
 dataqueue.next  
 delay  
 digio.readbit  
 digio.readport  
 digio.trigger[N].assert  
 digio.trigger[N].clear  
 digio.trigger[N].EVENT\_ID  
 digio.trigger[N].mode  
 digio.trigger[N].overrun  
 digio.trigger[N].pulsewidth  
 digio.trigger[N].release  
 digio.trigger[N].stimulus  
 digio.trigger[N].wait  
 digio.writebit  
 digio.writeport  
 digio.writeprotect  
 display.clear  
 display.getannunciators  
 display.getcursor  
 display.getlastkey  
 display.gettext  
 display.inputvalue  
 display.loadmenu.add  
 display.loadmenu.catalog  
 display.loadmenu.delete  
 display.locallockout  
 display.menu  
 display.numpad  
 display.prompt  
 display.screen  
 display.sendkey  
 display.setcursor  
 display.settext  
 display.smuX.digits  
 display.smuX.measure.func  
 display.trigger.clear  
 display.trigger.overrun  
 display.trigger.wait  
 display.waitkey

### E

errorqueue.clear  
 errorqueue.count  
 errorqueue.next  
 eventlog.all  
 eventlog.clear  
 eventlog.count  
 eventlog.enable  
 eventlog.next  
 eventlog.overwritemethod  
 exit

### F

fs.chdir  
 fs.cwd  
 fs.is\_dir  
 fs.is\_file  
 fs.mkdir  
 fs.readdir  
 fs.rmdir  
 format.asciiprecision  
 format.byteorder  
 format.data

### G

gpib.address

### I

io.close  
 io.flush  
 io.input  
 io.open  
 io.output  
 io.read  
 io.type  
 io.write

### L

lan.applysettings  
 lan.autoconnect  
 lan.config.dns.address[N]  
 lan.config.dns.domain  
 lan.config.dns.dynamic  
 lan.config.dns.hostname  
 lan.config.dns.verify  
 lan.config.duplex  
 lan.config.gateway  
 lan.config.ipaddress  
 lan.config.method  
 lan.config.speed  
 lan.config.subnetmask  
 lan.linktimeout  
 lan.lxidomain  
 lan.nagle  
 lan.reset  
 lan.restoredefaults  
 lan.status.dns.address[N]  
 lan.status.dns.name  
 lan.status.duplex  
 lan.status.gateway  
 lan.status.ipaddress  
 lan.status.macaddress  
 lan.status.port.dst

lan.status.port.rawsocket  
 lan.status.port.telnet  
 lan.status.port.vxi11  
 lan.status.speed  
 lan.status.subnetmask  
 lan.timedwait  
 lan.trigger[N].assert  
 lan.trigger[N].clear  
 lan.trigger[N].connect  
 lan.trigger[N].connected  
 lan.trigger[N].disconnect  
 lan.trigger[N].EVENT\_ID  
 lan.trigger[N].ipaddress  
 lan.trigger[N].ipaddress  
 lan.trigger[N].mode  
 lan.trigger[N].overrun  
 lan.trigger[N].protocol  
 lan.trigger[N].pseudostate  
 lan.trigger[N].stimulus  
 lan.trigger[N].wait  
 localnode.autolinefreq  
 localnode.description  
 localnode.execute  
 localnode.getglobal  
 localnode.gettimezone  
 localnode.linefreq  
 localnode.model  
 localnode.password  
 localnode.passwordmode  
 localnode.prompts  
 localnode.prompts4882  
 localnode.reset  
 localnode.revision  
 localnode.serialno  
 localnode.setglobal  
 localnode.settime  
 localnode.settimezone  
 localnode.showerrors  
**M**  
 makegetter  
 makesetter  
 meminfo  
**O**  
 opc  
**P**  
 printbuffer  
 printnumber  
**R**  
 reset  
**S**  
 serial.baud  
 serial.databits  
 serial.flowcontrol  
 serial.parity  
 serial.read  
 serial.write  
 setup.poweron  
 setup.recall  
 setup.save  
 smuX.abort  
 smuX.cal.adjustdate  
 smuX.cal.date  
 smuX.cal.due  
 smuX.cal.lock  
 smuX.cal.password  
 smuX.cal.polarity  
 smuX.cal.restore  
 smuX.cal.save  
 smuX.cal.state  
 smuX.cal.unlock  
 smuX.contact.calibratehi  
 smuX.contact.calibratelo  
 smuX.contact.check  
 smuX.contact.r  
 smuX.contact.speed  
 smuX.contact.threshold  
 smuX.makebuffer  
 smuX.measure.analogfilter  
 smuX.measure.autorangeY  
 smuX.measure.autozero  
 smuX.measure.calibrateY  
 smuX.measure.count  
 smuX.measure.delay  
 smuX.measure.delayfactor  
 smuX.measure.filter.count  
 smuX.measure.filter.enable  
 smuX.measure.filter.type  
 smuX.measure.highcrangedelayfactor  
 smuX.measure.interval  
 smuX.measure.lorangeY  
 smuX.measure.nplc  
 smuX.measure.overlappedY  
 smuX.measure.rangeY  
 smuX.measure.rel.enableY  
 smuX.measure.rel.levelY  
 smuX.measure.Y  
 smuX.measureYandstep  
 smuX.nvbufferY  
 smuX.nvbufferY.appendmode  
 smuX.nvbufferY.basetimestamp  
 smuX.nvbufferY.capacity  
 smuX.nvbufferY.clear  
 smuX.nvbufferY.clearcache  
 smuX.nvbufferY.collectsourcevalues  
 smuX.nvbufferY.collecttimestamps  
 smuX.nvbufferY.n  
 smuX.nvbufferY.timestampresolution  
 smuX.reset  
 smuX.savebuffer  
 smuX.sense  
 smuX.source.autorangeY  
 smuX.source.calibrateY  
 smuX.source.compliance  
 smuX.source.delay  
 smuX.source.func  
 smuX.source.levelY  
 smuX.source.limitY  
 smuX.source.lorangeY  
 smuX.source.offlimiti

```

smuX.source.offmode
smuX.source.output
smuX.source.outputenableaction
smuX.source.rangeY
smuX.trigger.arm.count
smuX.trigger.arm.set
smuX.trigger.arm.stimulus
smuX.trigger.ARMED_EVENT_ID
smuX.trigger.autoclear
smuX.trigger.count
smuX.trigger.endpulse.action
smuX.trigger.endpulse.set
smuX.trigger.endpulse.stimulus
smuX.trigger.endsweep.action
smuX.trigger.IDLE_EVENT_ID
smuX.trigger.initiate
smuX.trigger.measure.action
smuX.trigger.measure.set
smuX.trigger.measure.stimulus
smuX.trigger.measure.Y
smuX.trigger.MEASURE_COMPLETE_EVENT_ID
smuX.trigger.PULSE_COMPLETE_EVENT_ID
smuX.trigger.source.action
smuX.trigger.source.limitY
smuX.trigger.source.linearY
smuX.trigger.source.listY
smuX.trigger.source.logY
smuX.trigger.source.set
smuX.trigger.source.stimulus
smuX.trigger.SOURCE_COMPLETE_EVENT_ID
smuX.trigger.SWEEP_COMPLETE_EVENT_ID
smuX.trigger.SWEEPING_EVENT_ID
smuX.trigger.source.limitY
status.condition
status.measurement.condition
status.measurement.enable
status.measurement.event
status.measurement.ntr
status.measurement.ptr
status.measurement.buffer_available.condition
status.measurement.buffer_available.enable
status.measurement.buffer_available.event
status.measurement.buffer_available.ntr
status.measurement.buffer_available.ptr
status.measurement.current_limit.condition
status.measurement.current_limit.enable
status.measurement.current_limit.event
status.measurement.current_limit.ntr
status.measurement.current_limit.ptr
status.measurement.instrument
status.measurement.instrument.smuX.condition
status.measurement.instrument.smuX.enable
status.measurement.instrument.smuX.event
status.measurement.instrument.smuX.ntr
status.measurement.instrument.smuX.ntr
status.measurement.reading_overflow.condition
status.measurement.reading_overflow.enable
status.measurement.reading_overflow.event
status.measurement.reading_overflow.ntr
status.measurement.reading_overflow.ptr
status.measurement.voltage_limit
status.node_enable
status.node_event
status.operation
status.operation.calibrating
status.operation.instrument
status.operation.instrument.digio
status.operation.instrument.digio.trigger_overn
status.operation.instrument.lan
status.operation.instrument.lan.trigger_overn
status.operation.instrument.smuX
status.operation.instrument.smuX.trigger_overn
status.operation.instrument.trigger_blender
status.operation.instrument.trigger_blender.trigger_overn
status.operation.instrument.trigger_timer
status.operation.instrument.trigger_timer.trigger_overn
status.operation.instrument.tsplink
status.operation.instrument.tsplink.trigger_overn
status.operation.measuring
status.operation.remote
status.operation.sweeping
status.operation.trigger_overn
status.operation.user
status.questionable
status.questionable.calibration
status.questionable.instrument
status.questionable.instrument.smuX
status.questionable.over_temperature
status.questionable.unstable_output
status.request_enable
status.request_event
status.reset
status.standard
status.system
status.system2
status.system3
status.system4
status.system5
T
timer.measure.t
timer.reset
trigger.blender[N].clear
trigger.blender[N].EVENT_ID
trigger.blender[N].orenable
trigger.blender[N].overn
trigger.blender[N].stimulus[M]
trigger.blender[N].wait
trigger.clear
trigger.EVENT_ID
trigger.timer[N].clear
trigger.timer[N].count
trigger.timer[N].delay
trigger.timer[N].delaylist

trigger.timer[N].overn
trigger.timer[N].passthrough

```

trigger.timer[N].stimulus  
trigger.timer[N].wait  
trigger.wait  
tsplink.group  
tsplink.master  
tsplink.node  
tsplink.readbit  
tsplink.readport  
tsplink.reset  
tsplink.state  
tsplink.trigger[N].assert  
tsplink.trigger[N].clear  
tsplink.trigger[N].EVENT\_ID  
tsplink.trigger[N].mode  
tsplink.trigger[N].overrun  
tsplink.trigger[N].pulsewidth  
tsplink.trigger[N].release  
tsplink.trigger[N].stimulus  
tsplink.trigger[N].wait  
tsplink.writebit  
tsplink.writeport  
tsplink.writeprotect  
tspnet.clear  
tspnet.connect  
tspnet.disconnect  
tspnet.execute  
tspnet.idn  
tspnet.read  
tspnet.readavailable  
tspnet.reset  
tspnet.termination  
tspnet.timeout  
tspnet.tsp.abort  
tspnet.tsp.abortonconnect  
tspnet.tsp.rtablecopy  
tspnet.tsp.runscript  
tspnet.write

**U**  
userstring.add  
userstring.catalog  
userstring.delete  
userstring.get

**W**  
waitcomplete



## beeper

The beeper generates a beep tone. It is typically used to announce the start and/or completion of a test or operation.

| <b>beeper.beep</b>     |                                                                                                                                                                                                                                                                                                                                              |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Generates a beep tone.                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                   |
| Usage                  | <code>beeper.beep(duration, frequency)</code><br><br><div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><code>duration</code><br/><code>frequency</code></p> </div> <div style="width: 50%;"> <p>Set from 0.1 to 100 (seconds).<br/>Specifies the frequency the beeper should beep.</p> </div> </div> |
| Remarks                | <ul style="list-style-type: none"> <li>The beeper will not sound if it is disabled (see <a href="#">beeper.enable</a> attribute).</li> </ul>                                                                                                                                                                                                 |
| Also see               | <a href="#">beeper.enable</a>                                                                                                                                                                                                                                                                                                                |
| Example                | Enables the beeper and generates a two-second, 2400Hz beep:<br><pre>beeper.enable = 1 beeper.beep(2, 2400)</pre>                                                                                                                                                                                                                             |

| <b>beeper.enable</b>   |                                                                                                                                                                                                                                                                                           |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | Beeper control (on/off).                                                                                                                                                                                                                                                                  |
| Default                | 1 (enabled)                                                                                                                                                                                                                                                                               |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                               |
| Usage                  | <pre>beeperstate = beeper.enable    -- Reads beeper state. beeper.enable = beeperstate    -- Writes beeper state.</pre> <p>Set <code>beeperstate</code> to one of the following values:</p> <ul style="list-style-type: none"> <li>0 Beeper disabled</li> <li>1 Beeper enabled</li> </ul> |
| Remarks                | <ul style="list-style-type: none"> <li>This attribute enables or disables the beeper. Disabling the beeper also disables front panel key clicks.</li> </ul>                                                                                                                               |
| Also see               | <a href="#">beeper.beep</a>                                                                                                                                                                                                                                                               |
| Example                | Enables the beeper and generates a two-second, 2400Hz beep:<br><pre>beeper.enable = 1 beeper.beep(2, 2400)</pre>                                                                                                                                                                          |

## bit

### Logic and bit operations

The bit functions are used to perform bitwise logic operations on two given numbers, and bit operations on one given number. Logic and bit operations truncate the fractional part of given numbers to make them integers.

**Logic operations:** The `bit.bitand`, `bit.bitor` and `bit.bitxor` functions in this group perform logic operations on two numbers. The TSP will perform the indicated logic operation on the binary equivalents of the two integers. Logic operations are performed bitwise. That is, Bit 1 of the first number is AND'ed, OR'ed, or XOR'ed with bit 1 of the second number. Bit 2 of the first number is AND'ed, OR'ed or XOR'ed with Bit 2 of the second number. This bitwise logic operation is performed on all corresponding bits of the two numbers. The result of a logic operation will be returned as an integer.

**Bit operations:** The rest of the functions in this group are used for operations on the bits of a given number. These functions can be used to clear a bit, toggle a bit, test a bit, set a bit (or bit field) and retrieve the weighted value of a bit (or field value). All of these functions use an `index` parameter to “point” to the bit position of the given number. The least significant bit of a given number has an index of 1, and the most significant bit has an index of 32.

| <b>bit.bitand</b>      |                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Performs a bitwise logical AND operation on two numbers.                                                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                            |
| Usage                  | <pre>value = bit.bitand(value1, value2)</pre> <p> <code>value1</code>                      First number for the AND operation.<br/> <code>value2</code>                      Second number for the AND operation.<br/> <code>value</code>                         Returned result of the AND operation. </p>                                                             |
| Remarks                | <ul style="list-style-type: none"> <li>• This function performs a logical AND operation on two numbers.</li> <li>• Any fractional parts of <code>value1</code> and <code>value2</code> are truncated to make them integers. The returned <code>value</code> is also an integer.</li> <li>• See <a href="#">Logic and bit operations</a> for more information.</li> </ul> |
| Also see               | <a href="#">bit.bitor</a> , <a href="#">bit.bitxor</a>                                                                                                                                                                                                                                                                                                                   |
| Example                | <p>AND'ing decimal 10 (binary 1010) with decimal 9 (binary 1001) will return a value of decimal 8 (binary 1000):</p> <pre>value = bit.bitand(10, 9) print(value) Output: 8.000000e+00</pre>                                                                                                                                                                              |

| <b>bit.bitor</b>       |                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Performs a bitwise logical OR operation on two numbers.                                                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                           |
| Usage                  | <pre>value = bit.bitor(value1, value2)</pre> <p> <code>value1</code>                      First number for the OR operation.<br/> <code>value2</code>                      Second number for the OR operation.<br/> <code>value</code>                         Returned result of the OR operation. </p>                                                                |
| Remarks                | <ul style="list-style-type: none"> <li>• This function performs a logical OR operation on two numbers.</li> <li>• Any fractional parts of <code>value1</code> and <code>value2</code> are truncated to make them integers. The returned <code>value</code> is also an integer.</li> <li>• See <a href="#">Logic and bit operations</a> for more information.</li> </ul> |
| Also see               | <a href="#">bit.bitand</a> , <a href="#">bit.bitxor</a>                                                                                                                                                                                                                                                                                                                 |
| Example                | <p>OR'ing decimal 10 (binary 1010) with decimal 9 (binary 1001) will return a value of decimal 11 (binary 1011):</p> <pre>value = bit.bitor(10, 9) print(value) Output: 1.100000e+01</pre>                                                                                                                                                                              |

| <b>bit.bitxor</b>      |                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Performs a bitwise logical XOR (Exclusive OR) operation on two numbers.                                                                                                                                                                                                                                                                                                           |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                     |
| Usage                  | <pre>value = bit.xor(value1, value2)</pre> <p>value1                      First number for the XOR operation.<br/> value2                      Second number for the XOR operation.<br/> value                        Returned result of the XOR operation.</p>                                                                                                                   |
| Remarks                | <ul style="list-style-type: none"> <li>• This function performs a logical Exclusive OR operation on two numbers.</li> <li>• Any fractional parts of <code>value1</code> and <code>value2</code> are truncated to make them integers. The returned <code>value</code> is also an integer.</li> <li>• See <a href="#">Logic and bit operations</a> for more information.</li> </ul> |
| Also see               | <a href="#">bit.bitand</a> , <a href="#">bit.bitor</a>                                                                                                                                                                                                                                                                                                                            |
| Example                | <p>XOR'ing decimal 10 (binary 1010) with decimal 9 (binary 1001) will return a <code>value</code> of decimal 3 (binary 0011):</p> <pre>value = bit.bitxor(10, 9) print(value) Output: 3.000000e+00</pre>                                                                                                                                                                          |

| <b>bit.clear</b>       |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Clears a bit at a given index position.                                                                                                                                                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                          |
| Usage                  | <pre>value = bit.clear(value1, index)</pre> <p>value1                      Given number.<br/> index                        Index position of the bit to be cleared (1 to 32).<br/> value                        Returns the result of the manipulation.</p>                                                                                                                                                                                            |
| Remarks                | <ul style="list-style-type: none"> <li>• This function clears a bit at a given index position.</li> <li>• Any fractional part of <code>value1</code> is truncated to make it an integer. The returned <code>value</code> is also an integer.</li> <li>• The least significant bit of the given number is at index 1. The most significant bit is at index 32.</li> <li>• See <a href="#">Logic and bit operations</a> for more information.</li> </ul> |
| Also see               | <a href="#">bit.get</a> , <a href="#">bit.getfield</a> , <a href="#">bit.set</a> , <a href="#">bit.setfield</a> , <a href="#">bit.test</a> , <a href="#">bit.toggle</a>                                                                                                                                                                                                                                                                                |
| Example                | <p>The binary equivalent of decimal 15 is 1111. If you clear the bit at index position 2, the returned decimal <code>value</code> would be 13 (binary 1101):</p> <pre>value = bit.clear(15, 2) print(value) Output: 1.300000e+01</pre>                                                                                                                                                                                                                 |

| <b>bit.get</b>         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Retrieves the weighted value of a bit at a given index position.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Usage                  | <pre>value = bit.get(value1, index)</pre> <p>value1                                      Given number.<br/> index                                         Index position of the bit to be retrieved (1 to 32).<br/> value                                         Returned weighted value of the bit.</p>                                                                                                                                                                                                                                                                                                                                                |
| Remarks                | <ul style="list-style-type: none"> <li>• This function returns the value of the bit in <code>value1</code> at the given index. This is the same as returning <code>value1</code> with all other non-indexed bits set to zero.</li> <li>• Prior to retrieving the indexed bit, any fractional part of the given number will be truncated to make it an integer. The least significant bit of the given number has an index of 1 and the most significant bit has an index of 32.</li> <li>• If the indexed bit for the number is set to 0, the result will be 0.</li> <li>• See <a href="#">Logic and bit operations</a> for more information.</li> </ul> |
| Also see               | <a href="#">bit.clear</a> , <a href="#">bit.getfield</a> , <a href="#">bit.set</a> , <a href="#">bit.setfield</a> , <a href="#">bit.test</a> , <a href="#">bit.toggle</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Example                | <p>The binary equivalent of decimal 10 is 1010. Getting the bit at index position 4 will return decimal value 8:</p> <pre>value = bit.get(10, 4) print(value) Output: 8.000000e+00</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

| <b>bit.getfield</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Returns a field of bits starting at a given index position.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Usage                  | <pre>value = bit.getfield(value1, index, width)</pre> <p>value1                                      Given number.<br/> index                                         Index position of the first bit; 1 to (33 – width).<br/> width                                         Field width – number of bits to be included in the field; 1 to 24.<br/> value                                         Returned value of the bit field.</p>                                                                                                                                                                                                                                                                               |
| Remarks                | <ul style="list-style-type: none"> <li>• A field of bits is a contiguous group of bits. This function retrieves a field of bits from <code>value1</code> starting at the given <code>index</code> position. The <code>index</code> position is the least significant bit of the retrieved field. The number of bits to return is given by <code>width</code>.</li> <li>• Prior to retrieving the field of bits, any fractional part of the given number will be truncated to make it an integer.</li> <li>• The least significant bit of the given number has an index of 1 and the most significant bit has an index of 32.</li> <li>• See <a href="#">Logic and bit operations</a> for more information.</li> </ul> |
| Also see               | <a href="#">bit.clear</a> , <a href="#">bit.get</a> , <a href="#">bit.set</a> , <a href="#">bit.setfield</a> , <a href="#">bit.test</a> , <a href="#">bit.toggle</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Example                | <p>The binary equivalent of decimal 13 is 1101. The field at <code>index2</code> and <code>width3</code> consists of the binary bits 110. The returned <code>value</code> will be decimal 6 (binary 110):</p> <pre>value = bit.getfield(13, 2, 3) print(value) Output: 6.000000e+00</pre>                                                                                                                                                                                                                                                                                                                                                                                                                             |

| <b>bit.set</b>         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Sets a bit at a given index position.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Usage                  | <pre>value = bit.set(value1, index)</pre> <p>value1                      Given number.<br/>index                        Index position of the bit to be set (1 to 32).<br/>value                         Returned value of the new number.</p>                                                                                                                                                                                                                                                        |
| Remarks                | <ul style="list-style-type: none"> <li>This function returns <code>value</code>, which is <code>value1</code> with the indexed bit set. The <code>index</code> must be a value between 1 and 32. The least significant bit of the given number has an index of 1 and the most significant bit has an index of 32.</li> <li>Any fractional part of <code>value1</code> will be truncated to make it an integer.</li> <li>See <a href="#">Logic and bit operations</a> for more information.</li> </ul> |
| Also see               | <a href="#">bit.clear</a> , <a href="#">bit.get</a> , <a href="#">bit.getfield</a> , <a href="#">bit.setfield</a> , <a href="#">bit.test</a> , <a href="#">bit.toggle</a>                                                                                                                                                                                                                                                                                                                             |
| Example                | <p>The binary equivalent of decimal 8 is 1000. If the bit at <code>index3</code> is set to 1, the returned <code>value</code> will be decimal 12 (binary 1100):</p> <pre>value = bit.set(8, 3) print(value) Output: 1.200000e+01</pre>                                                                                                                                                                                                                                                                |

| <b>bit.setfield</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Overwrites a bit field at a given index position.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Usage                  | <pre>value = bit.setfield(value1, index, width, fieldvalue)</pre> <p>value1                      The given number.<br/>index                        Index position of the least significant bit of the field<br/>                                  1 to (33 – width).<br/>width                         Field width – number of bits in the field; 1 to 24.<br/>fieldvalue                    Value to write to the field.<br/>value                         Returned value of the new number.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Remarks                | <ul style="list-style-type: none"> <li>This function returns <code>value</code>, which is <code>value1</code> with a field of bits overwritten, starting at the given <code>index</code> position. The <code>index</code> specifies the position of the least significant bit of the given field. The <code>width</code> bits starting at the given <code>index</code> will be set to the value given by <code>fieldvalue</code>. The least significant bit in <code>value1</code> has an index of 1 and the most significant bit has an index of 32.</li> <li>Prior to setting the field of bits, any fractional parts of <code>value1</code> and <code>fieldvalue</code> will be truncated to make them integers.</li> <li>If the <code>fieldvalue</code> is wider than the <code>width</code>, the extra most significant bits of the <code>fieldvalue</code> will be truncated. For example, assume the <code>width</code> is 4 bits, and the binary value for <code>fieldwidth</code> is 11110 (5 bits). The most significant bit of <code>fieldwidth</code> will be truncated, and a binary value of 1110 will be used as the <code>fieldvalue</code>.</li> <li>See <a href="#">Logic and bit operations</a> for more information.</li> </ul> |
| Also see               | <a href="#">bit.clear</a> , <a href="#">bit.get</a> , <a href="#">bit.getfield</a> , <a href="#">bit.set</a> , <a href="#">bit.test</a> , <a href="#">bit.toggle</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Example                | <p>The binary equivalent of decimal 15 is 1111. After overwriting it with a decimal 5 (binary 101) at <code>index</code> position 2, the returned <code>value</code> will be decimal 11 (binary 1011):</p> <pre>value = bit.setfield(15, 2, 3, 5) print(value) Output: 1.100000e+01</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |



## data queue

You can use the data queue commands to share data between test scripts running in parallel and to access data from a remote group or a local node on a TSP-Link network. You can access data from the data queue even if a remote group or a local node has overlapped operations in process.

| <b>dataqueue.add</b>   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Adds an entry into the data queue.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Usage                  | <pre>results = dataqueue.add(value) results = dataqueue.add(value, timeout)</pre> <p>value                                    The data item to add.</p> <p>timeout                                   The maximum number of seconds to wait for room in the data queue.</p> <p>results                                   The resulting value of <code>true</code> or <code>false</code> based on the success of the add function. Replace the word <code>results</code> with the name of the variable in which you want to store the result indicator.</p>                                                                                      |
| Remarks                | <ul style="list-style-type: none"> <li>You can only use the <code>timeout</code> value while adding data to the local data queue.</li> <li>The <code>timeout</code> value is ignored if the data queue is not full.</li> <li>The <code>dataqueue.add</code> function returns <code>false</code> if time-out expires before room is available in the data queue or if the data queue is full and a <code>timeout</code> value is not specified.</li> <li>If the value is a table, a duplicate of the table and any subtables is made. The duplicate table does not contain any references to the original table or to any subtables.</li> </ul> |
| Example                | <pre>dataqueue.add(10) dataqueue.add(10, 2) data_added = dataqueue.add(10, 3)</pre> <p>Use the following code to verify data was added to the data queue:</p> <pre>if not data_added then   print("timeout error") end</pre>                                                                                                                                                                                                                                                                                                                                                                                                                   |

| <b>dataqueue.CAPACITY</b> |                                                                                                                                                                                                                                                                   |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                 | The maximum number of entries that you can store in the data queue.                                                                                                                                                                                               |
| TSP-Link accessibility    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                       |
| Usage                     | <pre>capacity = dataqueue.CAPACITY -- Reads dataqueue capacity dataqueue.CAPACITY = capacity -- Writes dataqueue capacity.</pre> <p>capacity                                   A custom variable that stores the maximum number of entries in the data queue.</p> |
| Remarks                   | A read only attribute.                                                                                                                                                                                                                                            |
| Example                   | <pre>print(dataqueue.CAPACITY)</pre>                                                                                                                                                                                                                              |

| <b>dataqueue.clear</b> |                                                                                                                                                                                                                               |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Clears the data queue.                                                                                                                                                                                                        |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                    |
| Usage                  | <code>dataqueue.clear()</code>                                                                                                                                                                                                |
| Remarks                | <ul style="list-style-type: none"> <li>The <code>dataqueue.clear</code> command forces all <code>dataqueue.add</code> commands in progress to timeout.</li> <li>The function deletes all data from the data queue.</li> </ul> |

| <b>dataqueue.count</b> |                                                                                                                                                                                                                                                                          |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | Stores the number of entries saved in the data queue.                                                                                                                                                                                                                    |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                              |
| Usage                  | <pre>count = dataqueue.count      -- Reads number of data queue entries. dataqueue.count = count     -- Writes number of data queue entries.</pre> <p><code>count</code>                      A custom variable that stores the number of entries in the data queue.</p> |
| Remarks                | This is a read-only attribute.                                                                                                                                                                                                                                           |

| <b>dataqueue.next</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Removes the next entry from the data queue.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Usage                  | <pre>value = dataqueue.next() value = dataqueue.next(timeout)</pre> <p><code>timeout</code>                      The maximum number of seconds to wait for data in the data queue.</p> <p><code>value</code>                              The next entry in the data queue.</p>                                                                                                                                                                                                                                                                                     |
| Remarks                | <ul style="list-style-type: none"> <li>If the data queue is empty, the function waits up to the <code>timeout</code> value.</li> <li>If data is not available in the data queue before the <code>timeout</code> value expires, the return value is <code>nil</code>.</li> <li>The entries in the data queue are removed in a first in and first out order.</li> <li>If the value is a table, a duplicate of the original table and any subtables is made. The duplicate table does not contain any references to the original table or to any subtables.</li> </ul> |



## delay

This function is used to hold up system operation for a specified period of time. It is typically used to soak an instrument at a specific voltage or current for a period of time.

| delay                  |                                                                                                                                                                                                                                                                                                                                         |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Delays system operation.                                                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                           |
| Usage                  | <pre>delay(seconds)</pre> <p>seconds                                Sets the delay in seconds (100,000 seconds maximum).</p>                                                                                                                                                                                                            |
| Remarks                | <ul style="list-style-type: none"> <li>This function will delay for the specified number of seconds. It is impossible to delay for zero seconds.</li> <li>Delay time will be at least the given number of seconds. Due to overhead, the actual delay will be 5-10 <math>\mu</math>s (typical) more than the requested delay.</li> </ul> |
| Example                | <pre>Sets SMU A output to 1V, soaks the DUT for 50ms and then turns the output off: smua.source.levelv = 1.0 delay(0.050) smua.source.off()</pre>                                                                                                                                                                                       |

## digio

The functions and attributes in this group are used to control read/write and trigger operations for the digital I/O port.

---

**NOTE** The digital I/O lines can be used for both input and output. If a line is being driven low, then a 0 value will be read by a command for that line. You must write a 1 to all digital I/O lines that are to be used as inputs.

---

| digio.readbit          |                                                                                                                                                                                                                           |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Reads one digital I/O line.                                                                                                                                                                                               |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                |
| Usage                  | <pre>data = digio.readbit(n)</pre> <p>data                                A custom variable that stores the state of the I/O line.<br/>n                                      Digital I/O number to be read (1 - 14).</p> |
| Remarks                | <ul style="list-style-type: none"> <li>A returned value of 0 indicates that the line is low. A returned value of 1 indicates that the line is high.</li> </ul>                                                            |
| Details                | See in <a href="#">Section 8</a> .                                                                                                                                                                                        |
| Also see               | <a href="#">digio.readport</a> , <a href="#">digio.writebit</a> , <a href="#">digio.writeport</a>                                                                                                                         |
| Example                | <pre>Assume line 4 is set high, and it is then read: data = digio.readbit(4) print(data) Output: 1.000000e+00</pre>                                                                                                       |

| <b>digio.readport</b>  |                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Reads the digital I/O port.                                                                                                                                                                                                                                                                                                                                                                            |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                             |
| Usage                  | <code>data = digio.readport()</code>                                                                                                                                                                                                                                                                                                                                                                   |
| Remarks                | <ul style="list-style-type: none"><li>The binary equivalent of the returned value indicates the input pattern on the I/O port. The least significant bit of the binary number corresponds to line 1 and bit 14 corresponds to line 14. For example, a returned value of 170 has a binary equivalent of 00000010101010. Lines 2, 4, 6 and 8 are high (1), and the other 10 lines are low (0).</li></ul> |
| Details                | See in <a href="#">Section 8</a> .                                                                                                                                                                                                                                                                                                                                                                     |
| Also see               | <a href="#">digio.readbit</a> , <a href="#">digio.writebit</a> , <a href="#">digio.writeport</a>                                                                                                                                                                                                                                                                                                       |
| Example                | Assume lines 2, 4, 6 and 8 are set high, and the I/O port is then read:<br><code>data = digio.readport()</code><br><code>print(data)</code><br>Output: 1.700000e+02 (binary 10101010)                                                                                                                                                                                                                  |

| <b>digio.trigger[N].assert</b> |                                                                                                                  | Replace N with the number of the digital I/O trigger line: 1 to 14. |
|--------------------------------|------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| Function                       | Asserts a trigger on one of the digital I/O lines.                                                               |                                                                     |
| TSP-Link accessibility         | This function can be accessed from a remote TSP-Link node.                                                       |                                                                     |
| Usage                          | <code>digio.trigger[n].assert()</code><br><br><code>n</code> The trigger line.                                   |                                                                     |
| Remarks                        | <ul style="list-style-type: none"><li>The set pulse width determines how long the trigger is asserted.</li></ul> |                                                                     |
| Details                        | See <a href="#">Interactive triggering</a> in <a href="#">Section 10</a> .                                       |                                                                     |
| Also see                       | <a href="#">digio.trigger[N].pulsewidth</a>                                                                      |                                                                     |
| Example                        | Asserts a trigger on I/O line 2:<br><code>digio.trigger[2].assert()</code>                                       |                                                                     |

| <b>digio.trigger[N].clear</b> |                                                                                                                                                                                                                                                                                                                                                          | Replace N with the number of the digital I/O trigger line: 1 to 14. |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| Function                      | Clears a trigger event on a digital I/O line.                                                                                                                                                                                                                                                                                                            |                                                                     |
| TSP-Link accessibility        | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                               |                                                                     |
| Usage                         | <code>digio.trigger[n].clear()</code><br><br><code>n</code> The trigger line.                                                                                                                                                                                                                                                                            |                                                                     |
| Remarks                       | <ul style="list-style-type: none"><li>The trigger event detector recalls if a trigger event has been detected since the last <code>digio.trigger[n].wait</code> call.</li><li>This function clears a trigger event detector, discards the previous history of the trigger line and clears the <code>digio.trigger[n].overrun</code> attribute.</li></ul> |                                                                     |
| Details                       | See <a href="#">Interactive triggering</a> in <a href="#">Section 10</a> .                                                                                                                                                                                                                                                                               |                                                                     |
| Also see                      | <a href="#">digio.trigger[N].stimulus</a>                                                                                                                                                                                                                                                                                                                |                                                                     |
| Example                       | Clears trigger event on I/O line 2:<br><code>digio.trigger[2].clear()</code>                                                                                                                                                                                                                                                                             |                                                                     |

| <b>digio.trigger[N].EVENT_ID</b> Replace N with the number of the digital I/O trigger line: 1 to 14. |                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                            | Used to identify a specific event.                                                                                                                                                                                 |
| TSP-Link accessibility                                                                               | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                        |
| Usage                                                                                                | <pre>event_id = digio.trigger[n].EVENT_ID</pre> <p>               event_id                      The trigger event number.<br/>               n                                The trigger line.         </p>       |
| Remarks                                                                                              | <ul style="list-style-type: none"> <li>To have another trigger object respond to trigger events generated by the trigger line, set the other object's stimulus attribute to the value of this constant.</li> </ul> |

| <b>digio.trigger[N].mode</b> Replace N with the number of the digital I/O trigger line: 1 to 14. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                        |                                    |                         |                                                                                           |                        |                                                                                                                                                                                                                              |                        |                                                                           |                             |                                                                                                                                                            |                              |                                                                                                                                                  |                              |                                                                                   |                         |                                                                                     |                         |                                                                                                    |
|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------------------------------------|-------------------------|-------------------------------------------------------------------------------------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------------------------------------------------------|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------------------------------------------------------------------------|-------------------------|-------------------------------------------------------------------------------------|-------------------------|----------------------------------------------------------------------------------------------------|
| Attribute                                                                                        | The trigger operation and detection mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                        |                                    |                         |                                                                                           |                        |                                                                                                                                                                                                                              |                        |                                                                           |                             |                                                                                                                                                            |                              |                                                                                                                                                  |                              |                                                                                   |                         |                                                                                     |                         |                                                                                                    |
| Default                                                                                          | digio.TRIG_BYPASS.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                        |                                    |                         |                                                                                           |                        |                                                                                                                                                                                                                              |                        |                                                                           |                             |                                                                                                                                                            |                              |                                                                                                                                                  |                              |                                                                                   |                         |                                                                                     |                         |                                                                                                    |
| TSP-Link accessibility                                                                           | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                        |                                    |                         |                                                                                           |                        |                                                                                                                                                                                                                              |                        |                                                                           |                             |                                                                                                                                                            |                              |                                                                                                                                                  |                              |                                                                                   |                         |                                                                                     |                         |                                                                                                    |
| Usage                                                                                            | <pre>mode = digio.trigger[n].mode      -- Reads the trigger mode. digio.trigger[n].mode = mode      -- Writes the trigger mode.</pre> <p>               n                                The trigger line.<br/>               mode                            Selects the current trigger mode.         </p> <p>Choose one the following values for mode:</p> <table> <tbody> <tr> <td>0 or digio.TRIG_BYPASS</td> <td>Allows direct control of the line.</td> </tr> <tr> <td>1 or digio.TRIG_FALLING</td> <td>Detects falling edge input triggers as input. Asserts TTL-low pulse as an output trigger.</td> </tr> <tr> <td>2 or digio.TRIG_RISING</td> <td>If the programmed state of the line is high, the digio.TRIG_RISING mode behaves similar to digio.TRIG_RISINGA. If the programmed state of the line is low, the digio.TRIG_RISING mode behaves similar to digio.TRIG_RISINGM.</td> </tr> <tr> <td>3 or digio.TRIG_EITHER</td> <td>Detects rising or falling edge triggers. Asserts a TTL-low trigger pulse.</td> </tr> <tr> <td>4 or digio.TRIG_SYNCHRONOUS</td> <td>Detects the falling edge input triggers and automatically latches and drives the trigger line low. Asserting the output trigger releases the latched line.</td> </tr> <tr> <td>5 or digio.TRIG_SYNCHRONOUSM</td> <td>Detects the falling edge input triggers and automatically latches and drives the trigger line low. Asserts a TTL-low pulse as an output trigger.</td> </tr> <tr> <td>6 or digio.TRIG_SYNCHRONOUSA</td> <td>Detects rising edge triggers as an input. Asserts a low TTL-low pulse for output.</td> </tr> <tr> <td>7 or digio.TRIG_RISINGA</td> <td>Detects Rising Edge triggers as an input. Asserts a low TTL-low pulse as an output.</td> </tr> <tr> <td>8 or digio.TRIG_RISINGM</td> <td>Asserts a TTL-high pulse as an output trigger. Input edge detection is not available in this mode.</td> </tr> </tbody> </table> | 0 or digio.TRIG_BYPASS | Allows direct control of the line. | 1 or digio.TRIG_FALLING | Detects falling edge input triggers as input. Asserts TTL-low pulse as an output trigger. | 2 or digio.TRIG_RISING | If the programmed state of the line is high, the digio.TRIG_RISING mode behaves similar to digio.TRIG_RISINGA. If the programmed state of the line is low, the digio.TRIG_RISING mode behaves similar to digio.TRIG_RISINGM. | 3 or digio.TRIG_EITHER | Detects rising or falling edge triggers. Asserts a TTL-low trigger pulse. | 4 or digio.TRIG_SYNCHRONOUS | Detects the falling edge input triggers and automatically latches and drives the trigger line low. Asserting the output trigger releases the latched line. | 5 or digio.TRIG_SYNCHRONOUSM | Detects the falling edge input triggers and automatically latches and drives the trigger line low. Asserts a TTL-low pulse as an output trigger. | 6 or digio.TRIG_SYNCHRONOUSA | Detects rising edge triggers as an input. Asserts a low TTL-low pulse for output. | 7 or digio.TRIG_RISINGA | Detects Rising Edge triggers as an input. Asserts a low TTL-low pulse as an output. | 8 or digio.TRIG_RISINGM | Asserts a TTL-high pulse as an output trigger. Input edge detection is not available in this mode. |
| 0 or digio.TRIG_BYPASS                                                                           | Allows direct control of the line.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                        |                                    |                         |                                                                                           |                        |                                                                                                                                                                                                                              |                        |                                                                           |                             |                                                                                                                                                            |                              |                                                                                                                                                  |                              |                                                                                   |                         |                                                                                     |                         |                                                                                                    |
| 1 or digio.TRIG_FALLING                                                                          | Detects falling edge input triggers as input. Asserts TTL-low pulse as an output trigger.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                        |                                    |                         |                                                                                           |                        |                                                                                                                                                                                                                              |                        |                                                                           |                             |                                                                                                                                                            |                              |                                                                                                                                                  |                              |                                                                                   |                         |                                                                                     |                         |                                                                                                    |
| 2 or digio.TRIG_RISING                                                                           | If the programmed state of the line is high, the digio.TRIG_RISING mode behaves similar to digio.TRIG_RISINGA. If the programmed state of the line is low, the digio.TRIG_RISING mode behaves similar to digio.TRIG_RISINGM.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                    |                         |                                                                                           |                        |                                                                                                                                                                                                                              |                        |                                                                           |                             |                                                                                                                                                            |                              |                                                                                                                                                  |                              |                                                                                   |                         |                                                                                     |                         |                                                                                                    |
| 3 or digio.TRIG_EITHER                                                                           | Detects rising or falling edge triggers. Asserts a TTL-low trigger pulse.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                        |                                    |                         |                                                                                           |                        |                                                                                                                                                                                                                              |                        |                                                                           |                             |                                                                                                                                                            |                              |                                                                                                                                                  |                              |                                                                                   |                         |                                                                                     |                         |                                                                                                    |
| 4 or digio.TRIG_SYNCHRONOUS                                                                      | Detects the falling edge input triggers and automatically latches and drives the trigger line low. Asserting the output trigger releases the latched line.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                        |                                    |                         |                                                                                           |                        |                                                                                                                                                                                                                              |                        |                                                                           |                             |                                                                                                                                                            |                              |                                                                                                                                                  |                              |                                                                                   |                         |                                                                                     |                         |                                                                                                    |
| 5 or digio.TRIG_SYNCHRONOUSM                                                                     | Detects the falling edge input triggers and automatically latches and drives the trigger line low. Asserts a TTL-low pulse as an output trigger.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                        |                                    |                         |                                                                                           |                        |                                                                                                                                                                                                                              |                        |                                                                           |                             |                                                                                                                                                            |                              |                                                                                                                                                  |                              |                                                                                   |                         |                                                                                     |                         |                                                                                                    |
| 6 or digio.TRIG_SYNCHRONOUSA                                                                     | Detects rising edge triggers as an input. Asserts a low TTL-low pulse for output.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                        |                                    |                         |                                                                                           |                        |                                                                                                                                                                                                                              |                        |                                                                           |                             |                                                                                                                                                            |                              |                                                                                                                                                  |                              |                                                                                   |                         |                                                                                     |                         |                                                                                                    |
| 7 or digio.TRIG_RISINGA                                                                          | Detects Rising Edge triggers as an input. Asserts a low TTL-low pulse as an output.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                        |                                    |                         |                                                                                           |                        |                                                                                                                                                                                                                              |                        |                                                                           |                             |                                                                                                                                                            |                              |                                                                                                                                                  |                              |                                                                                   |                         |                                                                                     |                         |                                                                                                    |
| 8 or digio.TRIG_RISINGM                                                                          | Asserts a TTL-high pulse as an output trigger. Input edge detection is not available in this mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                        |                                    |                         |                                                                                           |                        |                                                                                                                                                                                                                              |                        |                                                                           |                             |                                                                                                                                                            |                              |                                                                                                                                                  |                              |                                                                                   |                         |                                                                                     |                         |                                                                                                    |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks  | <ul style="list-style-type: none"> <li>You can express the mode as a number (0 through 8) or you can use one of the pre-defined constants.</li> <li>The custom variable <code>mode</code> stores the trigger mode as a numeric value when the attribute is read.</li> <li>The default trigger mode for a line is <code>digio.TRIG_BYPASS</code>. In this mode, the line can be directly controlled as a digital I/O line. When programmed to any other mode, the output state of the I/O line is controlled by the trigger logic and the user-specified output state of the line will be ignored.</li> <li>To control the line state, use the <code>digio.TRIG_BYPASS</code> mode with the <code>digio.writebit</code> and the <code>digio.writeport</code> commands.</li> </ul> |
| Details  | See <a href="#">Triggering</a> in <a href="#">Section 10</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Also see | <a href="#">digio.writebit</a> , <a href="#">digio.writeport</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Example  | Sets the trigger mode for the I/O line 7 to <code>digio.TRIG_RISINGM</code> :<br><code>digio.trigger[7] = 8</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

|                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>digio.trigger[N].overrun</b> Replace N with the number of the digital I/O trigger line: 1 to 14 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Attribute                                                                                          | Use this attribute to read the trigger detector overrun status.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| TSP-Link accessibility                                                                             | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Usage                                                                                              | <pre>overrun = digio.trigger[n].overrun</pre><br><pre>overrun                                      The trigger overrun state.</pre> <pre>  n                                          The trigger line.</pre>                                                                                                                                                                                                                                                                                                                                                                |
| Remarks                                                                                            | <ul style="list-style-type: none"> <li>A read-only attribute.</li> <li>Indicates an event was ignored because the event detector was in the detected state when the event was detected.</li> <li>Indicates the overrun state of the event detector built into the line itself.</li> <li>It does not indicate whether an overrun occurred in any other part of the trigger model or in any other detector that is monitoring the event.</li> <li>It does not indicate output trigger overrun. Output trigger overrun indications are provided in the status model.</li> </ul> |

|                                                                                                        |                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>digio.trigger[N].pulsewidth</b> Replace N with the number of the digital I/O trigger line: 1 to 14. |                                                                                                                                                                                                                                                                                                                    |
| Attribute                                                                                              | The length of time that the trigger line will be asserted for output triggers.                                                                                                                                                                                                                                     |
| Default                                                                                                | 10e-6.                                                                                                                                                                                                                                                                                                             |
| TSP-Link accessibility                                                                                 | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                        |
| Usage                                                                                                  | <pre>width = digio.trigger[n].pulsewidth      -- Reads pulse width.</pre> <pre>digio.trigger[n].pulsewidth = width      -- Writes pulse width.</pre><br><pre>width                                      The pulse width (seconds).</pre> <pre>  n                                          The trigger line.</pre> |
| Remarks                                                                                                | <ul style="list-style-type: none"> <li>Setting pulsewidth to 0 (seconds) asserts the trigger indefinitely.</li> <li>The default pulsewidth time is 10µs.</li> </ul>                                                                                                                                                |
| Details                                                                                                | See <a href="#">Interactive triggering</a> in <a href="#">Section 10</a> .                                                                                                                                                                                                                                         |
| Also see                                                                                               | <a href="#">digio.trigger[N].release</a>                                                                                                                                                                                                                                                                           |
| Example                                                                                                | Sets the pulse width for trigger line 4 to 20µs:<br><code>digio.trigger[4].pulsewidth = 20e-6</code>                                                                                                                                                                                                               |

| <b>digio.trigger[N].release</b> <span style="float: right;">Replace N with the number of the digital I/O trigger line: 1 to 14.</span> |                                                                                                                                                                                                                   |
|----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                                                                                                                               | Releases an indefinite length or latched trigger.                                                                                                                                                                 |
| TSP-Link accessibility                                                                                                                 | This function can be accessed from a remote TSP-Link node.                                                                                                                                                        |
| Usage                                                                                                                                  | <code>digio.trigger[n].release()</code><br><br>n <span style="float: right;">The trigger line.</span>                                                                                                             |
| Remarks                                                                                                                                | <ul style="list-style-type: none"> <li>Releases a trigger that was asserted with an indefinite pulse width, as well as a trigger that was latched in response to receiving a synchronous mode trigger.</li> </ul> |
| Details                                                                                                                                | See <a href="#">Controlling digital I/O lines</a> in <a href="#">Section 8</a> .                                                                                                                                  |
| Also see                                                                                                                               | <a href="#">digio.trigger[N].pulsewidth</a>                                                                                                                                                                       |
| Example                                                                                                                                | Releases trigger line 4:<br><code>digio.trigger[4].release()</code>                                                                                                                                               |

| <b>digio.trigger[N].stimulus</b> <span style="float: right;">Replace N with the number of the digital I/O trigger line: 1 to 14.</span> |                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                                                               | Selects the event used to generate a trigger.                                                                                                                                                                                                                                                                                                                              |
| Default                                                                                                                                 | 0                                                                                                                                                                                                                                                                                                                                                                          |
| TSP-Link accessibility                                                                                                                  | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                |
| Usage                                                                                                                                   | <pre>stimulus = digio.trigger[n].stimulus    -- Reads stimulus event. digio.trigger[n].stimulus = stimulus    -- Writes stimulus event.</pre><br>n <span style="float: right;">The number of the trigger line.</span><br>stimulus <span style="float: right;">The identifier for the triggering event.</span>                                                              |
| Remarks                                                                                                                                 | <ul style="list-style-type: none"> <li>Use this attribute to select an event that triggers the digital output line.</li> <li>Set this attribute to 0 (zero) to disable automatic trigger output.</li> <li>Do not use the <code>stimulus</code> attribute for generating output triggers under script control. Use <code>digio.trigger[n].assert</code> instead.</li> </ul> |
| Also see                                                                                                                                | <a href="#">digio.trigger[N].clear</a>                                                                                                                                                                                                                                                                                                                                     |

| <b>digio.trigger[N].wait</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Replace N with the number of the digital I/O trigger line: 1 to 14. |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| Function                     | Waits for a trigger.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                     |
| TSP-Link accessibility       | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                     |
| Usage                        | <pre>triggered = digio.trigger[n].wait(timeout)</pre> <p> <code>timeout</code> Specifies the time-out value in seconds.<br/> <code>triggered</code> A customized variable that stores the value <code>true</code> if a trigger is detected or <code>false</code> if a trigger is not detected during the time-out period.<br/> <code>n</code> The number of the trigger line. </p>                                                                                                                   |                                                                     |
| Remarks                      | <ul style="list-style-type: none"> <li>This function waits up to the <code>timeout</code> value in seconds for an input trigger. If one or more trigger events are detected since the last time <code>digio.trigger[n].wait</code> or <code>digio.trigger[n].clear</code> was called, this function immediately returns. After waiting for a trigger with this function, the event detector is automatically reset and rearmed. This is true regardless of the number of events detected.</li> </ul> |                                                                     |
| Details                      | See <a href="#">Interactive triggering</a> in <a href="#">Section 10</a> .                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                     |
| Also see                     | <a href="#">digio.trigger[N].clear</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                     |
| Example                      | <p>Waits up to three seconds for a trigger to be detected on trigger line 4, then displays if the trigger was detected:</p> <pre>triggered = digio.trigger[4].wait(3) print(triggered)</pre> <p>Output:</p> <pre>false           A trigger was not detected. true            A trigger was detected.</pre>                                                                                                                                                                                           |                                                                     |

| <b>digio.writebit</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Sets a digital I/O line high or low.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Usage                  | <pre>digio.writebit(n, data)</pre> <p> <code>n</code> The digital I/O line number (1 to 14).<br/> <code>data</code> The value to write to the bit; 0 (low) or 1 (high). </p>                                                                                                                                                                                                                                                                                                                    |
| Remarks                | <ul style="list-style-type: none"> <li>If the output line is write protected, via the <a href="#">digio.writeprotect</a> attribute, the command will be ignored.</li> <li>The <code>reset</code> function does not affect the present state of the digital I/O lines.</li> <li>Use the <code>digio.writebit</code> and <code>digio.writeport</code> commands to control the output state of the synchronization line when the trigger mode is set to <code>digio.TRIG_BYPASS</code>.</li> </ul> |
| Details                | See <a href="#">Controlling digital I/O lines</a> in <a href="#">Section 8</a> .                                                                                                                                                                                                                                                                                                                                                                                                                |
| Also see               | <a href="#">digio.readbit</a> , <a href="#">digio.readport</a> , <a href="#">digio.trigger[N].mode</a>                                                                                                                                                                                                                                                                                                                                                                                          |
| Example                | <p>Sets digital I/O line 4 low (0):</p> <pre>digio.writebit(4, 0)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                         |

| <b>digio.writeport</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Writes to all digital I/O lines.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Usage                  | <code>digio.writeport(data)</code><br><br><code>data</code> Value to write to the port; 0 to 16383.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Remarks                | <ul style="list-style-type: none"> <li>The binary representation of <code>data</code> indicates the output pattern to be written to the I/O port. For example, a <code>data</code> value of 170 has a binary equivalent of 00000010101010. Lines 2, 4, 6 and 8 are set high (1), and the other 10 lines are set low (0).</li> <li>Write protected lines will not be changed (see <a href="#">digio.writeprotect</a>).</li> <li>The <code>reset</code> function does not affect the present states of the digital I/O lines.</li> <li>Use the <code>digio.writebit</code> and <code>digio.writeport</code> commands to control the output state of the synchronization line while the trigger mode is set to <code>digio.TRIG_BYPASS</code>.</li> </ul> |
| Details                | See <a href="#">Controlling digital I/O lines</a> in <a href="#">Section 8</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Also see               | <a href="#">digio.readbit</a> , <a href="#">digio.readport</a> , <a href="#">digio.writebit</a> , <a href="#">digio.writebit</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Example                | Sets digital I/O lines 1 through 8 high (binary 00000011111111):<br><code>digio.writeport(255)</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

| <b>digio.writeprotect</b> |                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                 | Write protect mask that disables bits from being changed with the <code>digio.writebit</code> and <code>digio.writeport</code> functions.                                                                                                                                                                                                                      |
| Default                   | 0                                                                                                                                                                                                                                                                                                                                                              |
| TSP-Link accessibility    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                    |
| Usage                     | <code>mask = digio.writeprotect</code> -- Reads write protect mask.<br><code>digio.writeprotect = mask</code> -- Writes write protect mask.<br><br><code>mask</code> Set to the value that specifies the bit pattern for write protect.                                                                                                                        |
| Remarks                   | <ul style="list-style-type: none"> <li>Bits that are set to 1 cause the corresponding line to be write protected.</li> <li>The binary equivalent of <code>mask</code> indicates the mask to be set for the I/O port. For example, a <code>mask</code> value of 7 has a binary equivalent 00000000000111. This mask write protects lines 1, 2 and 3.</li> </ul> |
| Details                   | See <a href="#">Controlling digital I/O lines</a> in <a href="#">Section 8</a> .                                                                                                                                                                                                                                                                               |
| Also see                  | <a href="#">digio.writebit</a> , <a href="#">digio.writeport</a> .                                                                                                                                                                                                                                                                                             |
| Example                   | Write protects lines 1, 2, 3 and 4:<br><code>digio.writeprotect = 15</code>                                                                                                                                                                                                                                                                                    |

## display

The functions and attributes in this group are used for various display operations, which are explained in [Section 11](#).

| <b>display.clear</b>   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Clears all lines of the display.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Usage                  | <code>display.clear()</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Remarks                | <ul style="list-style-type: none"> <li>This function will switch to the user screen and then clear the display.</li> <li>The <code>display.clear()</code>, <code>display.setcursor()</code>, and <code>display.settext()</code> functions are overlapped, non-blocking commands. That is, the script will NOT wait for one of these commands to complete. These non-blocking functions do not immediately update the display. For performance considerations, they write to a shadow and will update the display as soon as processing time becomes available.</li> </ul> |
| Details                | See <a href="#">Clearing the display</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Also see               | <a href="#">display.setcursor</a> , <a href="#">display.settext</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| <b>display.getannunciators</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                |             |                |                |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------|----------------|----------------|-----|----------------|------|---|---|------|---|-----|------|---|----|-----|----|-----|----|---|---|-----|----|------|------|---|---|------|----|------|-----|---|----|------|----|------|------|---|----|-----|----|------|---------|---|----|------|----|-------|------|---|-----|-----|----|-------|
| Function                       | Reads the indicators that are presently turned on.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                |             |                |                |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |
| TSP-Link accessibility         | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                |             |                |                |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |
| Usage                          | <pre>annun = display.getannunciators()</pre> <p>annun Returns the bitmap value for indicators that are active.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                |             |                |                |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |
| Remarks                        | <ul style="list-style-type: none"> <li>This function returns a bitmap value that indicates which indicators are turned on. The 16-bit binary equivalent of the returned value is the bitmap. For example, assume the returned value is 1028. The binary equivalent for this value is as follows:<br/>0000010000000100</li> <li>The above bitmap indicates that bits 3 and 11 are set. From the chart below, bit 3 and bit 11 corresponds to the indicators that are turned on (<b>4W</b> and <b>REM</b>). Notice that the sum of the weighted values for bits 3 and 11 is the returned value (1028).</li> </ul> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Annunciator</th> <th>Bit</th> <th>Weighted value</th> <th>Annunciator</th> <th>Bit</th> <th>Weighted value</th> </tr> </thead> <tbody> <tr> <td>FILT</td> <td>1</td> <td>1</td> <td>EDIT</td> <td>9</td> <td>256</td> </tr> <tr> <td>MATH</td> <td>2</td> <td>22</td> <td>ERR</td> <td>10</td> <td>512</td> </tr> <tr> <td>4W</td> <td>3</td> <td>4</td> <td>REM</td> <td>11</td> <td>1024</td> </tr> <tr> <td>AUTO</td> <td>4</td> <td>8</td> <td>TALK</td> <td>12</td> <td>2048</td> </tr> <tr> <td>ARM</td> <td>5</td> <td>16</td> <td>LSTN</td> <td>13</td> <td>4096</td> </tr> <tr> <td>TRIG</td> <td>6</td> <td>32</td> <td>SRQ</td> <td>14</td> <td>8192</td> </tr> <tr> <td>*(STAR)</td> <td>7</td> <td>64</td> <td>REAR</td> <td>15</td> <td>16384</td> </tr> <tr> <td>SMPL</td> <td>8</td> <td>128</td> <td>REL</td> <td>16</td> <td>32768</td> </tr> </tbody> </table> | Annunciator    | Bit         | Weighted value | Annunciator    | Bit | Weighted value | FILT | 1 | 1 | EDIT | 9 | 256 | MATH | 2 | 22 | ERR | 10 | 512 | 4W | 3 | 4 | REM | 11 | 1024 | AUTO | 4 | 8 | TALK | 12 | 2048 | ARM | 5 | 16 | LSTN | 13 | 4096 | TRIG | 6 | 32 | SRQ | 14 | 8192 | *(STAR) | 7 | 64 | REAR | 15 | 16384 | SMPL | 8 | 128 | REL | 16 | 32768 |
| Annunciator                    | Bit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Weighted value | Annunciator | Bit            | Weighted value |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |
| FILT                           | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1              | EDIT        | 9              | 256            |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |
| MATH                           | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 22             | ERR         | 10             | 512            |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |
| 4W                             | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 4              | REM         | 11             | 1024           |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |
| AUTO                           | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 8              | TALK        | 12             | 2048           |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |
| ARM                            | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 16             | LSTN        | 13             | 4096           |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |
| TRIG                           | 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 32             | SRQ         | 14             | 8192           |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |
| *(STAR)                        | 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 64             | REAR        | 15             | 16384          |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |
| SMPL                           | 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 128            | REL         | 16             | 32768          |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |
| Details                        | See <a href="#">Indicators</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                |             |                |                |     |                |      |   |   |      |   |     |      |   |    |     |    |     |    |   |   |     |    |      |      |   |   |      |    |      |     |   |    |      |    |      |      |   |    |     |    |      |         |   |    |      |    |       |      |   |     |     |    |       |



|         |                                                                                                                                                                                                                                                                                                                                             |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Example | <p>Reads the indicators that are turned on:</p> <pre>annun = display.getannunciators() print(annun)</pre> <p>Output: 1.280000e+03</p> <p>For the returned value of 1280, the binary equivalent is 0000010100000000. Bits 9 and 11 are set. Using the above chart in “Remarks”, the <b>REM</b> and <b>EDIT</b> indicators are turned on.</p> |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| <b>display.getcursor</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                 | Reads the present position of the cursor for the user display.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility   | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Usage                    | <pre>row, column, style = display.getcursor()</pre> <p><code>row</code> Returns the row for the present cursor position.<br/> <code>column</code> Returns the column for the present cursor position.<br/> <code>style</code> Returns the cursor style.</p>                                                                                                                                                                                                                                                                                                                                                          |
| Remarks                  | <ul style="list-style-type: none"> <li>• This function switches the display to the user screen, and then returns values to indicate row and column position, and cursor style.</li> <li>• The <code>row</code> value is returned as 1 (top row) or 2 (bottom row).</li> <li>• With the cursor in the top row, the <code>column</code> is returned as a value from 1 to 20. With the cursor in the bottom row, the <code>column</code> is returned as a value from 1 to 32. Columns are numbered from left to right on the display.</li> <li>• The returned value for style is 0 (invisible) or 1 (blink).</li> </ul> |
| Details                  | See <a href="#">Cursor position</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Also see                 | <a href="#">display.gettext</a> , <a href="#">display.screen</a> , <a href="#">display.setcursor</a> , <a href="#">display.settext</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Example                  | <p>Reads cursor position (row and column):</p> <pre>row, column = display.getcursor() print(row, column)</pre> <p>Output: 1.000000e+00 3.000000e+00</p> <p>The above output indicates that the cursor is in Row 1 at Column 3.</p>                                                                                                                                                                                                                                                                                                                                                                                   |

| <b>display.getlastkey</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                                      |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
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| Function                  | Retrieves the key code for the last pressed key.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |                                      |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| TSP-Link accessibility    | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            |                                      |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| Usage                     | <code>key = display.getlastkey()</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |                                      |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| Remarks                   | <ul style="list-style-type: none"> <li>This read-only function returns the key code for the last pressed key. <code>key</code> returns one of the following values:</li> </ul> <table border="1" data-bbox="418 554 1349 1314"> <tbody> <tr><td><b>0</b></td><td>(<code>display.KEY_NONE</code>)</td><td><b>82</b></td><td>(<code>display.KEY_ENTER</code>)</td></tr> <tr><td><b>65</b></td><td>(<code>display.KEY_RANGEUP</code>)</td><td><b>83</b></td><td>(<code>display.KEY_MEASB</code>)</td></tr> <tr><td><b>67</b></td><td>(<code>display.KEY_RELB</code>)</td><td><b>84</b></td><td>(<code>display.DIGITSB</code>)</td></tr> <tr><td><b>68</b></td><td>(<code>display.KEY_MENU</code>)</td><td><b>85</b></td><td>(<code>display.KEY_RECALL</code>)</td></tr> <tr><td><b>69</b></td><td>(<code>display.KEY_MODEA</code>)</td><td><b>86</b></td><td>(<code>display.KEY_MEASA</code>)</td></tr> <tr><td><b>70</b></td><td>(<code>display.KEY_RELA</code>)</td><td><b>87</b></td><td>(<code>display.KEY_DIGITSA</code>)</td></tr> <tr><td><b>71</b></td><td>(<code>display.KEY_RUN</code>)</td><td><b>90</b></td><td>(<code>display.KEY_LIMITB</code>)</td></tr> <tr><td><b>72</b></td><td>(<code>display.KEY_DISPLAY</code>)</td><td><b>91</b></td><td>(<code>display.KEY_SPEEDB</code>)</td></tr> <tr><td><b>73</b></td><td>(<code>display.KEY_AUTO</code>)</td><td><b>92</b></td><td>(<code>display.KEY_TRIG</code>)</td></tr> <tr><td><b>74</b></td><td>(<code>display.KEY_FILTERB</code>)</td><td><b>93</b></td><td>(<code>display.KEY_LIMITA</code>)</td></tr> <tr><td><b>75</b></td><td>(<code>display.KEY_EXIT</code>)</td><td><b>94</b></td><td>(<code>display.KEY_SPEEDA</code>)</td></tr> <tr><td><b>76</b></td><td>(<code>display.KEY_SRCB</code>)</td><td><b>95</b></td><td>(<code>display.KEY_LOAD</code>)</td></tr> <tr><td><b>77</b></td><td>(<code>display.KEY_FILTERA</code>)</td><td><b>97</b></td><td>(<code>display.WHEEL_ENTER</code>)</td></tr> <tr><td><b>78</b></td><td>(<code>display.KEY_STORE</code>)</td><td><b>103</b></td><td>(<code>display.KEY_RIGHT</code>)</td></tr> <tr><td><b>79</b></td><td>(<code>display.KEY_SRC A</code>)</td><td><b>104</b></td><td>(<code>display.KEY_LEFT</code>)</td></tr> </tbody> </table> <ul style="list-style-type: none"> <li>A history of the key code for the last pressed front panel key is maintained by the Series 2600A. When the instrument is powered-on, (or when transitioning from local to remote), the key code is set to 0 (<code>display.KEY_NONE</code>).</li> <li>The <b>OUTPUT ON/OFF</b> keys for SMU A and SMU B cannot be tracked by this function.</li> <li>Pressing the <b>EXIT/LOCAL</b> key normally aborts a script. In order to use this function with the <b>EXIT</b> key, <code>display.locallockout</code> must be used.</li> </ul> | <b>0</b>   | ( <code>display.KEY_NONE</code> )    | <b>82</b> | ( <code>display.KEY_ENTER</code> ) | <b>65</b> | ( <code>display.KEY_RANGEUP</code> ) | <b>83</b> | ( <code>display.KEY_MEASB</code> ) | <b>67</b> | ( <code>display.KEY_RELB</code> ) | <b>84</b> | ( <code>display.DIGITSB</code> ) | <b>68</b> | ( <code>display.KEY_MENU</code> ) | <b>85</b> | ( <code>display.KEY_RECALL</code> ) | <b>69</b> | ( <code>display.KEY_MODEA</code> ) | <b>86</b> | ( <code>display.KEY_MEASA</code> ) | <b>70</b> | ( <code>display.KEY_RELA</code> ) | <b>87</b> | ( <code>display.KEY_DIGITSA</code> ) | <b>71</b> | ( <code>display.KEY_RUN</code> ) | <b>90</b> | ( <code>display.KEY_LIMITB</code> ) | <b>72</b> | ( <code>display.KEY_DISPLAY</code> ) | <b>91</b> | ( <code>display.KEY_SPEEDB</code> ) | <b>73</b> | ( <code>display.KEY_AUTO</code> ) | <b>92</b> | ( <code>display.KEY_TRIG</code> ) | <b>74</b> | ( <code>display.KEY_FILTERB</code> ) | <b>93</b> | ( <code>display.KEY_LIMITA</code> ) | <b>75</b> | ( <code>display.KEY_EXIT</code> ) | <b>94</b> | ( <code>display.KEY_SPEEDA</code> ) | <b>76</b> | ( <code>display.KEY_SRCB</code> ) | <b>95</b> | ( <code>display.KEY_LOAD</code> ) | <b>77</b> | ( <code>display.KEY_FILTERA</code> ) | <b>97</b> | ( <code>display.WHEEL_ENTER</code> ) | <b>78</b> | ( <code>display.KEY_STORE</code> ) | <b>103</b> | ( <code>display.KEY_RIGHT</code> ) | <b>79</b> | ( <code>display.KEY_SRC A</code> ) | <b>104</b> | ( <code>display.KEY_LEFT</code> ) |
| <b>0</b>                  | ( <code>display.KEY_NONE</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>82</b>  | ( <code>display.KEY_ENTER</code> )   |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>65</b>                 | ( <code>display.KEY_RANGEUP</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>83</b>  | ( <code>display.KEY_MEASB</code> )   |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>67</b>                 | ( <code>display.KEY_RELB</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>84</b>  | ( <code>display.DIGITSB</code> )     |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>68</b>                 | ( <code>display.KEY_MENU</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>85</b>  | ( <code>display.KEY_RECALL</code> )  |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>69</b>                 | ( <code>display.KEY_MODEA</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>86</b>  | ( <code>display.KEY_MEASA</code> )   |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>70</b>                 | ( <code>display.KEY_RELA</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>87</b>  | ( <code>display.KEY_DIGITSA</code> ) |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>71</b>                 | ( <code>display.KEY_RUN</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>90</b>  | ( <code>display.KEY_LIMITB</code> )  |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>72</b>                 | ( <code>display.KEY_DISPLAY</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>91</b>  | ( <code>display.KEY_SPEEDB</code> )  |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>73</b>                 | ( <code>display.KEY_AUTO</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>92</b>  | ( <code>display.KEY_TRIG</code> )    |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>74</b>                 | ( <code>display.KEY_FILTERB</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>93</b>  | ( <code>display.KEY_LIMITA</code> )  |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>75</b>                 | ( <code>display.KEY_EXIT</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>94</b>  | ( <code>display.KEY_SPEEDA</code> )  |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>76</b>                 | ( <code>display.KEY_SRCB</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>95</b>  | ( <code>display.KEY_LOAD</code> )    |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>77</b>                 | ( <code>display.KEY_FILTERA</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>97</b>  | ( <code>display.WHEEL_ENTER</code> ) |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>78</b>                 | ( <code>display.KEY_STORE</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>103</b> | ( <code>display.KEY_RIGHT</code> )   |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| <b>79</b>                 | ( <code>display.KEY_SRC A</code> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>104</b> | ( <code>display.KEY_LEFT</code> )    |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| Details                   | See <a href="#">Sending key codes</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                                      |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| Also see                  | <a href="#">display.sendkey</a> , <a href="#">display.locallockout</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |                                      |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |
| Example                   | <p>On the front panel, press the <b>MENU</b> key and then send the following code:</p> <pre>key = display.getlastkey() print(key) Output: 6.800000e+01</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                                      |           |                                    |           |                                      |           |                                    |           |                                   |           |                                  |           |                                   |           |                                     |           |                                    |           |                                    |           |                                   |           |                                      |           |                                  |           |                                     |           |                                      |           |                                     |           |                                   |           |                                   |           |                                      |           |                                     |           |                                   |           |                                     |           |                                   |           |                                   |           |                                      |           |                                      |           |                                    |            |                                    |           |                                    |            |                                   |

| <b>display.gettext</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Reads the text presently displayed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Usage                  | <p>There are five ways to use this function:</p> <pre>text = display.gettext() text = display.gettext(embellished) text = display.gettext(embellished, row) text = display.gettext(embellished, row, column_start) text = display.gettext(embellished, row, column_start, column_end)</pre> <p>embellished                      Set to <code>false</code> to return text as a simple character string. Set to <code>true</code> to include all character codes.</p> <p>row                                      Set to 1 or 2 to select which row to read text. If not included, text from both rows are read.</p> <p>column_start                      Set to starting column for reading text. Default is 1.</p> <p>column_end                          Set to ending column for reading text. Default is 20 (Row 1) or 32 (Row 2).</p>                                                     |
| Remarks                | <ul style="list-style-type: none"> <li>The range of valid column numbers depends on which row is specified. For Row 1, valid column numbers are 1 to 20. For Row 2, valid column numbers are 1 to 32.</li> <li>Sending the command without any parameters returns both lines of the display. The <code>\$N</code> character code will be included to show where the top line ends and the bottom line begins.</li> <li>With <code>embellished</code> set to <code>true</code>, all other character codes will be returned along with the message. With <code>embellished</code> set to <code>false</code>, only the message and the <code>\$N</code> character code will be returned. See the <a href="#">display.settext</a> function for details on the character codes.</li> <li>The display will not be switched to the user screen. Text will be read from the active screen.</li> </ul> |
| Details                | See <a href="#">Displaying text messages</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Also see               | <a href="#">display.getcursor</a> , <a href="#">display.setcursor</a> , <a href="#">display.settext</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Example                | <p>Returns all text in both lines of the display:</p> <pre>text = display.gettext() print(text)</pre> <p>Output: User Screen            \$N</p> <p>The above output indicates that the message "User Screen" is on the top line. The bottom line is blank.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

| <b>display.inputvalue</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |                                                                                                                   |         |                                          |     |                                              |     |                                              |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------------------------------------------------------------------------------------------------------------------|---------|------------------------------------------|-----|----------------------------------------------|-----|----------------------------------------------|
| Function                  | Displays a formatted input field that the operator can edit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |                                                                                                                   |         |                                          |     |                                              |     |                                              |
| TSP-Link accessibility    | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |                                                                                                                   |         |                                          |     |                                              |     |                                              |
| Usage                     | <p>There are four ways to use this function:</p> <pre>value = display.inputvalue(format) value = display.inputvalue(format, default) value = display.inputvalue(format, default, min) value = display.inputvalue(format, default, min, max)</pre> <table border="0"> <tr> <td style="padding-right: 20px;">format</td> <td>Defines format string for the input field using 0, the decimal point (.), polarity sign (+) and 'E' for exponent.</td> </tr> <tr> <td>default</td> <td>Set the default value for the parameter.</td> </tr> <tr> <td>min</td> <td>Set the minimum input value that can be set.</td> </tr> <tr> <td>max</td> <td>Set the maximum input value that can be set.</td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | format | Defines format string for the input field using 0, the decimal point (.), polarity sign (+) and 'E' for exponent. | default | Set the default value for the parameter. | min | Set the minimum input value that can be set. | max | Set the maximum input value that can be set. |
| format                    | Defines format string for the input field using 0, the decimal point (.), polarity sign (+) and 'E' for exponent.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |                                                                                                                   |         |                                          |     |                                              |     |                                              |
| default                   | Set the default value for the parameter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |                                                                                                                   |         |                                          |     |                                              |     |                                              |
| min                       | Set the minimum input value that can be set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |                                                                                                                   |         |                                          |     |                                              |     |                                              |
| max                       | Set the maximum input value that can be set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |                                                                                                                   |         |                                          |     |                                              |     |                                              |
| Remarks                   | <ul style="list-style-type: none"> <li>Examples of the input field:<br/>+0.0000+00.0000E+000.00000E+0</li> <li><b>Value field:</b> <ul style="list-style-type: none"> <li>+ Include a "+" sign for positive/negative value entry. Not including the "+" sign prevents negative value entry.</li> <li>0 Defines the digit positions for the value. Up to six 0 can be used for the value (as shown above in the third and fourth examples).</li> </ul> </li> <li>.If used, include the decimal point (.) where needed for the value.</li> <li><b>Exponent field (optional):</b> <ul style="list-style-type: none"> <li>E Include the "E" for exponent entry.</li> <li>+ Include a "+" sign for positive/negative exponent entry. Not including the "+" sign prevents negative exponent entry.</li> <li>0 Defines the digit positions for the exponent.</li> </ul> </li> <li>Along with specifying the <code>format</code> for the input field, there are options to specify minimum and maximum limits for the input field. When NOT using the "+" sign for the value field, the minimum limit cannot be set to less than zero. When using the "+" sign, the minimum limit can set to less than zero (for example, -2).</li> <li>There is also an option to specify a default value. When this command is executed, the initially displayed value for the field will be the <code>default</code> value.</li> <li>The input value is limited to <math>\pm 1e37</math>.</li> </ul> |        |                                                                                                                   |         |                                          |     |                                              |     |                                              |
| Remarks (cont.)           | <ul style="list-style-type: none"> <li>After sending this command, script execution waits for the operator to enter a value and press <b>ENTER</b>:</li> <li>If limits are used, the operator will not be able to input values outside the minimum and maximum limits.</li> <li>For positive and negative entry ("+" sign used for the value field and/or the exponent field), polarity of a non-zero value or exponent can be toggled by positioning the cursor on the polarity sign and turning the wheel. Polarity will also toggle when using the wheel to decrease or increase the value or exponent past zero. A zero value or exponent (for example +00) is always positive and cannot be toggled to negative polarity.</li> <li>After sending this command and pressing the <b>EXIT</b> key, <code>value</code> will return <code>nil</code>.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |                                                                                                                   |         |                                          |     |                                              |     |                                              |
| Details                   | See <a href="#">Parameter value prompting</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |                                                                                                                   |         |                                          |     |                                              |     |                                              |
| Also see                  | <a href="#">display.prompt</a> , <a href="#">display.setcursor</a> , <a href="#">display.settext</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |                                                                                                                   |         |                                          |     |                                              |     |                                              |
| Example                   | <p>Displays an editable field ("0.50") for operator input – Valid input range is -0.10 to +2.00, with a default of 0.50:</p> <pre>display.clear() value = display.inputvalue("+0.00", 0.5, -0.1, 2.0)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |                                                                                                                   |         |                                          |     |                                              |     |                                              |

| <b>display.loadmenu.add</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                    | Adds an entry to the “USER TESTS” submenu of the “LOAD TEST” menu.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| TSP-Link accessibility      | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Usage                       | <p>There are two ways to use this function:</p> <pre>display.loadmenu.add(displayname, chunk) display.loadmenu.add(displayname, chunk, memory)</pre> <p>displayname                      Name to display in the menu.<br/> chunk                                Chunk is the code to be executed.<br/> memory                               Save or don't save chunk and displayname in nonvolatile memory.</p> <p>Set memory to one of the following values:<br/> 0 or display.DONT_SAVE<br/> 1 or display.SAVE<br/> The default memory setting is display.SAVE.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Remarks                     | <ul style="list-style-type: none"> <li>This function adds an entry to the “USER TESTS” submenu of the “LOAD TEST” menu. If the given item is subsequently selected via the front panel, the chunk will be executed when the <b>RUN</b> key is pressed.</li> <li>The chunk can be made up of scripts, functions, variables, and commands. With memory set to display.SAVE, commands are saved with the chunk in nonvolatile memory. Scripts, functions and variables used in the chunk are not saved by display.SAVE. Functions and variables need to be saved along with the script (see <a href="#">Loading and saving a user script</a> in <a href="#">Section 11</a>). If the script is not saved in nonvolatile memory, it will be lost when the Series 2600A is turned off. See <b>Example 1</b> below.</li> <li>It does not matter what order the menu items are added. They will be displayed in alphabetical order when the “USER TESTS” menu is selected.</li> </ul>                                                                                                                                                                                                                                                                                 |
| Details                     | See <a href="#">Load test menu</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Also see                    | <a href="#">display.loadmenu.delete</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Examples                    | <p><b>Example 1:</b> Assume a script with a function named “DUT1” has already been loaded into the Series 2600A, and the script has NOT been saved in nonvolatile memory. Now assume you want to add a test named “Test” to the USER TESTS menu. You want the test to run the function named “DUT1” and sound the beeper. The following command will add “Test” to the menu, define the chunk, and then save displayname and chunk in nonvolatile memory:</p> <pre>display.loadmenu.add("Test", "DUT1() beeper.beeper(2, 500)", display.SAVE)</pre> <p>When “Test” is run from the front panel USER TESTS menu, the function named “DUT1” will execute and the beeper will beep for two seconds.</p> <p>Now assume you cycle power on the Series 2600A. Since the script was not saved in nonvolatile memory, the function named “DUT1” is lost. When “Test” is again run from the front panel, the beeper will beep, but “DUT1” will not execute because it no longer exists in the chunk.</p> <p><b>Example 2:</b> Adds entry called “Part1” to the front panel “USER TESTS” load menu for the chunk “testpart([[Part1]], 5.0)”, and saves it in nonvolatile memory:</p> <pre>display.loadmenu.add("Part1", "testpart([[Part1]], 5.0)", display.SAVE)</pre> |

| <b>display.loadmenu.catalog</b> |                                                                                                                                                                                                                                                       |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                        | Creates an iterator for the loadmenu catalog.                                                                                                                                                                                                         |
| TSP-Link accessibility          | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                         |
| Usage                           | <pre>for displayname, chunk in display.loadmenu.catalog() do ... end</pre> <p>displayname                      The name displayed in the LOAD menu.<br/> chunk                                The value of the chunk associated with displayname.</p> |
| Remarks                         | <ul style="list-style-type: none"> <li>Function is used to iterate over all the entries in the display LOAD menu.</li> <li>Each time through the loop displayname and chunk will take on the values in the LOAD menu.</li> </ul>                      |
| Details                         | See <a href="#">Load test menu</a> in <a href="#">Section 11</a> .                                                                                                                                                                                    |
| Also see                        | <a href="#">display.loadmenu.add</a>                                                                                                                                                                                                                  |

| <b>display.loadmenu.delete</b> |                                                                                                                                                                         |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                       | Deletes an entry from the "USER" submenu of the "LOAD TEST" menu.                                                                                                       |
| TSP-Link accessibility         | This function can be accessed from a remote TSP-Link node.                                                                                                              |
| Usage                          | <pre>display.loadmenu.delete(displayname)</pre> <p>displayname                      Name to remove from the menu.</p>                                                   |
| Remarks                        | <ul style="list-style-type: none"> <li>This function is used to delete an entry (displayname) from the front panel USER TESTS submenu of the LOAD TEST menu.</li> </ul> |
| Details                        | See <a href="#">Load test menu</a> in <a href="#">Section 11</a> .                                                                                                      |
| Also see                       | <a href="#">display.loadmenu.add</a>                                                                                                                                    |
| Example                        | Removes the entry named "Part1" from the front panel "USER TESTS" load menu:<br><pre>display.loadmenu.delete("Part1")</pre>                                             |

| <b>display.locallockout</b> |                                                                                                                                                                                                                                                                                                        |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                   | <b>LOCAL</b> key disabled.                                                                                                                                                                                                                                                                             |
| Default                     | display.UNLOCK                                                                                                                                                                                                                                                                                         |
| TSP-Link accessibility      | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                            |
| Usage                       | <pre>lockout = display.locallockout    -- Reads state of lockout. display.locallockout = lockout    -- Writes state of lockout.</pre> <p>Set lockout to one of the following values:<br/> 0 or display.UNLOCK    Unlocks <b>LOCAL</b> key.<br/> 1 or display.LOCK      Locks out <b>LOCAL</b> key.</p> |
| Remarks                     | <ul style="list-style-type: none"> <li>Setting display.locallockout to display.LOCK prevents the user from interrupting remote operation by pressing the <b>LOCAL</b> key. Set this attribute to display.UNLOCK to allow the <b>LOCAL</b> key to abort script/remote operation.</li> </ul>             |
| Details                     | See <a href="#">LOCAL lockout</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                      |

|         |                                                                                                |
|---------|------------------------------------------------------------------------------------------------|
| Example | Disables the front panel <b>LOCAL</b> key:<br><code>display.locallockout = display.LOCK</code> |
|---------|------------------------------------------------------------------------------------------------|

| <b>display.menu</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Presents a menu on the front panel display.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Usage                  | <code>selection = display.menu(name, items)</code><br><br>name                                   Menu name to display on the top line.<br>items                                   Menu items to display on the bottom line.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Remarks                | <ul style="list-style-type: none"> <li>The menu consists of the menu <code>name</code> string on the top line, and a selectable list of <code>items</code> on the bottom line. The menu items must be a single string with each item separated by white space. The name for the top line is limited to 20 characters.</li> <li>After sending this command, script execution waits for the operator to select a menu item. An item is selected by rotating the wheel (or using the cursor keys) to place the blinking cursor on the item, and then pressing the wheel (or <b>ENTER</b> key). When an item is selected, the text of that selection is returned.</li> <li>Pressing the <b>EXIT</b> key will not abort the script while the menu is displayed, but it will return <code>nil</code>. The script can be aborted by calling the <code>exit</code> function when <code>nil</code> is returned.</li> </ul> |
| Details                | See <a href="#">Menu</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Example                | Displays a menu with three menu items. If the second menu item is selected, <code>selection</code> will be given the value <code>Test2</code> :<br><code>selection = display.menu("Sample Menu", "Test1 Test2 Test3")</code><br><code>print(selection)</code><br>Output: Test2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| <b>display.numpad</b>  |                                                                                                                                                                                                                                                                                                                                        |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | This attribute controls whether the front panel keys act as a numeric keypad during value entry.                                                                                                                                                                                                                                       |
| Default                | <code>display.ENABLE</code>                                                                                                                                                                                                                                                                                                            |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                            |
| Usage                  | <code>X = display.numpad            -- Read the numpad option.</code><br><code>display.numpad = X            -- Write the numpad option.</code><br><br>Where <code>X</code> is one of:<br>1 or <code>display.ENABLE</code> Enable the numeric keypad feature.<br>0 or <code>display.DISABLE</code> Disable the numeric keypad feature. |
| Remarks                | <ul style="list-style-type: none"> <li>The numeric keypad feature is only available when editing a numeric value and the EDIT indicator is lit.</li> </ul>                                                                                                                                                                             |
| Example                | Turn on the numeric keypad feature:<br><code>display.numpad = 1</code>                                                                                                                                                                                                                                                                 |

| <b>display.prompt</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |                                                                                                                  |       |                                                            |      |                                                                    |         |                                          |     |                                              |     |                                              |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------------------------------------------------------------------------------------------------|-------|------------------------------------------------------------|------|--------------------------------------------------------------------|---------|------------------------------------------|-----|----------------------------------------------|-----|----------------------------------------------|
| Function               | Prompts the user to enter a parameter from the front panel.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |                                                                                                                  |       |                                                            |      |                                                                    |         |                                          |     |                                              |     |                                              |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |                                                                                                                  |       |                                                            |      |                                                                    |         |                                          |     |                                              |     |                                              |
| Usage                  | <p>There are four ways to use this function:</p> <pre>value = display.prompt(format, units, help) value = display.prompt(format, units, help, default) value = display.prompt(format, units, help, default, min) value = display.prompt(format, units, help, default, min, max)</pre> <table border="0"> <tr> <td style="padding-right: 20px;">format</td> <td>Define format string for the input field using 0, the decimal point (.), polarity sign (+) and 'E' for exponent.</td> </tr> <tr> <td>units</td> <td>Set units text string for top line (8 characters maximum).</td> </tr> <tr> <td>help</td> <td>Text string to display on the bottom line (32 characters maximum).</td> </tr> <tr> <td>default</td> <td>Set the default value for the parameter.</td> </tr> <tr> <td>min</td> <td>Set the minimum input value that can be set.</td> </tr> <tr> <td>max</td> <td>Set the maximum input value that can be set.</td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | format | Define format string for the input field using 0, the decimal point (.), polarity sign (+) and 'E' for exponent. | units | Set units text string for top line (8 characters maximum). | help | Text string to display on the bottom line (32 characters maximum). | default | Set the default value for the parameter. | min | Set the minimum input value that can be set. | max | Set the maximum input value that can be set. |
| format                 | Define format string for the input field using 0, the decimal point (.), polarity sign (+) and 'E' for exponent.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |                                                                                                                  |       |                                                            |      |                                                                    |         |                                          |     |                                              |     |                                              |
| units                  | Set units text string for top line (8 characters maximum).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |                                                                                                                  |       |                                                            |      |                                                                    |         |                                          |     |                                              |     |                                              |
| help                   | Text string to display on the bottom line (32 characters maximum).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |                                                                                                                  |       |                                                            |      |                                                                    |         |                                          |     |                                              |     |                                              |
| default                | Set the default value for the parameter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |                                                                                                                  |       |                                                            |      |                                                                    |         |                                          |     |                                              |     |                                              |
| min                    | Set the minimum input value that can be set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |                                                                                                                  |       |                                                            |      |                                                                    |         |                                          |     |                                              |     |                                              |
| max                    | Set the maximum input value that can be set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |                                                                                                                  |       |                                                            |      |                                                                    |         |                                          |     |                                              |     |                                              |
| Remarks                | <ul style="list-style-type: none"> <li>• This function will create an editable input field at the present cursor position, and an input prompt message on the bottom line. Example of a displayed input field and prompt:<br/>0.00V<br/>Input 0 to +2V</li> <li>• The <code>format</code> configures the editable input field. Four examples for the format:<br/>+0.0000+00.0000E+000.0000E+0</li> <li>• <b>Value field:</b> <ul style="list-style-type: none"> <li>• + Include a "+" sign for positive/negative value entry. Not including the "+" sign prevents negative value entry.</li> <li>• 0 Defines the digit positions for the value. Up to six 0 can be used for the value (as shown above in the third and fourth examples).</li> <li>• If used, include the decimal point (.) where needed for the value.</li> </ul> </li> <li>• <b>Exponent field (optional):</b> <ul style="list-style-type: none"> <li>• E Include the "E" for exponent entry.</li> <li>• + Include a "+" sign for positive/negative exponent entry. Not including the "+" sign prevents negative exponent entry.</li> <li>• 0 Defines the digit positions for the exponent.</li> </ul> </li> <li>• <code>units</code> is a string that indicates the units (for example, "V" or "A") for the value and <code>help</code> provides a message prompt on the bottom line.</li> <li>• Along with specifying the <code>format</code> for the input field, there are options to specify minimum and maximum limits for the input field. When NOT using the "+" sign for the value field, the minimum limit cannot be set to less than zero. When using the "+" sign, the minimum limit can set to less than zero (for example, -2).</li> <li>• There is also an option to specify a default value. When this command is executed, the initially displayed value for the field will be the <code>default</code> value.</li> <li>• The input value is limited to <math>\pm 1e37</math>.</li> <li>• After sending this command, script execution holds and waits for the operator to enter a value and press <b>ENTER</b>.</li> <li>• If limits are used, the operator will not be able to input values outside the minimum and maximum limits.</li> <li>• For positive and negative entry ("+" sign used for the value field and/or the exponent field), polarity of a non-zero value or exponent can be toggled by positioning the cursor on the polarity sign and turning the wheel. Polarity will also toggle when using the wheel to decrease or increase the value or exponent past zero. A zero value or exponent (for example +00) is always positive and cannot be toggled to negative polarity.</li> <li>• After sending this command and pressing the <b>EXIT</b> key, <code>value</code> will return <code>nil</code>.</li> </ul> |        |                                                                                                                  |       |                                                            |      |                                                                    |         |                                          |     |                                              |     |                                              |
| Details                | See <a href="#">Parameter value prompting</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |                                                                                                                  |       |                                                            |      |                                                                    |         |                                          |     |                                              |     |                                              |
| Also see               | <a href="#">display.inputvalue</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |                                                                                                                  |       |                                                            |      |                                                                    |         |                                          |     |                                              |     |                                              |



|         |                                                                                                                                                                                                                                                                                            |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Example | <p>Prompts the operator to enter a voltage value – Valid input range is 0 to +2.00, with a default of 0.50:</p> <pre>value = display.prompt("0.00", "V", "Input 0 to +2V", 0.5, 0, 2)</pre> <p>The above command will display the following input prompt:<br/>0.50V<br/>Input 0 to +2V</p> |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| <b>display.screen</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                |                                                   |                                |                                                   |                                     |                                              |                                |                           |
|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------------------------------------------------|--------------------------------|---------------------------------------------------|-------------------------------------|----------------------------------------------|--------------------------------|---------------------------|
| Attribute                           | The selected display screen.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                |                                                   |                                |                                                   |                                     |                                              |                                |                           |
| Default                             | display.SMUA (2601A/2611A/2635A)<br>display.SMUA_SMUB (2602A/2612A/2636A)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                |                                                   |                                |                                                   |                                     |                                              |                                |                           |
| TSP-Link accessibility              | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                |                                                   |                                |                                                   |                                     |                                              |                                |                           |
| Usage                               | <pre>displayid = display.screen -- Reads display screen.</pre> <pre>display.screen = displayid -- Writes display screen.</pre> <p>Set <code>displayid</code> to one of the following values:</p> <table> <tr> <td>0 or <code>display.SMUA</code></td> <td>Displays source-measure and compliance for SMU A.</td> </tr> <tr> <td>1 or <code>display.SMUB</code></td> <td>Displays source-measure and compliance for SMU B.</td> </tr> <tr> <td>2 or <code>display.SMUA_SMUB</code></td> <td>Displays source-measure for SMU A and SMU B.</td> </tr> <tr> <td>3 or <code>display.USER</code></td> <td>Displays the user screen.</td> </tr> </table> | 0 or <code>display.SMUA</code> | Displays source-measure and compliance for SMU A. | 1 or <code>display.SMUB</code> | Displays source-measure and compliance for SMU B. | 2 or <code>display.SMUA_SMUB</code> | Displays source-measure for SMU A and SMU B. | 3 or <code>display.USER</code> | Displays the user screen. |
| 0 or <code>display.SMUA</code>      | Displays source-measure and compliance for SMU A.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                |                                                   |                                |                                                   |                                     |                                              |                                |                           |
| 1 or <code>display.SMUB</code>      | Displays source-measure and compliance for SMU B.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                |                                                   |                                |                                                   |                                     |                                              |                                |                           |
| 2 or <code>display.SMUA_SMUB</code> | Displays source-measure for SMU A and SMU B.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                |                                                   |                                |                                                   |                                     |                                              |                                |                           |
| 3 or <code>display.USER</code>      | Displays the user screen.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                |                                                   |                                |                                                   |                                     |                                              |                                |                           |
| Remarks                             | <ul style="list-style-type: none"> <li>Setting this attribute selects the display screen for the front panel. This attribute can be read to determine which of the four available display screens was last selected by the user. The user can select the screen by value or one of the enumerations.</li> </ul>                                                                                                                                                                                                                                                                                                                                   |                                |                                                   |                                |                                                   |                                     |                                              |                                |                           |
| Details                             | See <a href="#">Display screen</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                |                                                   |                                |                                                   |                                     |                                              |                                |                           |
| Example                             | <p>Selects the source-measure and compliance limit display for SMUA:</p> <pre>display.screen = display.SMUA</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                |                                                   |                                |                                                   |                                     |                                              |                                |                           |

| <b>display.sendkey</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |                                    |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------------------------------|----|----------------------------------|-----------|---------------------------------|----|----------------------------------|-----------|----------------------------------|----|------------------------------------|-----------|----------------------------------|----|----------------------------------|-----------|----------------------------------|----|---------------------------------|-----------|--------------------------------|----|-------------------------------|-----------|-------------------------------|----|-------------------------------|-----------|----------------------------------|-----|--------------------------------|-----------|----------------------------------|----|------------------------------|------------|-------------------------------|----|---------------------------------|-----------|---------------------------------|----|---------------------------------|-----------|---------------------------------|----|-------------------------------|-----------|-------------------------------|----|-------------------------------|-----------|--------------------------------|----|--------------------------------|-----------|--------------------------------|----|-------------------------------|-----------|-------------------------------|----|----------------------------------|
| Function               | Sends a key code to simulate the action of a front panel control.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |                                    |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                                    |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| Usage                  | <p><code>display.sendkey(keycode)</code></p> <p>Set <i>keycode</i> to one of the values shown below:</p> <table border="1"> <tbody> <tr> <td><b>73</b></td> <td><code>display.KEY_AUTO</code></td> <td>88</td> <td><code>display.KEY_OUTPUTA</code></td> </tr> <tr> <td><b>80</b></td> <td><code>display.KEY_CONFIG</code></td> <td>96</td> <td><code>display.KEY_OUTPUTB</code></td> </tr> <tr> <td><b>87</b></td> <td><code>display.KEY_DIGITSA</code></td> <td>81</td> <td><code>display.KEY_RANGEDOWN</code></td> </tr> <tr> <td><b>84</b></td> <td><code>display.KEY_DIGITSB</code></td> <td>65</td> <td><code>display.KEY_RANGEUP</code></td> </tr> <tr> <td><b>72</b></td> <td><code>display.KEY_DISPLAY</code></td> <td>85</td> <td><code>display.KEY_RECALL</code></td> </tr> <tr> <td><b>82</b></td> <td><code>display.KEY_ENTER</code></td> <td>70</td> <td><code>display.KEY_RELA</code></td> </tr> <tr> <td><b>75</b></td> <td><code>display.KEY_EXIT</code></td> <td>67</td> <td><code>display.KEY_RELB</code></td> </tr> <tr> <td><b>77</b></td> <td><code>display.KEY_FILTERA</code></td> <td>103</td> <td><code>display.KEY_RIGHT</code></td> </tr> <tr> <td><b>74</b></td> <td><code>display.KEY_FILTERB</code></td> <td>71</td> <td><code>display.KEY_RUN</code></td> </tr> <tr> <td><b>104</b></td> <td><code>display.KEY_LEFT</code></td> <td>94</td> <td><code>display.KEY_SPEEDA</code></td> </tr> <tr> <td><b>93</b></td> <td><code>display.KEY_LIMITA</code></td> <td>91</td> <td><code>display.KEY_SPEEDB</code></td> </tr> <tr> <td><b>90</b></td> <td><code>display.KEY_LIMITB</code></td> <td>79</td> <td><code>display.KEY_SRCA</code></td> </tr> <tr> <td><b>95</b></td> <td><code>display.KEY_LOAD</code></td> <td>76</td> <td><code>display.KEY_SRCB</code></td> </tr> <tr> <td><b>86</b></td> <td><code>display.KEY_MEASA</code></td> <td>78</td> <td><code>display.KEY_STORE</code></td> </tr> <tr> <td><b>83</b></td> <td><code>display.KEY_MEASB</code></td> <td>92</td> <td><code>display.KEY_TRIG</code></td> </tr> <tr> <td><b>99</b></td> <td><code>display.KEY_MENU</code></td> <td>97</td> <td><code>display.WHEEL_ENTER</code></td> </tr> </tbody> </table> | <b>73</b> | <code>display.KEY_AUTO</code>      | 88 | <code>display.KEY_OUTPUTA</code> | <b>80</b> | <code>display.KEY_CONFIG</code> | 96 | <code>display.KEY_OUTPUTB</code> | <b>87</b> | <code>display.KEY_DIGITSA</code> | 81 | <code>display.KEY_RANGEDOWN</code> | <b>84</b> | <code>display.KEY_DIGITSB</code> | 65 | <code>display.KEY_RANGEUP</code> | <b>72</b> | <code>display.KEY_DISPLAY</code> | 85 | <code>display.KEY_RECALL</code> | <b>82</b> | <code>display.KEY_ENTER</code> | 70 | <code>display.KEY_RELA</code> | <b>75</b> | <code>display.KEY_EXIT</code> | 67 | <code>display.KEY_RELB</code> | <b>77</b> | <code>display.KEY_FILTERA</code> | 103 | <code>display.KEY_RIGHT</code> | <b>74</b> | <code>display.KEY_FILTERB</code> | 71 | <code>display.KEY_RUN</code> | <b>104</b> | <code>display.KEY_LEFT</code> | 94 | <code>display.KEY_SPEEDA</code> | <b>93</b> | <code>display.KEY_LIMITA</code> | 91 | <code>display.KEY_SPEEDB</code> | <b>90</b> | <code>display.KEY_LIMITB</code> | 79 | <code>display.KEY_SRCA</code> | <b>95</b> | <code>display.KEY_LOAD</code> | 76 | <code>display.KEY_SRCB</code> | <b>86</b> | <code>display.KEY_MEASA</code> | 78 | <code>display.KEY_STORE</code> | <b>83</b> | <code>display.KEY_MEASB</code> | 92 | <code>display.KEY_TRIG</code> | <b>99</b> | <code>display.KEY_MENU</code> | 97 | <code>display.WHEEL_ENTER</code> |
| <b>73</b>              | <code>display.KEY_AUTO</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 88        | <code>display.KEY_OUTPUTA</code>   |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>80</b>              | <code>display.KEY_CONFIG</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 96        | <code>display.KEY_OUTPUTB</code>   |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>87</b>              | <code>display.KEY_DIGITSA</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 81        | <code>display.KEY_RANGEDOWN</code> |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>84</b>              | <code>display.KEY_DIGITSB</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 65        | <code>display.KEY_RANGEUP</code>   |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>72</b>              | <code>display.KEY_DISPLAY</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 85        | <code>display.KEY_RECALL</code>    |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>82</b>              | <code>display.KEY_ENTER</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 70        | <code>display.KEY_RELA</code>      |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>75</b>              | <code>display.KEY_EXIT</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 67        | <code>display.KEY_RELB</code>      |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>77</b>              | <code>display.KEY_FILTERA</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 103       | <code>display.KEY_RIGHT</code>     |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>74</b>              | <code>display.KEY_FILTERB</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 71        | <code>display.KEY_RUN</code>       |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>104</b>             | <code>display.KEY_LEFT</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 94        | <code>display.KEY_SPEEDA</code>    |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>93</b>              | <code>display.KEY_LIMITA</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 91        | <code>display.KEY_SPEEDB</code>    |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>90</b>              | <code>display.KEY_LIMITB</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 79        | <code>display.KEY_SRCA</code>      |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>95</b>              | <code>display.KEY_LOAD</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 76        | <code>display.KEY_SRCB</code>      |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>86</b>              | <code>display.KEY_MEASA</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 78        | <code>display.KEY_STORE</code>     |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>83</b>              | <code>display.KEY_MEASB</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 92        | <code>display.KEY_TRIG</code>      |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| <b>99</b>              | <code>display.KEY_MENU</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 97        | <code>display.WHEEL_ENTER</code>   |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| Remarks                | <ul style="list-style-type: none"> <li>Sending this command simulates the pressing of a front panel key or wheel, or turning the navigation wheel one click to the left or right.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                    |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| Details                | See <a href="#">Sending key codes</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                    |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |
| Example                | To simulate pressing the <b>RUN</b> key:<br><code>display.sendkey(display.KEY_RUN)</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |                                    |    |                                  |           |                                 |    |                                  |           |                                  |    |                                    |           |                                  |    |                                  |           |                                  |    |                                 |           |                                |    |                               |           |                               |    |                               |           |                                  |     |                                |           |                                  |    |                              |            |                               |    |                                 |           |                                 |    |                                 |           |                                 |    |                               |           |                               |    |                               |           |                                |    |                                |           |                                |    |                               |           |                               |    |                                  |

| <b>display.setcursor</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                 | Sets the position of the cursor.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| TSP-Link accessibility   | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Usage                    | <p>There are two ways to use this function:</p> <pre>display.setcursor(row, column) display.setcursor(row, column, style)</pre> <p><code>row</code>                               Set <code>row</code> number for the cursor (1 or 2).<br/> <code>column</code>                             Set <code>column</code> number for the cursor. For row 1, <code>column</code> can be set from 1 to 20. For row 2, it can be set from 1 to 32.<br/> <code>style</code>                               Set cursor <code>style</code> to be invisible (0) or blink (1).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Remarks                  | <ul style="list-style-type: none"> <li>• Sending this command selects the user screen and then moves the cursor to the given location.</li> <li>• An out of range parameter for <code>row</code> will set the cursor to row 2. An out of range parameter for <code>column</code> will set the cursor to column 20 (for row 1) or 32 (for row 2).</li> <li>• An out of range parameter for <code>style</code> sets it to 0 (invisible).</li> <li>• A blinking cursor will only be visible when it is positioned over displayed text. It cannot be seen when positioned over a space character.</li> <li>• The <code>display.clear</code>, <code>display.setcursor</code>, and <code>display.settext</code> functions are overlapped, non-blocking commands. That is, the script will NOT wait for one of these commands to complete. These non-blocking functions do not immediately update the display. For performance considerations, they write to a shadow and will update the display as soon as processing time becomes available.</li> </ul> |
| Details                  | See <a href="#">Sending key codes</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Also see                 | <a href="#">display.clear</a> , <a href="#">display.getcursor</a> , <a href="#">display.gettext</a> , <a href="#">display.settext</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Example                  | Positions cursor on row 2 column 1:<br><pre>display.setcursor(2, 1)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| <b>display.settext</b> |                                                                                                                              |
|------------------------|------------------------------------------------------------------------------------------------------------------------------|
| Function               | Displays text on the user screen.                                                                                            |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                   |
| Usage                  | <pre>display.settext(text)</pre> <p><code>text</code>                               Text message string to be displayed.</p> |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks  | <ul style="list-style-type: none"> <li>This function selects the user display screen, and displays the given text. The first write to the display after power on will clear the user screen.</li> <li>The text starts at the present cursor position. After the text is displayed, the cursor will be located after the last character in the display message.</li> <li>The text remains on the display until replaced or cleared.</li> <li>The following character codes can be also be included in the <code>text</code> string: <ul style="list-style-type: none"> <li><code>\$N</code>Newline – Starts text on the next line. If the cursor is already on line 2, text will be ignored after the '<code>\$N</code>' is received.</li> <li><code>\$R</code>Sets text to Normal.</li> <li><code>\$B</code> Sets text to Blink.</li> <li><code>\$D</code>Sets text to Dim intensity.</li> <li><code>\$F</code>Sets text to background blink.</li> <li><code>\$\$</code>Escape sequence to display a single "\$".</li> </ul> </li> <li>The <code>display.clear</code>, <code>display.setcursor</code>, and <code>display.settext</code> functions are overlapped, non-blocking commands. That is, the script will NOT wait for one of these commands to complete. These non-blocking functions do not immediately update the display. For performance considerations, they write to a shadow and will update the display as soon as processing time becomes available.</li> </ul> |
| Details  | See <a href="#">Displaying text messages</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Also see | <a href="#">display.clear</a> , <a href="#">display.getcursor</a> , <a href="#">display.gettext</a> , <a href="#">display.setcursor</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Example  | Displays a message on the user screen:<br><pre>display.clear() display.settext("Message Test \$N\$B with Row 2 Blinking")</pre> The top line displays "Message Test" and the bottom line displays the blinking message "with Row 2 Blinking".                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

| <b>display.smuX.digits</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                      |                                  |                                      |                                  |                                      |                                  |
|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------------------------------|--------------------------------------|----------------------------------|--------------------------------------|----------------------------------|
| Attribute                                                                              | The selected measurement display resolution.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                      |                                  |                                      |                                  |                                      |                                  |
| Default                                                                                | <code>display.DIGITS_5_5</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                      |                                  |                                      |                                  |                                      |                                  |
| TSP-Link accessibility                                                                 | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                      |                                  |                                      |                                  |                                      |                                  |
| Usage                                                                                  | <pre>digits = display.smuX.digits      -- Reads resolution. display.smuX.digits = digits      -- Writes resolution.</pre> <p>Set <code>digits</code> to one of the following values:</p> <table style="width: 100%; border: none;"> <tr> <td style="padding-right: 20px;">4 or <code>display.DIGITS_4_5</code></td> <td>Selects 4-1/2d digit resolution.</td> </tr> <tr> <td style="padding-right: 20px;">5 or <code>display.DIGITS_5_5</code></td> <td>Selects 5-1/2d digit resolution.</td> </tr> <tr> <td style="padding-right: 20px;">6 or <code>display.DIGITS_6_5</code></td> <td>Selects 6-1/2d digit resolution.</td> </tr> </table> | 4 or <code>display.DIGITS_4_5</code> | Selects 4-1/2d digit resolution. | 5 or <code>display.DIGITS_5_5</code> | Selects 5-1/2d digit resolution. | 6 or <code>display.DIGITS_6_5</code> | Selects 6-1/2d digit resolution. |
| 4 or <code>display.DIGITS_4_5</code>                                                   | Selects 4-1/2d digit resolution.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                      |                                  |                                      |                                  |                                      |                                  |
| 5 or <code>display.DIGITS_5_5</code>                                                   | Selects 5-1/2d digit resolution.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                      |                                  |                                      |                                  |                                      |                                  |
| 6 or <code>display.DIGITS_6_5</code>                                                   | Selects 6-1/2d digit resolution.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                      |                                  |                                      |                                  |                                      |                                  |
| Remarks                                                                                | <ul style="list-style-type: none"> <li>This attribute selects the measurement display resolution; 4-1/2 digit, 5-1/2 digit or 6-1/2 digit.</li> <li>SMU A and SMU B can be set for a different measurement display resolution.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                    |                                      |                                  |                                      |                                  |                                      |                                  |
| Details                                                                                | See <a href="#">Display resolution</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                      |                                  |                                      |                                  |                                      |                                  |
| Example                                                                                | Selects 5-1/2d digit resolution for SMU A:<br><pre>display.smua.digits = display.DIGITS_5_5</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                      |                                  |                                      |                                  |                                      |                                  |

| <b>display.smuX.measure.func</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                             |
|----------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| Attribute                                                                                    | The type of measurement being displayed.                    |
| Default                                                                                      | <code>display.MEASURE_DCVOLTS</code>                        |
| TSP-Link accessibility                                                                       | This attribute can be accessed from a remote TSP-Link node. |

|         |                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Usage   | <pre>func = display.smuX.measure.func -- Reads function. display.smuX.measure.func = func -- Writes function.</pre> <p>Set func to one of the following values:</p> <pre>0 or display.MEASURE_DCAMPS   Selects current measure function. 1 or display.MEASURE_DCVOLTS  Selects volts measure function. 2 or display.MEASURE_OHMS     Selects ohms measure function. 3 or display.MEASURE_WATTS    Selects power measure function.</pre> |
| Remarks | <ul style="list-style-type: none"> <li>• Selects the displayed measurement function: amps, volts, ohms, or watts.</li> <li>• SMU A and SMU B can be set for different measurement functions.</li> </ul>                                                                                                                                                                                                                                 |
| Details | See <a href="#">Measurement functions</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                               |
| Example | Selects the current measure function for SMU A:<br><pre>display.smuA.measure.func = display.MEASURE_DCAMPS</pre>                                                                                                                                                                                                                                                                                                                        |

| <b>display.trigger.clear</b> |                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                     | Clears the front panel trigger event detector.                                                                                                                                                                                                                                                                                                                                          |
| TSP-Link accessibility       | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                              |
| Usage                        | <code>display.trigger.clear()</code>                                                                                                                                                                                                                                                                                                                                                    |
| Remarks                      | <ul style="list-style-type: none"> <li>• The trigger event detector remembers if an event has been detected since the last <code>display.trigger.wait</code> call. This function clears the trigger's event detector and discards the previous history of <b>TRIG</b> key presses.</li> <li>• This attribute also clears the <code>display.trigger.overrun</code> attribute.</li> </ul> |
| Also see                     | <a href="#">display.trigger.wait</a> , <a href="#">display.trigger.overrun</a>                                                                                                                                                                                                                                                                                                          |

| <b>display.trigger.EVENT_ID</b> |                                                                                                                                                                                    |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                       | The trigger event number.                                                                                                                                                          |
| TSP-Link accessibility          | This attribute can be accessed from a remote TSP-Link node.                                                                                                                        |
| Usage                           | <pre>event_id = display.trigger.EVENT_ID</pre> <p style="text-align: center;"><code>event_id</code>                      The trigger event number.</p>                             |
| Remarks                         | <ul style="list-style-type: none"> <li>• Set the stimulus of any trigger event detector to the value of this constant to have it respond to front panel trigger events.</li> </ul> |

| <b>display.trigger.overrun</b> |                                                                                                                                                      |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                      | The event detector overrun status.                                                                                                                   |
| TSP-Link accessibility         | This attribute can be accessed from a remote TSP-Link node.                                                                                          |
| Usage                          | <pre>overrun = display.trigger.overrun</pre> <p style="text-align: center;"><code>overrun</code>                      The trigger overrun state.</p> |

|         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>• This attribute is a read-only attribute that indicates if a trigger event was ignored because the event detector was already in the detected state when the <b>TRIG</b> button was pressed.</li> <li>• Indicates the overrun state of the event detector built into the display.</li> <li>• It does not indicate whether an overrun occurred in any other part of the trigger model or in any other detector that is monitoring the event.</li> </ul> |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| <b>display.trigger.wait</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                    | Waits for the <b>TRIG</b> key on the front panel to be pressed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility      | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Usage                       | <pre>triggered = display.trigger.wait(timeout)</pre> <p>                     timeout                                      Timeout in seconds.<br/>                     triggered                                      Returns a true if a trigger was detected. Returns false if the operation timed out.                 </p>                                                                                                                                                                                                                        |
| Remarks                     | <ul style="list-style-type: none"> <li>• This function will wait for the <b>TRIG</b> key on the front panel to be pressed. If the trigger key was previously pressed and one or more trigger events were detected, this function will return immediately.</li> <li>• After waiting for a trigger with this function, the event detector will be automatically reset and rearmed. This is true regardless of the number of events detected.</li> <li>• Use the <code>display.trigger.clear</code> call to clear the trigger event detector.</li> </ul> |
| Also see                    | <a href="#">display.trigger.clear</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Example                     | Waits up to five seconds for the <b>TRIG</b> key to be pressed:<br><pre>triggered = display.trigger.wait(5) print(triggered)</pre> Output: true<br>The above output indicates that the <b>TRIG</b> key was pressed (trigger detected) before the five second timeout expired.                                                                                                                                                                                                                                                                         |

| <b>display.waitkey</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |              |          |               |          |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
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| Function               | Captures the key code value for the next key press.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |              |          |               |          |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |          |               |          |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| Usage                  | <pre>key = display.waitkey()</pre> <p>key                                  The key code.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |          |               |          |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| Remarks                | <ul style="list-style-type: none"> <li>After sending this function, script execution will hold up until a front panel key or the wheel is pressed, or the wheel is turned. After pressing a control or turning the wheel, the key code value for that key will be returned. The chart shown below lists the key code value for each front panel control. The controls are listed alphabetically.</li> <li>If the <b>EXIT</b> key is pressed while this function is waiting for a keystroke, the script will not be aborted.</li> <li>A typical use for this function is to prompt the user to press <b>EXIT</b> to abort the script or press any other key to continue. If key code value 75 is returned (<b>EXIT</b> key pressed), then the <code>exit()</code> function can be called to abort the script. Sample code for this process is provided in <a href="#">Capturing key-press codes</a> in <a href="#">Section 11</a>.</li> </ul> <table border="1" data-bbox="393 905 1261 1514"> <thead> <tr> <th>Control</th> <th>Key code</th> <th>Control</th> <th>Key code</th> <th>Control</th> <th>Key code</th> </tr> </thead> <tbody> <tr> <td>AUTO</td> <td>73</td> <td>LIMIT (B)</td> <td>90</td> <td>REL (A)</td> <td>70</td> </tr> <tr> <td>CONFIG</td> <td>80</td> <td>LOAD</td> <td>95</td> <td>REL (B)</td> <td>67</td> </tr> <tr> <td>CURSOR (left)</td> <td>401</td> <td>MEAS (A)</td> <td>86</td> <td>RUN</td> <td>71</td> </tr> <tr> <td>CURSOR (right)</td> <td>103</td> <td>MEAS (B)</td> <td>83</td> <td>SPEED (A)</td> <td>94</td> </tr> <tr> <td>DIGITS (A)</td> <td>87</td> <td>MENU</td> <td>68</td> <td>SPEED (B)</td> <td>91</td> </tr> <tr> <td>DIGITS (B)</td> <td>84</td> <td>MODE (A)</td> <td>69</td> <td>SRC (A)</td> <td>79</td> </tr> <tr> <td>DISPLAY</td> <td>72</td> <td>MODE (B)</td> <td>66</td> <td>SRC (B)</td> <td>76</td> </tr> <tr> <td>ENTER</td> <td>82</td> <td>OUTPUT (A)</td> <td>88</td> <td>STORE</td> <td>78</td> </tr> <tr> <td>EXIT</td> <td>75</td> <td>OUTPUT (B)</td> <td>96</td> <td>TRIG</td> <td>92</td> </tr> <tr> <td>FILTER (A)</td> <td>77</td> <td>RANGE (down)</td> <td>84</td> <td>WHEEL (press)</td> <td>97</td> </tr> <tr> <td>FILTER (B)</td> <td>74</td> <td>RANGE (up)</td> <td>65</td> <td>WHEEL (left)</td> <td>107</td> </tr> <tr> <td>LIMIT (A)</td> <td>93</td> <td>RECALL</td> <td>85</td> <td>WHEEL (right)</td> <td>114</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>The above chart lists the numeric key code values for the front panel controls. The key code value identifiers are listed in the documentation for <a href="#">display.sendkey</a> (for example, <code>display.KEY_RUN</code> is the identifier for the <b>RUN</b> key).</li> </ul> | Control      | Key code | Control       | Key code | Control | Key code | AUTO | 73 | LIMIT (B) | 90 | REL (A) | 70 | CONFIG | 80 | LOAD | 95 | REL (B) | 67 | CURSOR (left) | 401 | MEAS (A) | 86 | RUN | 71 | CURSOR (right) | 103 | MEAS (B) | 83 | SPEED (A) | 94 | DIGITS (A) | 87 | MENU | 68 | SPEED (B) | 91 | DIGITS (B) | 84 | MODE (A) | 69 | SRC (A) | 79 | DISPLAY | 72 | MODE (B) | 66 | SRC (B) | 76 | ENTER | 82 | OUTPUT (A) | 88 | STORE | 78 | EXIT | 75 | OUTPUT (B) | 96 | TRIG | 92 | FILTER (A) | 77 | RANGE (down) | 84 | WHEEL (press) | 97 | FILTER (B) | 74 | RANGE (up) | 65 | WHEEL (left) | 107 | LIMIT (A) | 93 | RECALL | 85 | WHEEL (right) | 114 |
| Control                | Key code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Control      | Key code | Control       | Key code |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| AUTO                   | 73                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | LIMIT (B)    | 90       | REL (A)       | 70       |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| CONFIG                 | 80                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | LOAD         | 95       | REL (B)       | 67       |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| CURSOR (left)          | 401                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | MEAS (A)     | 86       | RUN           | 71       |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| CURSOR (right)         | 103                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | MEAS (B)     | 83       | SPEED (A)     | 94       |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| DIGITS (A)             | 87                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | MENU         | 68       | SPEED (B)     | 91       |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| DIGITS (B)             | 84                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | MODE (A)     | 69       | SRC (A)       | 79       |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| DISPLAY                | 72                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | MODE (B)     | 66       | SRC (B)       | 76       |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| ENTER                  | 82                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | OUTPUT (A)   | 88       | STORE         | 78       |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| EXIT                   | 75                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | OUTPUT (B)   | 96       | TRIG          | 92       |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| FILTER (A)             | 77                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | RANGE (down) | 84       | WHEEL (press) | 97       |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| FILTER (B)             | 74                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | RANGE (up)   | 65       | WHEEL (left)  | 107      |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| LIMIT (A)              | 93                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | RECALL       | 85       | WHEEL (right) | 114      |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| Details                | See <a href="#">Capturing key-press codes</a> in <a href="#">Section 11</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |          |               |          |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| Also see               | <a href="#">display.sendkey</a> , <a href="#">display.settext</a> , <a href="#">display.getlastkey</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |              |          |               |          |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |
| Example                | <p>The following code will hold up script execution and wait for the operator to press a key or the wheel, or rotate the wheel:</p> <pre>key = display.waitkey() print(key)</pre> <p>Output: 8.600000e+01</p> <p>The above output (86) indicates that the <b>MEAS (A)</b> key was pressed.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |              |          |               |          |         |          |      |    |           |    |         |    |        |    |      |    |         |    |               |     |          |    |     |    |                |     |          |    |           |    |            |    |      |    |           |    |            |    |          |    |         |    |         |    |          |    |         |    |       |    |            |    |       |    |      |    |            |    |      |    |            |    |              |    |               |    |            |    |            |    |              |     |           |    |        |    |               |     |

## errorqueue

The functions and attribute in this group are used to read the entries in the error/event queue.

| <b>errorqueue.clear</b> |                                                                                                                 |
|-------------------------|-----------------------------------------------------------------------------------------------------------------|
| Function                | Clears all entries out of the error/event queue.                                                                |
| TSP-Link accessibility  | This function can be accessed from a remote TSP-Link node.                                                      |
| Usage                   | <code>errorqueue.clear()</code>                                                                                 |
| Remarks                 | <ul style="list-style-type: none"> <li>This function removes all entries from the error/event queue.</li> </ul> |
| Details                 | See <a href="#">Appendix A</a> (Error and Status Messages) and <a href="#">Appendix C</a> (Status Model).       |
| Also see                | <a href="#">errorqueue.count</a> , <a href="#">errorqueue.next</a>                                              |

| <b>errorqueue.count</b> |                                                                                                                                                                                                                                                                                                                                 |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute               | The number of entries in the error/event queue.                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility  | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                     |
| Usage                   | <pre>count = errorqueue.count</pre> <p><code>count</code>                                The number of entries in the error queue.</p>                                                                                                                                                                                          |
| Remarks                 | <ul style="list-style-type: none"> <li>This attribute can be read to determine the number of messages in the error/event queue.</li> <li>This attribute is a variable to receive the number of entries in the error queue.</li> <li>This is a read-only attribute. Writing to this attribute will generate an error.</li> </ul> |
| Details                 | See <a href="#">Appendix A</a> (Error and Status Messages) and <a href="#">Appendix C</a> (Status Model).                                                                                                                                                                                                                       |
| Also see                | <a href="#">errorqueue.clear</a> , <a href="#">errorqueue.next</a>                                                                                                                                                                                                                                                              |
| Example                 | Reads number of entries in the error/event queue:<br><pre>count = errorqueue.count print(count)</pre> Output:<br>4.000000e+00<br>The above output indicates that there are four entries in the event/error queue.                                                                                                               |

| <b>errorqueue.next</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Reads an entry from the error/event queue.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Usage                  | <pre>errorcode, message, severity, node = errorqueue.next()</pre> <p><code>errorcode</code>                                Returns the error code number for the entry.<br/> <code>message</code>                                    Returns the message that describes the entry.<br/> <code>severity</code>                                  Returns the severity level (0, 10, 20, 30 or 40).<br/> <code>node</code>                                        Returns the node number where the error originated.</p> |



|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks  | <ul style="list-style-type: none"> <li>• Entries are stored in a first-in, first-out (FIFO) queue. This function reads the oldest entry and removes it from the queue.</li> <li>• Error codes and messages are listed in <a href="#">Table A-2</a> in <a href="#">Appendix A</a>.</li> <li>• If there are no entries in the queue, code 0, “Queue Is Empty” is returned.</li> <li>• Returned <i>severity</i> levels include the following: <ul style="list-style-type: none"> <li>• <b>0 Informational:</b> Indicates no error: “Queue is Empty”.</li> <li>• <b>10 Informational:</b> Indicates an event or a minor error. Examples: “Reading Available” and “Reading Overflow”.</li> <li>• <b>20 Recoverable:</b> Indicates possible invalid user input. Operation will continue but action should be taken to correct the error. Examples: “Exponent Too Large” and “Numeric Data Not Allowed”.</li> <li>• <b>30 Serious:</b> Indicates a serious error and may require technical assistance. Example: “Saved calibration constants corrupted”.</li> <li>• <b>40 Fatal:</b> Indicates that the Series 2600A is non-operational and will require service. Contact information for service is provided in <a href="#">Section 1</a>. Examples: “Bad SMU AFPGA image size”, “SMU is unresponsive”, and “Communication Timeout with DFPGA”.</li> </ul> </li> <li>• In an expanded system, each TSP-Link enabled instrument is assigned a node number. <i>node</i> returns the node number where the error originated.</li> </ul> |
| Details  | See <a href="#">Appendix A</a> (Error and Status Messages) and <a href="#">Appendix C</a> (Status Model).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Also see | <a href="#">errorqueue.clear</a> , <a href="#">errorqueue.count</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Example  | <p>Reads the oldest entry in the error/event queue:</p> <pre>errorcode, message = errorqueue.next() print(errorcode, message)</pre> <p>Output: 0.000000e+00 Queue Is Empty</p> <p>The above output indicates that the queue is empty.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

## event log

You can use the event log to view specific details about LAN triggering events.

| <b>eventlog.all</b>    |                                                                                                                                                                                                                                                           |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Returns all entries from the event log as a single string and then clears the event log.                                                                                                                                                                  |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                |
| Usage                  | <pre>logstring = eventlog.all()</pre><br><br><pre>logstring</pre> The returned string that includes all entries.                                                                                                                                          |
| Remarks                | Clears the event log after returning all entries as a single string.                                                                                                                                                                                      |
| Example                | <pre>print(eventlog.all())</pre><br>Output:<br><pre>17:26:35.690 10 Oct 2007, LAN0, 192.168.1.102, LXI, 0, 1192037132, 1192037155.733269000, 0, 0x0 17:26:39.009 10 Oct 2007, LAN5, 192.168.1.102, LXI, 0, 1192037133, 1192037159.052777000, 0, 0x0</pre> |

| <b>eventlog.clear</b>  |                                                                         |
|------------------------|-------------------------------------------------------------------------|
| Function               | Removes all entries from the event log.                                 |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.              |
| Usage                  | <pre>eventlog.clear()</pre>                                             |
| Remarks                | <ul style="list-style-type: none"> <li>Clears the event log.</li> </ul> |
| Example                | <pre>eventlog.clear()</pre>                                             |

| <b>eventlog.count</b>  |                                                                                                                                                                   |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | Indicates the number of entries in the event log.                                                                                                                 |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                       |
| Usage                  | <pre>count = eventlog.count -- Reads the count. eventlog.count = count -- Writes the count.</pre><br><br><pre>count</pre> The number of entries in the event log. |
| Remarks                | <ul style="list-style-type: none"> <li>Indicates the number of entries in the event log.</li> </ul>                                                               |
| Example                | <pre>print(eventlog.count)</pre><br>Output:<br><pre>3.000000000e+000</pre>                                                                                        |

| <b>eventlog.enable</b> |                                                                                                                                                                                                                                                                                                |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | The enabled or disabled status of the event log.                                                                                                                                                                                                                                               |
| Default                | eventlog.ENABLE                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                    |
| Usage                  | <pre>enable = eventlog.enable    -- Reads event log status. eventlog.enable = enable    -- Writes event log status.</pre> <p>Set <code>enable</code> to one of the following values:</p> <pre>1 or eventlog.ENABLE      Event log enabled. 0 or eventlog.DISABLE     Event log disabled.</pre> |
| Remarks                | <ul style="list-style-type: none"> <li>When the event log is disabled, no new events will be logged, but existing events may be read and removed.</li> <li>When the event log is enabled, new events will be logged.</li> </ul>                                                                |
| Example                | <code>eventlog.enable = 0</code>                                                                                                                                                                                                                                                               |

| <b>eventlog.next</b>   |                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Returns the next entry from the event log and removes it from the log.                                                                                                                                                                                                                                                                                                                                                         |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                     |
| Usage                  | <pre>logstring = eventlog.next()</pre> <p><code>logstring</code>                      The next log entry.</p>                                                                                                                                                                                                                                                                                                                  |
| Remarks                | <ul style="list-style-type: none"> <li>Returns the next entry from the event log and removes it from the log.</li> <li>If there are no entries in the event log, returns the value <code>nil</code>.</li> </ul>                                                                                                                                                                                                                |
| Example                | <pre>print(eventlog.next()) Output: 17:28:22.085 10 Oct 2007, LAN2, 192.168.1.102, LXI, 0, 1192037134, &lt;no time&gt;, 0, 0x0  print(eventlog.next()) Output: 17:28:25.549 10 Oct 2007, LAN6, 192.168.1.102, LXI, 0, 1192037135, &lt;no time&gt;, 0, 0x0  print(eventlog.next()) Output: 17:28:31.563 10 Oct 2007, LAN4, 192.168.1.102, LXI, 0, 1192037136, &lt;no time&gt;, 0, 0x0  print(eventlog.next()) Output: nil</pre> |

| <b>eventlog.overwritemethod</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                       | Indicates whether new entries will be logged and old entries deleted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Default                         | <code>eventlog.DISCARD_OLDEST</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| TSP-Link accessibility          | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Usage                           | <pre>method = eventlog.overwritemethod      -- Reads overwrite method. eventlog.overwritemethod = method      -- Writes overwrite method.</pre> <p><code>method</code>                                      The overwrite setting.</p> <p>Set <code>method</code> to one of the following values:</p> <ul style="list-style-type: none"> <li>0 or <code>DISCARD_NEWEST</code>                      New entries will not be logged.</li> <li>1 or <code>DISCARD_OLDEST</code>                      Old entries will be deleted as new events are logged.</li> </ul> |
| Remarks                         | <ul style="list-style-type: none"> <li>• Controls how the event log processes new events if the event log is full.</li> <li>• When this attribute is set to <code>eventlog.DISCARD_NEWEST</code>, new entries will be not be logged.</li> <li>• When this attribute is set to <code>eventlog.DISCARD_OLDEST</code>, the oldest entry is discarded when a new entry is added.</li> </ul>                                                                                                                                                                            |
| Example                         | Configure the event log to ignore new entries when the log is full:<br><code>eventlog.overwritemethod = 0</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

## exit

This function is used to terminate a script that is presently running.

| <b>exit</b>            |                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Stops execution of a script.                                                                                                                                                                                                                                                                                                                                        |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                       |
| Usage                  | <code>exit()</code>                                                                                                                                                                                                                                                                                                                                                 |
| Remarks                | <ul style="list-style-type: none"> <li>• Terminates script execution when called from a script that is being executed. This command will not wait for overlapped commands to complete before terminating script execution. If overlapped commands are required to finish, use the <code>waitcomplete</code> function prior to calling <code>exit</code>.</li> </ul> |
| Also see               | <a href="#">System behavior, Abort</a> in <a href="#">Section 14</a> .                                                                                                                                                                                                                                                                                              |

## file I/O

You can use the file I/O commands to open, close, write data, or to read a file.

| <b>file:close</b>      |                                                                                                                                                                                                                     |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Closes a file.                                                                                                                                                                                                      |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                       |
| Usage                  | <pre>file:close()</pre> <p><code>file</code>                                              The file descriptor to close.</p>                                                                                         |
| Remarks                | <ul style="list-style-type: none"> <li>• This command is equivalent to <code>io.close(file)</code>.</li> <li>• Note that files are automatically closed when the file descriptors are garbage collected.</li> </ul> |
| Also see               | <a href="#">file:write</a>                                                                                                                                                                                          |

| <b>file:flush</b>      |                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Writes buffered data to a file.                                                                                                                                                                                                                                                                                                                                                      |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                        |
| Usage                  | <code>file:flush()</code><br><br><div style="display: flex; justify-content: space-between;"> <span><code>file</code></span> <span>The file descriptor to flush.</span> </div>                                                                                                                                                                                                       |
| Remarks                | <ul style="list-style-type: none"> <li>The <code>file:write</code> function will buffer data but it may not be written to the USB drive immediately, in which case the buffered data will be written when the file is closed (using the <code>file:close</code> command). To force the buffered data to be written before closing the file, call <code>file:flush</code>.</li> </ul> |
| Also see               | <a href="#">file:write</a>                                                                                                                                                                                                                                                                                                                                                           |

| <b>file:read</b>       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Reads data from a file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Usage                  | <pre>data1 = file:read() data1 = file:read(format1) data1, data2 = file:read(format1, format2) data1, ..., datan = file:read(format1, ..., formatn)</pre> <div style="display: flex; justify-content: space-between;"> <div style="width: 15%;"> <p><code>data1</code></p> <p><code>data2</code></p> <p><code>datan</code></p> <p><code>file</code></p> <p><code>format1</code></p> <p><code>format2</code></p> <p><code>formatn</code></p> </div> <div style="width: 85%;"> <p>The data read from the file.</p> <p>The data read from the file.</p> <p>The data read from the file. The number of return values matches the number of format values provided.</p> <p>The descriptor of the file to be read.</p> <p>A string or number indicating the type of data to be read.</p> <p>A string or number indicating the type of data to be read.</p> <p>A string or number indicating the type of data to be read.</p> </div> </div>                                                                  |
| Remarks                | <ul style="list-style-type: none"> <li>The format parameters may be any of the following: <ul style="list-style-type: none"> <li><code>"*n"</code>: Returns a number.</li> <li><code>"*a"</code>: Returns the whole file, starting at the current position (returns an empty string if the current file position is at the end of the file).</li> <li><code>"*l"</code>: Returns the next line, skipping the end of line; returns <code>nil</code> if the current file position is at the end of file.</li> <li><code>n</code>: Returns a string with up to <code>n</code> characters; returns an empty string if <code>n</code> is zero; returns <code>nil</code> if the current file position is at the end of file.</li> </ul> </li> <li>If no format parameters are provided, the function will perform as if the function is passed the value <code>"*l"</code>.</li> <li>Any number of format parameters may be passed to this command, each corresponding to a returned data value.</li> </ul> |

| <b>file:seek</b>       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Sets and retrieves a file's current position.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Usage                  | <pre>position, errmsg = file:seek() position, errmsg = file:seek(whence) position, errmsg = file:seek(whence, offset)</pre> <p>                     position                      The new file position, measured in bytes from the beginning of the file.<br/>                     errmsg                          Indicates whether an error was encountered while processing the function.<br/>                     file                              The descriptor of the file.<br/>                     whence                          A string indicating the base against which offset is applied. Default is "cur".<br/>                     offset                            The intended new position, measured in bytes from a base indicated by whence. Default is 0.                 </p> |
| Remarks                | <ul style="list-style-type: none"> <li>The whence parameter may be any of the following:<br/>                             "set": beginning of file<br/>                             "cur": current position<br/>                             "end": end of file</li> <li>If an error is encountered, the command returns nil and the error string.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| <b>file:write</b>      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Writes data to a file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Usage                  | <pre>file:write(data1) file:write(data1, data2) file:write(data1, ..., datan)</pre> <p>                     data1                              The data to be written.<br/>                     data2                              The data to be written.<br/>                     datan                              The data written to the file. The number of data items written matches the number of values given.<br/>                     file                                The descriptor of the file to be written.                 </p> |
| Remarks                | <ul style="list-style-type: none"> <li>An arbitrary number of data values may be passed to this command.</li> <li>You must use strings or numbers as parameters.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                           |

## format

The format attributes are used to configure the output formats used by the `print`, `printnumber`, and `printbuffer` functions. These attributes are used to set the data format (ASCII or binary), ASCII precision (number of digits) and binary byte order (normal or swapped).

| <b>format.asciiprecision</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                    | The precision (number of digits) for all numbers printed with the ASCII format.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Default                      | 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| TSP-Link accessibility       | This attribute cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Usage                        | <pre>precision = format.asciiprecision -- Reads precision. format.asciiprecision = precision -- Writes precision.</pre> <p style="text-align: center;">precision                      Set from 1 to 16.</p>                                                                                                                                                                                                                                                                                                                                                                                              |
| Remarks                      | <ul style="list-style-type: none"> <li>This attribute selects the precision (number of digits) for data printed with the <code>print</code>, <code>printnumber</code> and <code>printbuffer</code> functions. The precision attribute is only used with the ASCII format. The precision must be a number between 1 and 16.</li> <li>Note that the precision is the number of significant digits printed. There will always be one digit to the left of the decimal point. Be sure to include this digit when setting the precision.</li> <li>The default (<code>reset</code>) precision is 6.</li> </ul> |
| Also see                     | <a href="#">format.byteorder</a> , <a href="#">format.data</a> , <a href="#">printbuffer</a> , <a href="#">printnumber</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Example                      | Sets the ASCII precision to 7 digits and prints a number:<br><pre>format.asciiprecision = 7 print(2.5) Output: 2.500000E+00</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| <b>format.byteorder</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                 |                              |                                    |                              |                                  |                              |                                  |                               |                                       |                               |
|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|------------------------------|------------------------------------|------------------------------|----------------------------------|------------------------------|----------------------------------|-------------------------------|---------------------------------------|-------------------------------|
| Attribute                             | The binary byte order for data printed using the <code>printnumber</code> and <code>printbuffer</code> functions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                 |                              |                                    |                              |                                  |                              |                                  |                               |                                       |                               |
| Default                               | <code>format.SWAPPED</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                 |                              |                                    |                              |                                  |                              |                                  |                               |                                       |                               |
| TSP-Link accessibility                | This attribute cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                 |                              |                                    |                              |                                  |                              |                                  |                               |                                       |                               |
| Usage                                 | <pre>order = format.byteorder -- Reads byte order. format.byteorder = order -- Writes byte order.</pre> <p>Set order to one of the following values:</p> <table style="width: 100%; border: none;"> <tr> <td style="padding-right: 20px;">0 or <code>format.NORMAL</code></td> <td>Most significant byte first.</td> </tr> <tr> <td>0 or <code>format.BIGENDIAN</code></td> <td>Most significant byte first.</td> </tr> <tr> <td>0 or <code>format.NETWORK</code></td> <td>Most significant byte first.</td> </tr> <tr> <td>1 or <code>format.SWAPPED</code></td> <td>Least significant byte first.</td> </tr> <tr> <td>1 or <code>format.LITTLEENDIAN</code></td> <td>Least significant byte first.</td> </tr> </table>                                                                 | 0 or <code>format.NORMAL</code> | Most significant byte first. | 0 or <code>format.BIGENDIAN</code> | Most significant byte first. | 0 or <code>format.NETWORK</code> | Most significant byte first. | 1 or <code>format.SWAPPED</code> | Least significant byte first. | 1 or <code>format.LITTLEENDIAN</code> | Least significant byte first. |
| 0 or <code>format.NORMAL</code>       | Most significant byte first.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                 |                              |                                    |                              |                                  |                              |                                  |                               |                                       |                               |
| 0 or <code>format.BIGENDIAN</code>    | Most significant byte first.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                 |                              |                                    |                              |                                  |                              |                                  |                               |                                       |                               |
| 0 or <code>format.NETWORK</code>      | Most significant byte first.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                 |                              |                                    |                              |                                  |                              |                                  |                               |                                       |                               |
| 1 or <code>format.SWAPPED</code>      | Least significant byte first.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                 |                              |                                    |                              |                                  |                              |                                  |                               |                                       |                               |
| 1 or <code>format.LITTLEENDIAN</code> | Least significant byte first.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                 |                              |                                    |                              |                                  |                              |                                  |                               |                                       |                               |
| Remarks                               | <ul style="list-style-type: none"> <li>This attribute selects the byte order that data is written when printing data values with the <code>printnumber</code> and the <code>printbuffer</code> functions. The byte order attribute is only used with the <code>SREAL</code>, <code>REAL</code>, <code>REAL32</code>, and <code>REAL64</code> data formats.</li> <li><code>NORMAL</code>, <code>BIGENDIAN</code>, and <code>NETWORK</code> select the same byte order. <code>SWAPPED</code> and <code>LITTLEENDIAN</code> select the same byte order. They are alternative identifiers. Selecting which to use is a matter of preference.</li> <li>Select the <code>SWAPPED</code> or <code>LITTLEENDIAN</code> byte order when sending data to an IBM PC compatible computer.</li> </ul> |                                 |                              |                                    |                              |                                  |                              |                                  |                               |                                       |                               |
| Also see                              | <a href="#">format.asciiprecision</a> , <a href="#">format.data</a> , <a href="#">printbuffer</a> , <a href="#">printnumber</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                 |                              |                                    |                              |                                  |                              |                                  |                               |                                       |                               |
| Example                               | Selects the <code>SWAPPED</code> byte order:<br><pre>format.byteorder = format.SWAPPED</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                 |                              |                                    |                              |                                  |                              |                                  |                               |                                       |                               |

| <b>format.data</b>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | The data format for data printed using the <code>printnumber</code> and <code>printbuffer</code> functions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Default                | <code>format.ASCII</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| TSP-Link accessibility | This attribute cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Usage                  | <pre>fmt = format.data          -- Reads data format. format.data = fmt         -- Writes data format.  Set fmt to one of the following values: 1 or format.ASCII        ASCII format. 2 or format.SREAL        Single precision IEEE-754 binary format. 2 or format.REAL32       Single precision IEEE-754 binary format. 3 or format.REAL         Double precision IEEE-754 binary format. 3 or format.REAL64       Double precision IEEE-754 binary format.</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Remarks                | <ul style="list-style-type: none"> <li>This attribute selects the data format used to print data values with the <code>printnumber</code> and <code>printbuffer</code> functions.</li> <li>The precision of the ASCII format can be controlled with the <code>format.asciiprecision</code> attribute. The byte order of SREAL, REAL, REAL32, and REAL64 can be selected with the <code>format.byteorder</code> attribute.</li> <li>REAL32 and SREAL select the same single precision format. REAL and REAL64 select the same double precision format. They are alternative identifiers. Selecting which to use is a matter of preference.</li> <li>The IEEE-754 binary formats use 4 bytes each for single precision values and 8 bytes each for double precision values.</li> <li>When data is written with any of the binary formats, the response message will start with "#0" and end with a new line. When data is written with the ASCII format, elements will be separated with a comma and space.</li> </ul> |
| Also see               | <a href="#">format.asciiprecision</a> , <a href="#">format.byteorder</a> , <a href="#">printbuffer</a> , <a href="#">printnumber</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Example                | Selects the ASCII data format:<br><code>format.data = format.ASCII</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

## file system

You can use the file system functions to access files saved on the USB flash drive. A compatible non-Keithley application may be required to navigate in the file system or to view a list the files available.

These commands interact as an fs logical instrument on the TSP Platform to share a file system from any node over the entire TSP-Link network.

To allow for future enhancements, the root folder of the USB memory stick has the absolute path `"/usb1/"`. Both the forward slash (/) and backslash (\) are supported as directory separators.

| <b>fs.chdir</b>        |                                                                                                                                                              |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Sets the current working directory.                                                                                                                          |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                   |
| Usage                  | <pre>fs.chdir(path)  path</pre> <p>The path of the new working directory. This path may be either absolute or relative to the current working directory.</p> |
| Remarks                | <ul style="list-style-type: none"> <li>An error is logged to the error queue if the given path does not exist.</li> </ul>                                    |



| <b>fs.cwd</b>          |                                                                                                                                                                                                         |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Returns the absolute path of the current working directory.                                                                                                                                             |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                              |
| Usage                  | <code>path = fs.cwd()</code><br><br><div style="display: flex; justify-content: space-between;"> <span><code>path</code></span> <span>The absolute path of the current working directory.</span> </div> |
| Remarks                | <ul style="list-style-type: none"> <li>This function returns the absolute path of the current working directory.</li> </ul>                                                                             |

| <b>fs.is_dir</b>       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Tests whether the specified path refers to a directory.                                                                                                                                                                                                                                                                                                                                                                                                         |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                      |
| Usage                  | <code>status = fs.is_dir(path)</code><br><br><div style="display: flex; justify-content: space-between;"> <span><code>status</code></span> <span>True if the given path is a directory, otherwise it is false.</span> </div> <div style="display: flex; justify-content: space-between;"> <span><code>path</code></span> <span>The path of the file system entry to test. This path may be absolute or relative to the current working directory.</span> </div> |
| Remarks                | <ul style="list-style-type: none"> <li>An error is logged to the error queue if the given path does not exist.</li> </ul>                                                                                                                                                                                                                                                                                                                                       |

| <b>fs.is_file</b>      |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Performs a test to determine if the absolute path refers to a file on the USB flash drive.                                                                                                                                                                                                                                                                                                                                                                  |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                  |
| Usage                  | <code>status = fs.is_file(path)</code><br><br><div style="display: flex; justify-content: space-between;"> <span><code>status</code></span> <span>True if the given path is a file, otherwise it is false.</span> </div> <div style="display: flex; justify-content: space-between;"> <span><code>path</code></span> <span>The path of the file system entry to test. This path may be absolute or relative to the current working directory.</span> </div> |
| Remarks                | <ul style="list-style-type: none"> <li>An error is logged to the error queue if the given path does not exist.</li> </ul>                                                                                                                                                                                                                                                                                                                                   |

| <b>fs.mkdir</b>        |                                                                                                                                                                                                                                                           |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Creates a directory at the specified path.                                                                                                                                                                                                                |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                |
| Usage                  | <code>fs.mkdir(path)</code><br><br><div style="display: flex; justify-content: space-between;"> <span><code>path</code></span> <span>The path of the new directory. This path may be absolute or relative to the current working directory.</span> </div> |

|         |                                                                                                                                                                                                               |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>An error is logged to the error queue if the parent folder of the new directory does not exist, or if a file system entry already exists at the given path.</li> </ul> |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                        |                                                                                                                                                                                                                                                                                                                          |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>fs.readdir</b>      |                                                                                                                                                                                                                                                                                                                          |
| Function               | Returns a list of the file system entries in the directory.                                                                                                                                                                                                                                                              |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                               |
| Usage                  | <pre>files = fs.readdir(path)</pre> <p>files                                    A table containing the names of all the file system entries in the specified directory.</p> <p>path                                      The directory path. This path may be absolute or relative to the current working directory.</p> |
| Remarks                | <ul style="list-style-type: none"> <li>This command is non-recursive. For example, entries in subfolders are not returned.</li> <li>An error is logged to the error queue if the given path does not exist, or does not represent a directory.</li> </ul>                                                                |

|                        |                                                                                                                                                                                                |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>fs.rmdir</b>        |                                                                                                                                                                                                |
| Function               | Removes a directory from the file system.                                                                                                                                                      |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                     |
| Usage                  | <pre>fs.rmdir(path)</pre> <p>path                                      The path of the directory to remove. This path may be absolute or relative to the current working directory.</p>        |
| Remarks                | <ul style="list-style-type: none"> <li>An error is logged to the error queue if the given path does not exist, or does not represent a directory, or if the directory is not empty.</li> </ul> |

## gpib

The following attribute is used to set the GPIB address.

| <b>gpib.address</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | GPIB address.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Default                | 26                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Usage                  | <pre>address = gpib.address      -- Reads address. gpib.address = address      -- Writes address.</pre> <p>address                      Set from 0 to 30.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Remarks                | <ul style="list-style-type: none"> <li>• A new GPIB address takes effect when the command is processed. If there are response messages in the output queue when this command is processed they must be read at the new address.</li> <li>• The user should allow ample time for the command to be processed before attempting to communicate with the instrument again. After sending this command, make sure to use the new address to communicate with the instrument.</li> <li>• The GPIB address is stored in nonvolatile memory. The <code>reset</code> function has no effect on the address.</li> </ul> |
| Details                | See <a href="#">GPIB operation</a> in <a href="#">Section 15</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Example                | Sets the GPIB address of the Series 2600A to 26 and then reads the address: <pre>gpib.address = 26 address = gpib.address print (address) Output: 2.600000e+01</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## io

| <b>io.close</b>        |                                                                                                                                                                                             |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Closes a file.                                                                                                                                                                              |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                  |
| Usage                  | <pre>io.close() io.close(file)</pre> <p>file                              The descriptor of the file to close.</p>                                                                          |
| Remarks                | <ul style="list-style-type: none"> <li>• If a file is not specified, the default output file closes.</li> <li>• Only <code>io.close()</code> can be accessed from a remote node.</li> </ul> |

| <b>io.flush</b>        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Saves buffered data to a file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Usage                  | <code>io.flush()</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Remarks                | <ul style="list-style-type: none"> <li>It is important to note that you must use the <code>io.flush</code> or <code>io.close()</code> commands to write data to the file system.</li> <li>Note: Data is not automatically written to a file when you use the <code>io.write</code> function.</li> <li>The <code>io.write</code> function will buffer data and it may not be written to the USB drive immediately while <code>io:flush</code> forces any buffered data to be written to the drive.</li> <li>This function only flushes the default output file.</li> </ul> |
| Also see               | <code>file:write</code> , <code>io.write</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| <b>io.input</b>        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Assigns a previously opened file, or opens a new file, as the default input file.                                                                                                                                                                                                                                                                                                                                                                                  |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                         |
| Usage                  | <pre>file = io.input(newfile) file = io.input()</pre> <p><code>newfile</code>                      A file descriptor to assign (or the path of a file to open) as the default input file. The path may be absolute or relative to the current working directory.</p> <p><code>file</code>                              The absolute path to the current default input file. If <code>file = io.input(newfile)</code> is used, the path indicates the new file.</p> |
| Remarks                | <ul style="list-style-type: none"> <li>When using this function from a remote TSP-Link node, this command does not accept a file descriptor.</li> </ul>                                                                                                                                                                                                                                                                                                            |

| <b>io.open</b>         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Opens a file for later access.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Usage                  | <pre>file, errmsg = io.open(path) file, errmsg = io.open(path, mode)</pre> <p><code>file</code>                              The descriptor of the opened file.</p> <p><code>path</code>                              The path to the file to open. This path may be absolute or relative to the current working directory.</p> <p><code>mode</code>                              A string representing the intended access mode; "r" indicates read mode, "w" indicates write mode, and "a" indicates append mode. Default is "r".</p> <p><code>errmsg</code>                            Indicates whether an error was encountered while processing the function.</p> |
| Remarks                | <ul style="list-style-type: none"> <li>If an error is encountered, the command returns <code>nil</code> and the error string.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

| <b>io.output</b>       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Assigns a previously opened file, or opens a new file, as the default output file.                                                                                                                                                                                                                                                                                                                                                                                     |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                             |
| Usage                  | <pre>file = io.output(newfile) file = io.output()</pre> <p><code>newfile</code>                      A file descriptor to assign (or the path of a file to open) as the default output file. The path may be absolute or relative to the current working directory.</p> <p><code>file</code>                              The absolute path to the current default input file. If <code>file = io.output(newfile)</code> is used, the path indicates the new file.</p> |
| Remarks                | <ul style="list-style-type: none"> <li>When accessed from a remote node using the TSP-Link network, this command does not accept a file descriptor parameter.</li> </ul>                                                                                                                                                                                                                                                                                               |

| <b>io.read</b>         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Reads data from the default input file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Usage                  | <pre>data1 = io.read() data1 = io.read(format1) data1, data2 = io.read(format1, format2) data1, ..., datan = io.read(format1, ..., formatn)</pre> <p><code>data1</code>                              The data read from the file.</p> <p><code>data2</code>                              The data read from the file.</p> <p><code>datan</code>                              The data read from the file. The number of return values matches the number of format values given.</p> <p><code>format1</code>                            A string or number indicating the type of data to be read.</p> <p><code>format2</code>                            A string or number indicating the type of data to be read.</p> <p><code>formatn</code>                            A string or number indicating the type of data to be read.</p>                                                                         |
| Remarks                | <ul style="list-style-type: none"> <li>The format parameters may be any of the following: <ul style="list-style-type: none"> <li>"*n": Returns a number.</li> <li>"*a": Returns the whole file, starting at the current position; return an empty string if it is at the end of file.</li> <li>"*1": Returns the next line, skipping the end of line; return <code>nil</code> if the current file position is at the end of file.</li> <li><code>n</code>: Returns a string with up to <code>n</code> characters; return an empty string if <code>n</code> is zero; return <code>nil</code> if the current file position is at the end of file.</li> </ul> </li> <li>Any number of format parameters may be passed to this command, each corresponding to a returned data value.</li> <li>If no format parameters are provided, the function will perform as if the function was passed the value "*1".</li> </ul> |

| <b>io.type</b>         |                                                                                                                                                                                                                                                                                 |                  |                  |                   |                                                      |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------|-------------------|------------------------------------------------------|
| Function               | Checks whether or not a given object is a file handle.                                                                                                                                                                                                                          |                  |                  |                   |                                                      |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                   |                  |                  |                   |                                                      |
| Usage                  | <code>type = io.type(obj)</code><br><br><table border="0" style="width: 100%;"> <tr> <td style="width: 30%;"><code>obj</code></td> <td>Object to check.</td> </tr> <tr> <td><code>type</code></td> <td>Indicates whether the object is an open file handle.</td> </tr> </table> | <code>obj</code> | Object to check. | <code>type</code> | Indicates whether the object is an open file handle. |
| <code>obj</code>       | Object to check.                                                                                                                                                                                                                                                                |                  |                  |                   |                                                      |
| <code>type</code>      | Indicates whether the object is an open file handle.                                                                                                                                                                                                                            |                  |                  |                   |                                                      |
| Remarks                | <ul style="list-style-type: none"> <li>Returns the string "file" if the object is an open file handle. Otherwise, nil is returned.</li> </ul>                                                                                                                                   |                  |                  |                   |                                                      |

| <b>io.write</b>        |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                    |                         |                    |                         |                    |                         |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------|--------------------|-------------------------|--------------------|-------------------------|
| Function               | Write data to the default output file.                                                                                                                                                                                                                                                                                                                                                                                                         |                    |                         |                    |                         |                    |                         |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                     |                    |                         |                    |                         |                    |                         |
| Usage                  | <code>io.write()</code><br><code>io.write(data1)</code><br><code>io.write(data1, data2)</code><br><code>io.write(data1, ..., datan)</code><br><br><table border="0" style="width: 100%;"> <tr> <td style="width: 30%;"><code>data1</code></td> <td>The data to be written.</td> </tr> <tr> <td><code>data2</code></td> <td>The data to be written.</td> </tr> <tr> <td><code>datan</code></td> <td>The data to be written.</td> </tr> </table> | <code>data1</code> | The data to be written. | <code>data2</code> | The data to be written. | <code>datan</code> | The data to be written. |
| <code>data1</code>     | The data to be written.                                                                                                                                                                                                                                                                                                                                                                                                                        |                    |                         |                    |                         |                    |                         |
| <code>data2</code>     | The data to be written.                                                                                                                                                                                                                                                                                                                                                                                                                        |                    |                         |                    |                         |                    |                         |
| <code>datan</code>     | The data to be written.                                                                                                                                                                                                                                                                                                                                                                                                                        |                    |                         |                    |                         |                    |                         |
| Remarks                | <ul style="list-style-type: none"> <li>All data parameters must be either strings or numbers.</li> <li>This command does not immediately write the data to the physical media. It may buffer the data and write it when the file is closed via the <code>io.close</code> command. To force the buffered data to be written before closing the file, call <code>io.flush</code>.</li> </ul>                                                     |                    |                         |                    |                         |                    |                         |

## LAN

Use the following functions and attributes to configure the LAN settings.

| <b>lan.applysettings</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                 | Use this function to re-initialize the LAN interface with new configuration settings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| TSP-Link accessibility   | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Usage                    | <code>lan.applysettings()</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Remarks                  | <ul style="list-style-type: none"> <li>• Use this function to disconnect the LAN interface and to re-initialize the LAN with the current configuration settings.</li> <li>• This function initiates an overlapped operation.</li> <li>• The LAN initialization continues to run in the background.</li> <li>• Automatically implements changes to the LAN because of Dynamic Host Configuration Protocol (DHCP) or DLLA.</li> <li>• Settings applied take effect even if the configuration has not changed since the last time the instrument connected to the LAN.</li> <li>• Changes to the LAN configuration disconnect the current connection.</li> </ul> |

| <b>lan.autoconnect</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | Enables or disables automatic monitoring of the LAN link.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Default                | <code>lan.ENABLE</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Usage                  | <pre>state = lan.autoconnect      -- Reads LAN monitoring state. lan.autoconnect = state     -- Writes LAN monitoring state.</pre> <p>state                           LAN link monitoring state.</p> <p>state has one of the following values:</p> <pre>lan.ENABLE                    Enables automatic link reconnection. lan.DISABLE                   Disables automatic link reconnection.</pre>                                                                                                                                          |
| Remarks                | <ul style="list-style-type: none"> <li>• This attribute sets the LAN link monitoring and automatic connection state.</li> <li>• Set this attribute to <code>lan.ENABLE</code> to monitor the LAN link.</li> <li>• Set this attribute to <code>lan.ENABLE</code> to close all connections if the link to the LAN is lost for more than the time specified by <code>lan.linktimeout</code>.</li> <li>• Set this attribute to <code>lan.ENABLE</code> to automatically reset the LAN configuration after the LAN link is established.</li> </ul> |

| <b>lan.config.dns.address[N]</b> |                                                                                                                                                                                                                                                                                                               |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                        | The IP address for the DNS server (Domain Name System)                                                                                                                                                                                                                                                        |
| Default                          | "0.0.0.0"                                                                                                                                                                                                                                                                                                     |
| TSP-Link accessibility           | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                   |
| Usage                            | <pre>lan.config.dns.address[index] = dnsaddress dnsaddress = lan.config.dns.address[index]</pre> <p>                     index Specifies the value of the index.<br/>                     dnsaddress The DNS server IP address.                 </p>                                                          |
| Remarks                          | <ul style="list-style-type: none"> <li>• IP addresses must be specified as strings using dotted decimal notation.</li> <li>• The value of index must be 1 or 2.</li> <li>• The IP address obtained from the DHCP server takes priority for all DNS lookups.</li> <li>• Stores up to two addresses.</li> </ul> |

| <b>lan.config.dns.domain</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                    | The DNS domain.                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Default                      | ""                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| TSP-Link accessibility       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                           |
| Usage                        | <pre>lan.config.dns.domain = domain domain = lan.config.dns.domain</pre> <p>                     domain The domain to use for DNS registration.                 </p>                                                                                                                                                                                                                                                                                                  |
| Remarks                      | <ul style="list-style-type: none"> <li>• Stores the domain to request during DNS registration.</li> <li>• DNS registration works with DHCP to register the domain specified in this attribute with the DNS server.</li> <li>• Domain must be a string that contains less than 255 characters.</li> <li>• The total number of characters in the host and domain names combined must be less than or equal to 255. Note: This includes separator characters.</li> </ul> |

| <b>lan.config.dns.dynamic</b> |                                                                                                                                                                                                                                                                                                                          |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                     | Enables or disables DNS registration.                                                                                                                                                                                                                                                                                    |
| Default                       | lan.ENABLE                                                                                                                                                                                                                                                                                                               |
| TSP-Link accessibility        | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                              |
| Usage                         | <pre>state = lan.config.dns.dynamic -- Reads DNS registration lan.config.dns.dynamic = state -- Writes DNS registration.</pre> <p>Use one of the following values:</p> <p>                     lan.ENABLE Enables DNS registration.<br/>                     lan.DISABLE Disables DNS registration.                 </p> |
| Remarks                       | <ul style="list-style-type: none"> <li>• Use this attribute to enable or disable DNS registration.</li> <li>• DNS registration works with the DHCP to register the host name specified in the lan.config.dns.hostname attribute with the DNS server.</li> </ul>                                                          |



| <b>lan.config.dns.hostname</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                      | Stores the DNS host name.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Default                        | ""                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| TSP-Link accessibility         | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Usage                          | <pre>hostname = lan.config.dns.hostname -- Reads DNS host name. lan.config.dns.hostname = hostname -- Writes DNS host name.</pre> <p>hostname                                   The host name to use for DNS registration.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Remarks                        | <ul style="list-style-type: none"> <li>• Stores the host name requested during DNS registration.</li> <li>• DNS registration works with the DHCP to register the host name specified in this attribute with the DNS server.</li> <li>• The host name must: <ul style="list-style-type: none"> <li>• Contain 255 characters or less.</li> <li>• Begin with a letter and end with a letter or a number.</li> <li>• Only contain letters, numbers, and hyphens.</li> </ul> </li> <li>• The host name must be a string that contains less than 255 characters.</li> <li>• The host name plus the domain name must be less than or equal to 255 characters.</li> </ul> <p>Note: This include the separator characters.</p> |

| <b>lan.config.dns.verify</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                    | The DNS host name verification state.                                                                                                                                                                                                                                                                                                                                                                                                   |
| Default                      | lan.ENABLE                                                                                                                                                                                                                                                                                                                                                                                                                              |
| TSP-Link accessibility       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                             |
| Usage                        | <pre>state = lan.config.dns.verify -- Reads host name state. lan.config.dns.verify = state -- Writes host name state.</pre> <p>state                                   The DNS host name verification state.</p> <p>Use one of the following values for state:</p> <pre>lan.ENABLE                           Enables the DNS host name verification. lan.DISABLE                         Disables the DNS host name verification.</pre> |
| Remarks                      | <ul style="list-style-type: none"> <li>• Used to enable or disable the DNS host name verification.</li> <li>• When enabled, the instrument performs a DNS lookup to verify the DNS host name matches the value specified in the command <code>lan.config.dns.hostname</code>.</li> </ul>                                                                                                                                                |

| <b>lan.config.duplex</b> |                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                | The LAN duplex mode.                                                                                                                                                                                                                                                                                                                                                                                            |
| Default                  | lan.FULL                                                                                                                                                                                                                                                                                                                                                                                                        |
| TSP-Link accessibility   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                     |
| Usage                    | <pre>duplex = lan.config.duplex    -- Reads LAN duplex mode. lan.config.duplex = duplex    -- Writes LAN duplex mode.</pre> <p>duplex                                    The LAN duplex setting.<br/>Use one of the following values for duplex:</p> <pre>lan.FULL                                Selects the full-duplex mode. lan.HALF                                Selects the half-duplex mode.</pre>     |
| Remarks                  | <ul style="list-style-type: none"> <li>This attribute selects which duplex mode will be used by the LAN interface when lan.config.autonegotiate is disabled. When lan.config.autonegotiate is enabled, this setting is ignored.</li> <li>This attribute does not indicate the actual setting currently in effect. Use the lan.status attributes to determine the current operating state of the LAN.</li> </ul> |

| <b>lan.config.gateway</b> |                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                 | The default gateway address.                                                                                                                                                                                                                                                                                                                                                                                 |
| Default                   | "0.0.0.0"                                                                                                                                                                                                                                                                                                                                                                                                    |
| TSP-Link accessibility    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                  |
| Usage                     | <pre>gatewayaddress = lan.config.gateway    -- Reads gateway address. lan.config.gateway = gatewayaddress    -- Writes gateway address.</pre> <p>gatewayaddress                            The default gateway address.</p>                                                                                                                                                                                  |
| Remarks                   | <ul style="list-style-type: none"> <li>Use this attribute to configure the LAN with manual or DLLA configuration methods.</li> <li>If DHCP is enabled the setting for this attribute is ignored.</li> <li>gatewayaddress must be a string that specifies the default IP address for the gateway.</li> <li>The IP address must be formatted in four groups of numbers each separated by a decimal.</li> </ul> |

| <b>lan.config.ipaddress</b> |                                                                                                                                                                                                                           |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                   | Specifies the IP address.                                                                                                                                                                                                 |
| Default                     | "192.168.0.2"                                                                                                                                                                                                             |
| TSP-Link accessibility      | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                               |
| Usage                       | <pre>ipaddress = lan.config.ipaddress      -- Reads IP address. lan.config.ipaddress = ipaddress      -- Writes IP address.</pre> <p>ipaddress                                    The settings configured on the LAN.</p> |
| Remarks                     | <ul style="list-style-type: none"> <li>This attribute identifies the IP address to use for manual configuration.</li> <li>If DLLA or DHCP is enabled, this setting is ignored.</li> </ul>                                 |

|         |                                                                                |
|---------|--------------------------------------------------------------------------------|
| Example | The IP address must be formatted in a dotted decimal notation:<br>169.254.10.2 |
|---------|--------------------------------------------------------------------------------|

| <b>lan.config.method</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                | The LAN settings configuration method.                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Default                  | lan.AUTO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| TSP-Link accessibility   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Usage                    | <pre>method = lan.config.method          -- Reads configuration method. lan.config.method = method          -- Writes configuration method.</pre> <p>method                                   LAN settings configuration method.</p> <p>Use one of the following values for method:</p> <pre>lan.AUTO                               Selects automatic sequencing of configuration methods. lan.MANUAL                             Uses the configuration settings specified manually.</pre> |
| Remarks                  | <ul style="list-style-type: none"> <li>This attribute controls how the IP address, subnet mask, default gateway address, and the DNS server addresses are determined.</li> <li>If method is set to lan.AUTO, DHCP is used first to configure the LAN settings. If DHCP fails, the instrument uses DLLA, if DLLA fails, the instrument uses the manual settings.</li> </ul>                                                                                                                  |

| <b>lan.config.speed</b> |                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute               | Specifies the LAN speed used when restarting in manual configuration mode.                                                                                                                                                                                                                                                                                                                                     |
| Default                 | 100                                                                                                                                                                                                                                                                                                                                                                                                            |
| TSP-Link accessibility  | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                    |
| Usage                   | <pre>speed = lan.config.speed            -- Reads LAN speed. lan.config.speed = speed            -- Writes LAN speed.</pre> <p>speed                                   Sets the LAN speed.</p>                                                                                                                                                                                                                 |
| Remarks                 | <ul style="list-style-type: none"> <li>This attribute stores the speed that will be used if the LAN is restarted in manual configuration mode.</li> <li>Do not use this attribute to retrieve the current speed settings on the LAN. Use the attribute <a href="#">lan.status.speed</a> to retrieve the current speed of the LAN.</li> <li>The LAN speed is measured in megabits per second (Mbps).</li> </ul> |

| <b>lan.config.subnetmask</b> |                                                                                                                                                                                                             |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                    | Specifies the LAN subnet mask.                                                                                                                                                                              |
| Default                      | "255.255.255.0"                                                                                                                                                                                             |
| TSP-Link accessibility       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                 |
| Usage                        | <pre>mask = lan.config.subnetmask        -- Reads LAN subnet mask. lan.config.subnetmask = mask        -- Writes LAN subnet mask.</pre> <p>mask                                    The LAN subnet mask.</p> |

|         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>• Use this attribute to specify the LAN subnet mask to use if manual configuration is enabled.</li> <li>• If DLLA or DHCP is enabled, this setting is ignored.</li> <li>• Do not use this attribute to retrieve the current state on the LAN. Use the attribute <code>lan.status.subnetmask</code> to retrieve the current state of the LAN.</li> <li>• The <code>mask</code> must be a string that specifies the subnet mask in a dotted decimal notation.</li> </ul> |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| <b>lan.linktimeout</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | Sets the LAN link time-out period.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Default                | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Usage                  | <pre>timeout = lan.linktimeout          -- Reads LAN timeout period. lan.linktimeout = timeout          -- Writes LAN timeout period.  timeout                            The LAN link monitor time-out period (in seconds).</pre>                                                                                                                                                                                                                                                                                                                                                                  |
| Remarks                | <ul style="list-style-type: none"> <li>• You must enable the command <code>lan.autoconnect</code> before you can use this attribute.</li> <li>• The time-out value represents the amount of time that passes before the instrument disconnects from the LAN due to the loss of the LAN link integrity.</li> <li>• The LAN interface does not disconnect if the connection to the LAN is re-established before the time-out value expires.</li> <li>• If the LAN link integrity is not restored before the time-out value expires, the instrument begins to monitor for a new connection.</li> </ul> |

| <b>lan.lxidomain</b>   |                                                                                                                                                                                                                                                                                                             |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | Sets the LXI domain.                                                                                                                                                                                                                                                                                        |
| Default                | 0                                                                                                                                                                                                                                                                                                           |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                 |
| Usage                  | <pre>domain = lan.lxidomain           -- Reads LXI domain. lan.lxidomain = domain           -- Writes LXI domain.  domain                           The LXI domain.</pre>                                                                                                                                   |
| Remarks                | <ul style="list-style-type: none"> <li>• The value of this command must be a number between 0 and 255.</li> <li>• The default value is 0.</li> <li>• All outgoing LXI packets are generated with this domain number.</li> <li>• Incoming LXI packets without the same domain number are ignored.</li> </ul> |

| <b>lan.nagle</b>       |                                                             |
|------------------------|-------------------------------------------------------------|
| Attribute              | Enables the use of the LAN Nagle algorithm.                 |
| Default                | <code>lan.ENABLE</code>                                     |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node. |

|         |                                                                                                                                                                                                                                                                                                                                                    |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Usage   | <pre>state = lan.nagle           -- Reads nagle state. lan.nagle = state          -- Writes nagle state.  state                       Enables the LAN Nagle algorithm. Use one of the following values for state: lan.ENABLE                  Enables the Nagle algorithm. lan.DISABLE                 Disables the Nagle algorithm</pre>          |
| Remarks | <ul style="list-style-type: none"> <li>Use this attribute to enable or disable the Nagle algorithm on Transmission Control Protocol (TCP) connections.</li> <li>lan.ENABLE permits the instrument to use the Nagle algorithm with future TCP connections.</li> <li>lan.DISABLE disables the Nagle algorithm for future TCP connections.</li> </ul> |

| <b>lan.reset</b>       |                                                                                                                                                                                                    |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Resets the LAN interface.                                                                                                                                                                          |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                         |
| Usage                  | lan.reset()                                                                                                                                                                                        |
| Remarks                | <ul style="list-style-type: none"> <li>This function performs the following commands: <ul style="list-style-type: none"> <li>lan.restoredefaults</li> <li>lan.applysettings</li> </ul> </li> </ul> |

| <b>lan.restoredefaults</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                   | Restores the default LAN settings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| TSP-Link accessibility     | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Usage                      | lan.restoredefaults()                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Remarks                    | <ul style="list-style-type: none"> <li>This function restores the following attributes: <pre>lan.autoconnect           lan.ENABLE lan.config.dns.address[n] "0.0.0.0" lan.config.dns.domain     "" lan.dns.dynamic           lan.ENABLE lan.config.hostname       "" lan.config.dnsverify      lan.ENABLE lan.config.duplex         lan.FULL lan.config.gateway        "0.0.0.0" lan.config.ipaddress      "192.168.0.2" lan.config.method         lan.AUTO lan.config.speed          100 lan.config.subnetmask     "255.255.255.0" lan.linktimeout           20 (in seconds) lan.lxidomain             0 lan.nagle                 lan.ENABLE lan.timedwait             20 (in seconds)</pre> <ul style="list-style-type: none"> <li>You cannot use this function to reset the LAN password.</li> <li>To reset the LAN password, use the attribute <a href="#">localnode.password</a>.</li> </ul> </li> </ul> |

| <b>lan.status.dns.address[N]</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                        | Stores the DNS server IP address.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| TSP-Link accessibility           | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Usage                            | <pre>dnsaddress = lan.status.dns.address[index]</pre> <p><code>index</code>                                   The entry index.<br/> <code>dnsaddress</code>                           The DNS server IP address.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Remarks                          | <ul style="list-style-type: none"> <li>• This attribute represents the DNS server addresses in use.</li> <li>• You can use up to three addresses.</li> <li>• The attribute index must be an integer from 1 to 3.</li> <li>• The value of <code>lan.status.dns.address[1]</code> is referenced first for all DNS lookups.</li> <li>• The values of <code>lan.status.dns.address[2]</code> and <code>lan.status.dns.address[3]</code> are referenced second and third, respectively.</li> <li>• The value of <code>dnsaddress</code> is a string that stores the IP address for the DNS server.</li> <li>• All IP address are noted in dotted decimal notation.</li> <li>• Unused entries return as "0.0.0.0"</li> </ul> |

| <b>lan.status.dns.name</b> |                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                  | The fully qualified DNS host name.                                                                                                                                                                                                                                                                                                                                                                             |
| TSP-Link accessibility     | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                    |
| Usage                      | <pre>name = lan.status.dns.name</pre> <p><code>name</code>                                   Stores the fully qualified DNS host name.</p>                                                                                                                                                                                                                                                                     |
| Remarks                    | <ul style="list-style-type: none"> <li>• This attribute stores at fully qualified domain name (FQDN).</li> <li>• A FQDN is the complete domain name for a specific computer or host, on the LAN. The FQDN consists of two parts: the hostname and the domain name.</li> <li>• If the DNS host name for an instrument is not found, this attribute stores the IP address in dotted decimal notation.</li> </ul> |

| <b>lan.status.duplex</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                | the LAN duplex mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Usage                    | <pre>duplex = lan.status.duplex                                   -- Reads duplex mode. lan.status.duplex = duplex                                   -- Writes duplex mode.</pre> <p><code>duplex = lan.status.duplex</code></p> <p><code>duplex</code>                                   The LAN duplex settings.<br/> The value of this attribute will be one of the following values:<br/> <code>lan.FULL</code>                                   Full-duplex operation.<br/> <code>lan.HALF</code>                                   Half-duplex operation.</p> |
| Remarks                  | <ul style="list-style-type: none"> <li>• This attribute returns the duplex mode in use on the LAN.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| <b>lan.status.gateway</b> |                                                                                                                                                                                                                                                                      |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                 | The default gateway address for the LAN.                                                                                                                                                                                                                             |
| TSP-Link accessibility    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                          |
| Usage                     | <pre>gatewayaddress = lan.status.gateway</pre> <p>gatewayaddress                      The default gateway address for the LAN.</p>                                                                                                                                   |
| Remarks                   | <ul style="list-style-type: none"> <li>• This attribute indicates the default gateway IP address in use.</li> <li>• The value of <code>gatewayaddress</code> is a string that indicates the IP address of the default gateway in dotted decimal notation.</li> </ul> |

| <b>lan.status.ipaddress</b> |                                                                                                                                                                                                                                                               |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                   | Indicates the IP address.                                                                                                                                                                                                                                     |
| TSP-Link accessibility      | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                   |
| Usage                       | <pre>ipaddress = lan.status.ipaddress</pre> <p>ipaddress                              Returns the IP address assigned to the instrument.</p>                                                                                                                  |
| Remarks                     | <ul style="list-style-type: none"> <li>• Use this attribute to retrieve the IP address for the instrument.</li> <li>• The IP address is a character string that represents the IP address assigned to the instrument (in dotted decimal notation).</li> </ul> |
| Example                     | Sample IP address<br>"192.168.0.2"                                                                                                                                                                                                                            |

| <b>lan.status.macaddress</b> |                                                                                                                                                                                                                                                                                                                                               |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                    | Indicates the LAN MAC address.                                                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                   |
| Usage                        | <pre>macaddress = lan.status.macaddress</pre> <p>macaddress                              Returns the MAC address assigned to the instrument.</p>                                                                                                                                                                                              |
| Remarks                      | <ul style="list-style-type: none"> <li>• Use this attribute to retrieve the MAC address for the instrument.</li> <li>• The MAC address is a character string that represents the MAC address assigned to the instrument in hexadecimal notation.</li> <li>• The character string includes colons that separate the address octets.</li> </ul> |
| Example                      | Sample MAC address<br>"00:60:1A:00:00:57"                                                                                                                                                                                                                                                                                                     |

| <b>lan.status.port.dst</b> |                                                                                                                                                                    |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                  | The LAN dead socket termination (DST) port number.                                                                                                                 |
| TSP-Link accessibility     | This attribute can be accessed from a remote TSP-Link node.                                                                                                        |
| Usage                      | <pre>port = lan.status.port.dst</pre> <p style="text-align: right;">Dead socket termination socket port.</p>                                                       |
| Remarks                    | <ul style="list-style-type: none"> <li>• Stores the DST port number.</li> <li>• To reset all LAN connections, open a connection to the DST port number.</li> </ul> |

| <b>lan.status.port.rawsocket</b> |                                                                                                                                                                                        |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                        | LAN raw socket connection port number.                                                                                                                                                 |
| TSP-Link accessibility           | This attribute can be accessed from a remote TSP-Link node.                                                                                                                            |
| Usage                            | <pre>port = lan.status.port.rawsocket</pre> <p style="text-align: right;">Returns the raw socket port number.</p>                                                                      |
| Remarks                          | <ul style="list-style-type: none"> <li>• Stores the TCP port number used to connect the instrument and to control the instrument over a raw socket communication interface.</li> </ul> |

| <b>lan.status.port.telnet</b> |                                                                                                                                                          |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                     | LAN telnet connection port number.                                                                                                                       |
| TSP-Link accessibility        | This attribute can be accessed from a remote TSP-Link node.                                                                                              |
| Usage                         | <pre>port = lan.status.port.telnet</pre> <p style="text-align: right;">The telnet port number.</p>                                                       |
| Remarks                       | <ul style="list-style-type: none"> <li>• This attribute stores the TCP port number used to connect to the instrument over a VXI-11 interface.</li> </ul> |

| <b>lan.status.port.vxi11</b> |                                                                                                                                                          |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                    | LAN VXI-11 connection port number.                                                                                                                       |
| TSP-Link accessibility       | This attribute can be accessed from a remote TSP-Link node.                                                                                              |
| Usage                        | <pre>port = lan.status.port.vxi11</pre> <p style="text-align: right;">VXI-11 port number.</p>                                                            |
| Remarks                      | <ul style="list-style-type: none"> <li>• This attribute stores the TCP port number used to connect to the instrument over a VXI-11 interface.</li> </ul> |





|                                                                                          |                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>lan.trigger[N].assert</b> <span style="float:right">Replace N with values 1-8.</span> |                                                                                                                                                                                                                                                                                                               |
| Function                                                                                 | Generates a trigger.                                                                                                                                                                                                                                                                                          |
| TSP-Link accessibility                                                                   | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                    |
| Usage                                                                                    | lan.trigger[lanevent].assert()<br><br>lanevent <span style="float:right">The LAN event number.</span>                                                                                                                                                                                                         |
| Remarks                                                                                  | <ul style="list-style-type: none"> <li>Generates and sends a LAN trigger packet for the LAN event number specified.</li> <li>Sets the pseudostate to the appropriate state.</li> <li>The following indexes will provide the listed LXI events:<br/>1:LAN0<br/>2:LAN1<br/>3:LAN2<br/>...<br/>8:LAN7</li> </ul> |

|                                                                                         |                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>lan.trigger[N].clear</b> <span style="float:right">Replace N with values 1-8.</span> |                                                                                                                                                                                                                                                                                                                                                                 |
| Function                                                                                | Clears a trigger.                                                                                                                                                                                                                                                                                                                                               |
| TSP-Link accessibility                                                                  | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                     |
| Usage                                                                                   | lan.trigger[lanevent].clear()<br><br>lanevent <span style="float:right">The LAN event number.</span>                                                                                                                                                                                                                                                            |
| Remarks                                                                                 | <ul style="list-style-type: none"> <li>A trigger's event detector remembers if an event has been detected since the last lan.trigger[n].wait call.</li> <li>This function clears a trigger's event detector and discards the previous history of the LAN trigger event.</li> <li>This function clears all overruns associated with this LAN trigger.</li> </ul> |

|                                                                                           |                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>lan.trigger[N].connect</b> <span style="float:right">Replace N with values 1-8.</span> |                                                                                                                                                                                                                                                                                                                                      |
| Function                                                                                  | Prepares the event generator for outgoing trigger events.                                                                                                                                                                                                                                                                            |
| TSP-Link accessibility                                                                    | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                           |
| Usage                                                                                     | lan.trigger[lanevent].connect()<br><br>lanevent <span style="float:right">The LAN event number.</span>                                                                                                                                                                                                                               |
| Remarks                                                                                   | <ul style="list-style-type: none"> <li>Prepares the event generator to send event messages. For TCP connections, this will open the TCP connection.</li> <li>The event generator will automatically disconnect when either the lan.trigger[n].protocol or lan.trigger[n].ipaddress attributes for this event are changed.</li> </ul> |

| <b>lan.trigger[N].connected</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Replace N with values 1-8. |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| Attribute                       | The LAN event connection state.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                            |
| TSP-Link accessibility          | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
| Usage                           | <pre>connected = lan.trigger[lanevent].connected</pre><br><div style="display: flex; justify-content: space-between;"> <span>lanevent</span> <span>The LAN event number.</span> </div> <div style="display: flex; justify-content: space-between;"> <span>connected</span> <span>The LAN event connection state.</span> </div>                                                                                                                                                                                             |                            |
| Remarks                         | <ul style="list-style-type: none"> <li>• Set to <code>true</code> when the LAN trigger is connected and ready to send trigger events following a successful <code>lan.trigger[n].connect</code> command. If the LAN trigger is not ready to send trigger events, this value is set to <code>false</code>.</li> <li>• Set to <code>false</code> when either <code>lan.trigger[n].protocol</code> or <code>lan.trigger[n].ipaddress</code> attributes are changed or the remote connection closes the connection.</li> </ul> |                            |

| <b>lan.trigger[N].disconnect</b> |                                                                                                                                                                                                                                                                                                        | Replace N with values 1-8. |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| Function                         | Disconnects the LAN trigger.                                                                                                                                                                                                                                                                           |                            |
| TSP-Link accessibility           | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                             |                            |
| Usage                            | <pre>lan.trigger[lanevent].disconnect()</pre><br><div style="display: flex; justify-content: space-between;"> <span>lanevent</span> <span>The LAN event number.</span> </div>                                                                                                                          |                            |
| Remarks                          | <ul style="list-style-type: none"> <li>• For TCP connections, this closes the TCP connection.</li> <li>• The LAN trigger will automatically disconnect when either the <code>lan.trigger[n].protocol</code> or <code>lan.trigger[n].ipaddress</code> attributes for this event are changed.</li> </ul> |                            |

| <b>lan.trigger[N].EVENT_ID</b> |                                                                                                                                                                                                                                                                                                                       | Replace N with values 1-8. |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| Attribute                      | Indicates the trigger event detector LAN event number.                                                                                                                                                                                                                                                                |                            |
| TSP-Link accessibility         | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                           |                            |
| Usage                          | <pre>event_id = lan.trigger[lanevent].EVENT_ID</pre><br><div style="display: flex; justify-content: space-between;"> <span>event_id</span> <span>The trigger event number.</span> </div> <div style="display: flex; justify-content: space-between;"> <span>lanevent</span> <span>The LAN event number.</span> </div> |                            |
| Remarks                        | <ul style="list-style-type: none"> <li>• Set the stimulus of any trigger event detector to the value of this constant to have it respond to incoming LAN trigger packets.</li> </ul>                                                                                                                                  |                            |

| <b>lan.trigger[N].ipaddress</b> <span style="float: right;">Replace N with values 1-8.</span> |                                                                                                                                                                                                                                                                                                                                          |
|-----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                     | Sets the IP address for outgoing trigger events.                                                                                                                                                                                                                                                                                         |
| Default                                                                                       | "0.0.0.0"                                                                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility                                                                        | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                              |
| Usage                                                                                         | <pre>ipaddress = lan.trigger[lanevent].ipaddress lan.trigger[lanevent].ipaddress = ipaddress</pre> <p> <span style="margin-left: 2em;">ipaddress</span>                      Sets and stores the LAN address for this attribute.<br/> <span style="margin-left: 2em;">lanevent</span>                         The LAN event number. </p> |
| Remarks                                                                                       | <ul style="list-style-type: none"> <li>• <code>ipaddress</code> must be a string in dotted decimal notation.</li> <li>• After changing this setting, <code>lan.trigger[n].connect</code> must be called before outgoing messages can be sent.</li> </ul>                                                                                 |

| <b>lan.trigger[N].mode</b> <span style="float: right;">Replace N with values 1-8.</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |                                                                                                        |                               |                                                                                              |                              |                                                                                             |                               |                                                                                                                                    |                               |                                                                                                                                    |                                   |                                                                                              |                                    |                                                                                              |                                    |                                                                                             |
|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------|----------------------------------------------------------------------------------------------|------------------------------|---------------------------------------------------------------------------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|----------------------------------------------------------------------------------------------|------------------------------------|----------------------------------------------------------------------------------------------|------------------------------------|---------------------------------------------------------------------------------------------|
| Attribute                                                                                | Sets the trigger event operation/detection mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |                                                                                                        |                               |                                                                                              |                              |                                                                                             |                               |                                                                                                                                    |                               |                                                                                                                                    |                                   |                                                                                              |                                    |                                                                                              |                                    |                                                                                             |
| Default                                                                                  | <code>lan.TRIG_EITHER</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                              |                                                                                                        |                               |                                                                                              |                              |                                                                                             |                               |                                                                                                                                    |                               |                                                                                                                                    |                                   |                                                                                              |                                    |                                                                                              |                                    |                                                                                             |
| TSP-Link accessibility                                                                   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                              |                                                                                                        |                               |                                                                                              |                              |                                                                                             |                               |                                                                                                                                    |                               |                                                                                                                                    |                                   |                                                                                              |                                    |                                                                                              |                                    |                                                                                             |
| Usage                                                                                    | <pre>mode = lan.trigger[lanevent].mode lan.trigger[lanevent].mode = mode</pre> <p> <span style="margin-left: 2em;">lanevent</span>                         The LAN event number.<br/> <span style="margin-left: 2em;">mode</span>                                The trigger mode. </p> <p>Choose one the following values for <code>mode</code>:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 20%;"><code>lan.TRIG_EITHER</code></td> <td>Input. Detects rising or falling edge trigger packets.<br/>Output. A negative state LAN trigger packet.</td> </tr> <tr> <td><code>lan.TRIG_FALLING</code></td> <td>Input. Detects falling edge trigger packets.<br/>Output. A negative state LAN trigger packet.</td> </tr> <tr> <td><code>lan.TRIG_RISING</code></td> <td>Input. Detects rising edge trigger packets.<br/>Output. A positive state LAN trigger packet.</td> </tr> <tr> <td><code>lan.TRIG_RISINGA</code></td> <td>Input. Detects rising edge trigger packets.<br/>Output. A positive state LAN trigger packet. Same as <code>lan.TRIG_RISING</code>.</td> </tr> <tr> <td><code>lan.TRIG_RISINGM</code></td> <td>Input. Detects rising edge trigger packets.<br/>Output. A positive state LAN trigger packet. Same as <code>lan.TRIG_RISING</code>.</td> </tr> <tr> <td><code>lan.TRIG_SYNCHRONOUS</code></td> <td>Input. Detects falling edge trigger packets.<br/>Output. A positive state LAN trigger packet.</td> </tr> <tr> <td><code>lan.TRIG_SYNCHRONOUSA</code></td> <td>Input. Detects falling edge trigger packets.<br/>Output. A positive state LAN trigger packet.</td> </tr> <tr> <td><code>lan.TRIG_SYNCHRONOUSM</code></td> <td>Input. Detects rising edge trigger packets.<br/>Output. A negative state LAN trigger packet.</td> </tr> </table> | <code>lan.TRIG_EITHER</code> | Input. Detects rising or falling edge trigger packets.<br>Output. A negative state LAN trigger packet. | <code>lan.TRIG_FALLING</code> | Input. Detects falling edge trigger packets.<br>Output. A negative state LAN trigger packet. | <code>lan.TRIG_RISING</code> | Input. Detects rising edge trigger packets.<br>Output. A positive state LAN trigger packet. | <code>lan.TRIG_RISINGA</code> | Input. Detects rising edge trigger packets.<br>Output. A positive state LAN trigger packet. Same as <code>lan.TRIG_RISING</code> . | <code>lan.TRIG_RISINGM</code> | Input. Detects rising edge trigger packets.<br>Output. A positive state LAN trigger packet. Same as <code>lan.TRIG_RISING</code> . | <code>lan.TRIG_SYNCHRONOUS</code> | Input. Detects falling edge trigger packets.<br>Output. A positive state LAN trigger packet. | <code>lan.TRIG_SYNCHRONOUSA</code> | Input. Detects falling edge trigger packets.<br>Output. A positive state LAN trigger packet. | <code>lan.TRIG_SYNCHRONOUSM</code> | Input. Detects rising edge trigger packets.<br>Output. A negative state LAN trigger packet. |
| <code>lan.TRIG_EITHER</code>                                                             | Input. Detects rising or falling edge trigger packets.<br>Output. A negative state LAN trigger packet.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |                                                                                                        |                               |                                                                                              |                              |                                                                                             |                               |                                                                                                                                    |                               |                                                                                                                                    |                                   |                                                                                              |                                    |                                                                                              |                                    |                                                                                             |
| <code>lan.TRIG_FALLING</code>                                                            | Input. Detects falling edge trigger packets.<br>Output. A negative state LAN trigger packet.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                              |                                                                                                        |                               |                                                                                              |                              |                                                                                             |                               |                                                                                                                                    |                               |                                                                                                                                    |                                   |                                                                                              |                                    |                                                                                              |                                    |                                                                                             |
| <code>lan.TRIG_RISING</code>                                                             | Input. Detects rising edge trigger packets.<br>Output. A positive state LAN trigger packet.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                              |                                                                                                        |                               |                                                                                              |                              |                                                                                             |                               |                                                                                                                                    |                               |                                                                                                                                    |                                   |                                                                                              |                                    |                                                                                              |                                    |                                                                                             |
| <code>lan.TRIG_RISINGA</code>                                                            | Input. Detects rising edge trigger packets.<br>Output. A positive state LAN trigger packet. Same as <code>lan.TRIG_RISING</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |                                                                                                        |                               |                                                                                              |                              |                                                                                             |                               |                                                                                                                                    |                               |                                                                                                                                    |                                   |                                                                                              |                                    |                                                                                              |                                    |                                                                                             |
| <code>lan.TRIG_RISINGM</code>                                                            | Input. Detects rising edge trigger packets.<br>Output. A positive state LAN trigger packet. Same as <code>lan.TRIG_RISING</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |                                                                                                        |                               |                                                                                              |                              |                                                                                             |                               |                                                                                                                                    |                               |                                                                                                                                    |                                   |                                                                                              |                                    |                                                                                              |                                    |                                                                                             |
| <code>lan.TRIG_SYNCHRONOUS</code>                                                        | Input. Detects falling edge trigger packets.<br>Output. A positive state LAN trigger packet.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                              |                                                                                                        |                               |                                                                                              |                              |                                                                                             |                               |                                                                                                                                    |                               |                                                                                                                                    |                                   |                                                                                              |                                    |                                                                                              |                                    |                                                                                             |
| <code>lan.TRIG_SYNCHRONOUSA</code>                                                       | Input. Detects falling edge trigger packets.<br>Output. A positive state LAN trigger packet.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                              |                                                                                                        |                               |                                                                                              |                              |                                                                                             |                               |                                                                                                                                    |                               |                                                                                                                                    |                                   |                                                                                              |                                    |                                                                                              |                                    |                                                                                             |
| <code>lan.TRIG_SYNCHRONOUSM</code>                                                       | Input. Detects rising edge trigger packets.<br>Output. A negative state LAN trigger packet.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                              |                                                                                                        |                               |                                                                                              |                              |                                                                                             |                               |                                                                                                                                    |                               |                                                                                                                                    |                                   |                                                                                              |                                    |                                                                                              |                                    |                                                                                             |
| Remarks                                                                                  | <ul style="list-style-type: none"> <li>• <code>lan.TRIG_EITHER</code> is the default mode.</li> <li>• The <code>lan.TRIG_SYNCHRONOUS</code> values are provided for compatibility with digio and tsplink triggering.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |                                                                                                        |                               |                                                                                              |                              |                                                                                             |                               |                                                                                                                                    |                               |                                                                                                                                    |                                   |                                                                                              |                                    |                                                                                              |                                    |                                                                                             |

| <b>lan.trigger[N].overrun</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Replace N with values 1-8. |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| Attribute                     | Event detector overrun status.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                            |
| TSP-Link accessibility        | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                            |
| Usage                         | <pre>overrun = lan.trigger[lanevent].overrun</pre> <p>lanevent                      The LAN event number.<br/>overrun                        Indicates whether the trigger event detector is in the overrun state.</p>                                                                                                                                                                                                                                                                                                                                                   |                            |
| Remarks                       | <ul style="list-style-type: none"> <li>• Read-only attribute indicating whether an event has been ignored because the event detector was already in the detected state when the event occurred.</li> <li>• Indicates the state of the LAN event receiver's built-in event detector.</li> <li>• It does not indicate whether an overrun has occurred in any other part of the trigger model that is monitoring the event.</li> <li>• It is not an indication of an output trigger overrun. Output trigger overrun indicators are provided in the status model.</li> </ul> |                            |

| <b>lan.trigger[N].protocol</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Replace N with values 1-8. |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| Attribute                      | Sets the LAN protocol to use for sending trigger messages.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                            |
| Default                        | lan.TCP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                            |
| TSP-Link accessibility         | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                            |
| Usage                          | <pre>protocol = lan.trigger[lanevent].protocol    -- Reads LAN protocol. lan.trigger[lanevent].protocol = protocol    -- Writes LAN protocol.</pre> <p>lanevent                      The LAN event number.<br/>protocol                      Sets the protocol used by the trigger.</p>                                                                                                                                                                                                                                                                                                                                                                                     |                            |
| Remarks                        | <ul style="list-style-type: none"> <li>• The LAN trigger will listen for trigger messages using either protocol but will use the selected protocol for outgoing messages.</li> <li>• After changing this setting, <code>lan.trigger[n].connect</code> must be called before outgoing event messages can be sent.</li> <li>• <code>protocol</code> must be either <code>lan.TCP</code>, <code>lan.UDP</code>, or <code>lan.MULTICAST</code>. The default is <code>lan.TCP</code>.</li> <li>• When <code>lan.MULTICAST</code> is selected, the <code>ipaddress</code> attribute will be ignored and event messages will be sent to multicast address 224.0.23.159.</li> </ul> |                            |

| <b>lan.trigger[N].pseudostate</b> |                                                                                                                                                                                                                                    | Replace N with values 1-8. |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| Attribute                         | Tracks the simulated line state for the LAN trigger.                                                                                                                                                                               |                            |
| Default                           | 1                                                                                                                                                                                                                                  |                            |
| TSP-Link accessibility            | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                        |                            |
| Usage                             | <pre>pseudostate = lan.trigger[lanevent].pseudostate lan.trigger[lanevent].pseudostate = pseudostate</pre> <p>lanevent                      The LAN event number.<br/>pseudostate                    The simulated line state.</p> |                            |

|         |                                                                                                                                                                                                                                                                    |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>• <code>lan.trigger[n].pseudostate</code> can be set to initialize the pseudo state to a known value.</li> <li>• Setting this attribute will not cause the LAN trigger to generate any events or output packets.</li> </ul> |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| <b>lan.trigger[N].stimulus</b> |                                                                                                                                                                                                                                                                                                                            | Replace N with values 1-8. |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| Attribute                      | Selects which events will trigger a LAN trigger packet.                                                                                                                                                                                                                                                                    |                            |
| Default                        | 0                                                                                                                                                                                                                                                                                                                          |                            |
| TSP-Link accessibility         | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                |                            |
| Usage                          | <pre>stimulus = lan.trigger[lanevent].stimulus -- Reads trigger identifier. lan.trigger[lanevent].stimulus = stimulus -- Writes trigger identifier.</pre> <p> <code>lanevent</code>                      The LAN event number.<br/> <code>stimulus</code>                        Identifier for the triggering event. </p> |                            |
| Remarks                        | <ul style="list-style-type: none"> <li>• Setting this attribute to zero will disable automatic trigger generation.</li> <li>• If any events are detected prior to calling <code>lan.trigger[n].connect</code>, the event will be ignored and the action overrun will be set.</li> </ul>                                    |                            |

| <b>lan.trigger[N].wait</b> |                                                                                                                                                                                                                                                                                                                                                                                                 | Replace N with values 1-8. |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| Function                   | Wait for LAN trigger event to be received.                                                                                                                                                                                                                                                                                                                                                      |                            |
| TSP-Link accessibility     | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                      |                            |
| Usage                      | <pre>triggered = lan.trigger[lanevent].wait(timeout)</pre> <p> <code>lanevent</code>                      The LAN event number.<br/> <code>timeout</code>                        Maximum amount of time (in seconds) to wait for the trigger event.<br/> <code>triggered</code>                      Trigger detected indicator. </p>                                                           |                            |
| Remarks                    | <ul style="list-style-type: none"> <li>• If one or more trigger events have been detected since the last time <code>lan.trigger[n].wait</code> or <code>lan.trigger[n].clear</code> was called, this function will return immediately.</li> <li>• After waiting for a LAN trigger event, the event detector will be automatically reset regardless of the number of events detected.</li> </ul> |                            |

## localnode

Use the attributes and functions in this section to set the power line frequency, control prompts (on and off), control error messages, (show and hide), to access global variables, and to run test scripts.

There are two different ways to use the `localnode` object.

- Send commands from the local node.
- Send commands from a remote node.

To send commands from the local node, use the `localnode` element:

```
localnode.linefreq = 50
```

---

**NOTE** Use the node reference to send commands from a remote node, do not use the `localnode` element.

---

```
node[n].linefreq = 50
```

---

**NOTE** Some `localnode` commands cannot be run on the local node. They must be run from a remote node.

---

| <b>localnode.autolinefreq</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                     | Automatic power line frequency detection control.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility        | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Usage                         | <pre>flag = localnode.autolinefreq-- Read auto line frequency detection                                 -- setting. localnode.autolinefreq = flag  -- Set auto line frequency detection                                 -- mode.</pre> <p>flag                                   The auto line frequency detection setting.</p> <p>Set flag to one of the following values:</p> <pre>true                                   Enable automatic line frequency detection at start-up. false                                  Disable automatic line frequency detection at start-up.</pre> |
| Remarks                       | <ul style="list-style-type: none"> <li>• When this attribute is set to <code>true</code>, the power line frequency is detected automatically the next time the Series 2600A powers up.</li> <li>• After the power line frequency is automatically detected at power-up, the <code>localnode.linefreq</code> attribute will be set automatically to 50 or 60.</li> <li>• If the <code>localnode.linefreq</code> attribute is explicitly set, <code>localnode.autolinefreq</code> will be automatically set to <code>false</code>.</li> </ul>                                             |
| Also see                      | <a href="#">localnode.linefreq</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Example                       | Disable automatic power line frequency detection:<br><pre>localnode.autolinefreq = false</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| <b>localnode.description</b> |                                                                                                                                                                                                                                   |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                    | User's description of the unit.                                                                                                                                                                                                   |
| TSP-Link accessibility       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                       |
| Usage                        | <pre>description = localnode.description    -- Reads user description. localnode.description = description    -- Writes user description.</pre> <p> code&gt;description                      User's description of the unit. </p> |
| Remarks                      | <ul style="list-style-type: none"> <li>• This attribute holds a string with the user-defined description of the unit.</li> <li>• This value appears on the unit's welcome web page.</li> </ul>                                    |

| <b>localnode.execute</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                 | Use this function to start test scripts on a remote node.                                                                                                                                                                                                                                                                                                                                                                                                                  |
| TSP-Link accessibility   | This function can only be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                            |
| Usage                    | <pre>node[n].execute(myscript)</pre> <p> code&gt;myscript                      A string containing the source code.<br/> code&gt;n                              The node number of the instrument on which to execute <code>myscript</code>. </p>                                                                                                                                                                                                                          |
| Remarks                  | <ul style="list-style-type: none"> <li>• Only the master node can issue the <code>execute</code> command to a remote node.</li> <li>• You cannot use the <code>execute</code> command to run test scripts on the master node.</li> <li>• This function initiates an overlapped operation and will not wait for the code to execute to completion.</li> <li>• This function may only be called when the node's group number is different than the master node's.</li> </ul> |
| Example                  | <p>Runs script code stored in the custom variable <code>sourcecode</code>:</p> <pre>node[n].execute(sourcecode)</pre> <p>Runs script code in a string constant:</p> <pre>node[n].execute("x = 5")</pre> <p>Runs a test script that was loaded into memory:</p> <pre>node[n].execute(myscript.source)</pre>                                                                                                                                                                 |

| <b>localnode.getglobal</b> |                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                   | This function returns the value of a global variable.                                                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility     | This function should only be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                   |
| Usage                      | <pre>value = node[n].getglobal(name)</pre> <p> code&gt;name                              The name of the global variable.<br/> code&gt;value                              The value of the global variable.<br/> code&gt;n                                      The node number of the instrument retrieving the global variable from its run-time environment. </p> |
| Remarks                    | <ul style="list-style-type: none"> <li>• Use this function to retrieve the value of a global variable from a remote node.</li> <li>• Do not use this command to retrieve the value of a global variable from the local node.</li> </ul>                                                                                                                              |
| Example                    | <p>Retrieves and outputs the value of the global variable named <code>meas_val</code> from node 5.</p> <pre>print(node[5].getglobal("meas_val"))</pre>                                                                                                                                                                                                               |



| <b>localnode.gettimezone</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                     | Retrieves the local time zone.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| TSP-Link accessibility       | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Usage                        | <pre>timezone = localnode.gettimezone()</pre> <p>timezone Returns the timezone.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Remarks                      | <ul style="list-style-type: none"> <li>• See <a href="#">localnode.settimezone</a> for additional details on the time zone format and a description of the fields.</li> <li>• <code>timezone</code> can be in either of the following formats: <ul style="list-style-type: none"> <li>• GMThh:mm:ss</li> <li>• GMThh:mm:ssGMTThh:mm:ss,Mmm.w.dw/hh:mm:ss,Mmm.w.dw/hh:mm:ss</li> </ul> </li> <li>• The first format is returned if one argument was used with <a href="#">localnode.settimezone</a>.</li> <li>• The second format is returned if four arguments were used with <a href="#">localnode.settimezone</a>.</li> </ul> |

| <b>localnode.linefreq</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                 | Power line frequency.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Default                   | 60                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Usage                     | <pre>frequency = localnode.linefreq --Reads line frequency. localnode.linefreq = frequency --Writes line frequency.</pre> <p>frequency Set to 50 or 60.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Remarks                   | <ul style="list-style-type: none"> <li>• To achieve optimum noise rejection when performing measurements at integer NPLC apertures, the line frequency setting must match the frequency (50Hz or 60Hz) of the AC power line.</li> <li>• When used in an expanded system (TSP-Link), <code>localnode.linefreq</code> is sent to the remote master node only. Use <code>node[n].linefreq</code> (where <code>n</code> is the node number) to send the command to any node in the system. See <a href="#">Section 14</a> for details on TSP-Link.</li> <li>• When this attribute is set, the <code>localnode.autolinefreq</code> attribute is automatically set to false.</li> </ul> |
| Also see                  | <a href="#">localnode.autolinefreq</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Example                   | Sets the line frequency to 60Hz:<br><code>localnode.linefreq = 60</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| <b>localnode.model</b> |                                                                                                                 |
|------------------------|-----------------------------------------------------------------------------------------------------------------|
| Attribute              | The instrument model.                                                                                           |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                     |
| Usage                  | <pre>model = localnode.model -- Reads the node model.</pre> <p>model The model number of the instrument.</p>    |
| Remarks                | <ul style="list-style-type: none"> <li>• This is the model number of the instrument.</li> </ul>                 |
| Also see               | <a href="#">localnode.description</a> , <a href="#">localnode.revision</a> , <a href="#">localnode.serialno</a> |

| <b>localnode.password</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                 | Sets the password for the remote interfaces.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| TSP-Link accessibility    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Usage                     | <pre>localnode.password = password</pre> <p><code>password</code> String containing the remote interface password.</p>                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Remarks                   | <ul style="list-style-type: none"> <li>• This attribute stores the password set for any remote interface.</li> <li>• If the attribute <code>localnode.passwordmode</code> is active, a password is required to access the command interface, modify the password or LAN settings, and to access the virtual front panel.</li> <li>• You cannot retrieve a lost password from any command interface.</li> <li>• The password can be reset by resetting the LAN from the front panel or by assigning an empty string to this attribute.</li> </ul> |
| Details                   | <a href="#">Password management</a> in <a href="#">Section 17</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Also see                  | <a href="#">localnode.passwordmode</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| <b>localnode.passwordmode</b>        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                      |                         |                                     |                                             |                                     |                                                          |                                     |                                                                      |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|-------------------------|-------------------------------------|---------------------------------------------|-------------------------------------|----------------------------------------------------------|-------------------------------------|----------------------------------------------------------------------|
| Attribute                            | Enables the password mode over a remote interface.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                      |                         |                                     |                                             |                                     |                                                          |                                     |                                                                      |
| TSP-Link accessibility               | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                      |                         |                                     |                                             |                                     |                                                          |                                     |                                                                      |
| Usage                                | <pre>mode = localnode.passwordmode      -- Reads password mode. localnode.passwordmode = mode      -- Writes password mode.  localnode.passwordmode = mode mode = localnode.passwordmode</pre> <p>Set the password mode to one of the following:</p> <table border="0"> <tr> <td><code>localnode.PASSWORD_NONE</code></td> <td>Disables all passwords.</td> </tr> <tr> <td><code>localnode.PASSWORD_WEB</code></td> <td>Enables password only on the web interface.</td> </tr> <tr> <td><code>localnode.PASSWORD_LAN</code></td> <td>Enables password on all the Ethernet and web interfaces.</td> </tr> <tr> <td><code>localnode.PASSWORD_ALL</code></td> <td>Enables passwords over all command interfaces and the web interface.</td> </tr> </table> | <code>localnode.PASSWORD_NONE</code> | Disables all passwords. | <code>localnode.PASSWORD_WEB</code> | Enables password only on the web interface. | <code>localnode.PASSWORD_LAN</code> | Enables password on all the Ethernet and web interfaces. | <code>localnode.PASSWORD_ALL</code> | Enables passwords over all command interfaces and the web interface. |
| <code>localnode.PASSWORD_NONE</code> | Disables all passwords.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                      |                         |                                     |                                             |                                     |                                                          |                                     |                                                                      |
| <code>localnode.PASSWORD_WEB</code>  | Enables password only on the web interface.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                      |                         |                                     |                                             |                                     |                                                          |                                     |                                                                      |
| <code>localnode.PASSWORD_LAN</code>  | Enables password on all the Ethernet and web interfaces.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                      |                         |                                     |                                             |                                     |                                                          |                                     |                                                                      |
| <code>localnode.PASSWORD_ALL</code>  | Enables passwords over all command interfaces and the web interface.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                      |                         |                                     |                                             |                                     |                                                          |                                     |                                                                      |
| Remarks                              | <ul style="list-style-type: none"> <li>• Configure the password mode to require passwords.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                      |                         |                                     |                                             |                                     |                                                          |                                     |                                                                      |
| Details                              | <a href="#">Password management</a> in <a href="#">Section 17</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                      |                         |                                     |                                             |                                     |                                                          |                                     |                                                                      |
| Also see                             | <a href="#">localnode.password</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                      |                         |                                     |                                             |                                     |                                                          |                                     |                                                                      |

| <b>localnode.prompts</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                | Prompting mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Default                  | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Usage                    | <pre>prompting = localnode.prompts -- Reads prompting state. localnode.prompts = prompting -- Writes prompting state.</pre> <p><code>prompting</code> Set to 0 to disable or 1 to enable.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Remarks                  | <ul style="list-style-type: none"> <li>• This attribute controls prompting. When it is set to 1, prompts are issued after each command message is processed by the instrument. When it is set to 0, prompts are not issued.</li> <li>• The command messages do not generate prompts. The Series 2600A generates prompts in response to command messages.</li> <li>• When the prompting mode is enabled, the Series 2600A generates prompts in response to command messages. There are three prompts that might be returned: <ul style="list-style-type: none"> <li>• "TSP&gt;" is the standard prompt. This prompt indicates that everything is normal and the command is done processing.</li> <li>• "TSP?" is issued if there are entries in the error queue when the prompt is issued. Like the "TSP&gt;" prompt, it indicates the command is done processing. It does not mean the previous command generated an error, only that there are still errors in the queue when the command was done processing.</li> <li>• "&gt;&gt;&gt;&gt;" is the continuation prompt. This prompt is used when downloading scripts or flash images. When downloading scripts or flash images, many command messages must be sent as a unit. The continuation prompt indicates that the instrument is expecting more messages as part of the current command.</li> </ul> </li> <li>• Test Script Builder (TSB) requires prompts. It sets the prompting mode automatically. If you disable prompting, use of the TSB will freeze because it will be waiting for the prompt that lets it know that the command is done executing. DO NOT disable prompting with the use of the TSB.</li> <li>• When used in an expanded system (TSP-Link), <code>localnode.prompt</code> is sent to the remote master node only. Use <code>node[n].prompt</code> (where <code>n</code> is the node number) to send the command to any node in the system. See <a href="#">Section 14</a> for details about TSP-Link.</li> </ul> |
| Also see                 | <a href="#">localnode.showerrors</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Example                  | Enables prompting:<br><code>localnode.prompts = 1</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| <b>localnode.prompts4882</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                    | Controls the generation of prompts for IEEE-488.2 common commands.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Default                      | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| TSP-Link accessibility       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Usage                        | <pre>localnode.prompts4882 = prompting prompting = localnode.prompts4882</pre> <p style="text-align: center;">prompting                                IEEE-488.2 prompting mode.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Remarks                      | <ul style="list-style-type: none"> <li>• When <code>localnode.prompts4882</code> is set to 1, the IEEE-488.2 common commands will generate prompts if <code>prompting</code> is enabled with the <code>localnode.prompts</code> attribute.</li> <li>• When <code>localnode.prompts4882</code> is set to 0, IEEE-488.2 common commands will not generate prompts.</li> <li>• When using the <code>*trg</code> command with a script that executes <code>trigger.wait</code> repeatedly, setting <code>localnode.prompts4882</code> to 0 will avoid problems associated with the command interface input queue filling.</li> <li>• If <code>localnode.prompts4882</code> is set to 1, limit the number of <code>*trg</code> commands sent to a running script to 50 regardless of the setting of the <code>localnode.prompts</code> attribute.</li> <li>• The default value for <code>localnode.prompts4882</code> is 1. It will reset to the default value each time the unit is powered up.</li> </ul> |

| <b>localnode.reset</b> |                                                                                                                                                                                                                                           |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Resets the local node.                                                                                                                                                                                                                    |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                |
| Usage                  | <pre>localnode.reset()                                -- Resets the local node.</pre>                                                                                                                                                     |
| Remarks                | <ul style="list-style-type: none"> <li>• This function resets the local node instrument.</li> <li>• <code>localnode.reset</code> is different from <code>reset()</code> because <code>reset()</code> resets the entire system.</li> </ul> |
| Also see               | <a href="#">reset</a>                                                                                                                                                                                                                     |
| Example                | Reset the local node:<br><code>localnode.reset()</code>                                                                                                                                                                                   |

| <b>localnode.revision</b> |                                                                                                                                                                                    |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                 | The firmware revision number of the instrument.                                                                                                                                    |
| TSP-Link accessibility    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                        |
| Usage                     | <pre>revision = localnode.revision    -- Reads the firmware revision number.</pre> <p style="text-align: center;">revision                                The revision number.</p> |
| Remarks                   | <ul style="list-style-type: none"> <li>• This attribute indicates the firmware revision number currently running in the instrument.</li> </ul>                                     |
| Also see                  | <a href="#">localnode.description</a> , <a href="#">localnode.model</a> , <a href="#">localnode.serialno</a>                                                                       |

| <b>localnode.serialno</b> |                                                                                                                                                                                                                                                  |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                 | The instrument serial number.                                                                                                                                                                                                                    |
| TSP-Link accessibility    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                      |
| Usage                     | <code>serialno = localnode.serialno</code> --Reads the instrument serial number.<br><br><div style="display: flex; justify-content: space-between;"> <span><code>serialno</code></span> <span>The serial number of the instrument.</span> </div> |
| Remarks                   | <ul style="list-style-type: none"> <li>• This attribute indicates the instrument serial number.</li> <li>• This attribute is read-only.</li> </ul>                                                                                               |
| Also see                  | <a href="#">localnode.description</a> , <a href="#">localnode.model</a> , <a href="#">localnode.revision</a>                                                                                                                                     |

| <b>localnode.setglobal</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                   | Sets the value of a global variable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility     | This function should only be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Usage                      | <code>node[n].setglobal(name, value)</code><br><br><div style="display: flex; justify-content: space-between;"> <span><code>name</code></span> <span>The name of the global variable.</span> </div> <div style="display: flex; justify-content: space-between;"> <span><code>value</code></span> <span>The value assigned to the variable.</span> </div> <div style="display: flex; justify-content: space-between;"> <span><code>n</code></span> <span>The node number of the instrument setting the global variable.</span> </div> |
| Remarks                    | <ul style="list-style-type: none"> <li>• Do not use this command to set the value of a global variable on the local node.</li> <li>• <code>localnode.setglobal</code> is provided to assign values to variables from a remote node.</li> <li>• <code>localnode.setglobal</code> should not be used to assign values to global variables on the local node when executing the code on the local node. The value should be assigned directly.</li> </ul>                                                                               |
| Example                    | <code>node[3].setglobal("x", 5)</code> --sets the global variable "x" on node 3 to the value of 5.                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| <b>localnode.settime</b> |                                                                                                                                                                                                                                                       |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                 | Sets the real-time clock.                                                                                                                                                                                                                             |
| TSP-Link accessibility   | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                            |
| Usage                    | <code>localnode.settime(time)</code><br><br><div style="display: flex; justify-content: space-between;"> <span><code>time</code></span> <span>The time in seconds since January 1, 1970 UTC.</span> </div>                                            |
| Remarks                  | <ul style="list-style-type: none"> <li>• Time must be specified as UTC time.</li> <li>• Set the time zone before reading the time using the <code>os.time</code> function or before generating a UTC time from a local time specification.</li> </ul> |
| Example                  | To set local time:<br><pre>-- Assumes the time zone is correct. time = os.time((year = 2000, month = 8, day = 13, hour = 14, min = 35, isdst = true)) localnode.settime(time)</pre>                                                                   |

| <b>localnode.settimezone</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                     | Sets the local time zone.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| TSP-Link accessibility       | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Usage                        | <pre>localnode.settimezone(offset) localnode.settimezone(offset, dst_offset, dst_start, dst_end)</pre> <p> <code>offset</code> String representing offset from UTC.<br/> <code>dst_offset</code> String representing daylight savings offset from UTC.<br/> <code>dst_start</code> String representing when daylight savings time starts.<br/> <code>dst_end</code> String representing when daylight savings time ends. </p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Remarks                      | <ul style="list-style-type: none"> <li>The time zone is only used when converting between local time and UTC time when using the <code>os.time</code> and <code>os.date</code> functions.</li> <li>If only one parameter is given, the same time offset is used throughout the year. If four parameters are given, time is adjusted twice during the year for daylight savings time.</li> <li><code>offset</code> and <code>dst_offset</code> are strings of the form "[+ -]hh[:mm[:ss]]" that indicate how much time must be added to the local time to get UTC time. <code>hh</code> is a number between 0 and 23 that represents hours, <code>mm</code> is a number between 0 and 59 that represents minutes, and <code>ss</code> is a number between 0 and 59 that represents seconds. The minutes and seconds fields are optional.</li> <li>The UTC-5 time zone would be specified with the string "5" because UTC-5 is 5 hours behind UTC and one must add 5 hours to the local time to get UTC time. The time zone UTC4 would be specified as "-4" because UTC4 is 4 hours ahead of UTC and 4 hours must be subtracted from the local time to get UTC.</li> <li><code>dst_start</code> and <code>dst_end</code> are strings of the form "MM.w.dw/hh[:mm[:ss]]" that indicate when daylight savings time begins and ends respectively. <code>MM</code> is a number between 1 and 12 that represents the month, <code>w</code> is a number between 1 and 5 that represents the week within the month, <code>dw</code> is a number between 0 and 6 that represents the day of the week where 0 is Sunday. The rest of the fields represent the time of day that the change takes effect. <code>hh</code> represents hours, <code>mm</code> represents minutes, and <code>ss</code> represents seconds. The minutes and seconds fields are optional.</li> <li>The week of the month and day of the week fields are not specific dates.</li> </ul> |

| <b>localnode.showerrors</b> |                                                                                                                                                                                      |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                   | Automatic display of errors.                                                                                                                                                         |
| Default                     | 0                                                                                                                                                                                    |
| TSP-Link accessibility      | This attribute can be accessed from a remote TSP-Link node.                                                                                                                          |
| Usage                       | <pre>errormode = localnode.showerrors -- Reads show-errors state. localnode.showerrors = errormode -- Writes show-errors state.</pre> <p> <code>errormode</code> Set to 0 or 1. </p> |

|         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>• If this attribute is set to 1, the unit will automatically display any generated errors stored in the error queue, and then clear the queue. Errors will be processed at the end of executing a command message (just prior to issuing a prompt, if prompts are enabled).</li> <li>• If this attribute is set to 0, errors will be left in the error queue and must be explicitly read or cleared.</li> <li>• When used in an expanded system (TSP-Link), <code>localnode.showerrors</code> is sent to the remote master node only. Use <code>node[n].showerrors</code> (where <code>n</code> is the node number) to send the command to any node in the system. See <a href="#">Section 14</a> for details about TSP-Link.</li> </ul> |
| Details | See <a href="#">errorqueue</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

## makegetter and makesetter

These functions are used create functions that set and retrieve the value of an attribute.

| makegetter                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                    |                                                 |                            |                                   |                     |                                                   |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------------------------------|----------------------------|-----------------------------------|---------------------|---------------------------------------------------|
| Function                   | Creates a function to set the value of an attribute.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                    |                                                 |                            |                                   |                     |                                                   |
| TSP-Link accessibility     | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                    |                                                 |                            |                                   |                     |                                                   |
| Usage                      | <pre>getter = makegetter(table, attributename)</pre> <p> <table> <tr> <td><code>table</code></td> <td>Read-only table where the attribute is located.</td> </tr> <tr> <td><code>attributename</code></td> <td>The string name of the attribute.</td> </tr> <tr> <td><code>getter</code></td> <td>Function that returns the value of the attribute.</td> </tr> </table> </p>                                                                                                                                                                                            | <code>table</code> | Read-only table where the attribute is located. | <code>attributename</code> | The string name of the attribute. | <code>getter</code> | Function that returns the value of the attribute. |
| <code>table</code>         | Read-only table where the attribute is located.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                    |                                                 |                            |                                   |                     |                                                   |
| <code>attributename</code> | The string name of the attribute.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                    |                                                 |                            |                                   |                     |                                                   |
| <code>getter</code>        | Function that returns the value of the attribute.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                    |                                                 |                            |                                   |                     |                                                   |
| Remarks                    | <ul style="list-style-type: none"> <li>• This function creates a function that when called returns the value of the attribute. This function is useful for aliasing attributes to improve execution speed. Calling the <code>getter</code> function will execute faster than accessing the attribute directly.</li> <li>• Creating a <code>getter</code> function is only useful if it is going to be called several times. Otherwise the overhead of creating the <code>getter</code> function outweighs the overhead of accessing the attribute directly.</li> </ul> |                    |                                                 |                            |                                   |                     |                                                   |
| Example                    | <pre>Creates a getter function called getlevel: getlevel = makegetter(smua.source, "levelv") ... v = getlevel() When getlevel is called, it returns the value of smua.source.levelv.</pre>                                                                                                                                                                                                                                                                                                                                                                             |                    |                                                 |                            |                                   |                     |                                                   |

| makesetter                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                    |                                                 |                            |                                   |                     |                                                |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------------------------------|----------------------------|-----------------------------------|---------------------|------------------------------------------------|
| Function                   | Creates a function to set the value of an attribute.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                    |                                                 |                            |                                   |                     |                                                |
| TSP-Link accessibility     | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                    |                                                 |                            |                                   |                     |                                                |
| Usage                      | <pre>setter = makesetter(table, attributename)</pre> <p> <table> <tr> <td><code>table</code></td> <td>Read-only table where the attribute is located.</td> </tr> <tr> <td><code>attributename</code></td> <td>The string name of the attribute.</td> </tr> <tr> <td><code>setter</code></td> <td>Function that sets the value of the attribute.</td> </tr> </table> </p>                                                                                                                                                                                            | <code>table</code> | Read-only table where the attribute is located. | <code>attributename</code> | The string name of the attribute. | <code>setter</code> | Function that sets the value of the attribute. |
| <code>table</code>         | Read-only table where the attribute is located.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                    |                                                 |                            |                                   |                     |                                                |
| <code>attributename</code> | The string name of the attribute.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                    |                                                 |                            |                                   |                     |                                                |
| <code>setter</code>        | Function that sets the value of the attribute.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                    |                                                 |                            |                                   |                     |                                                |
| Remarks                    | <ul style="list-style-type: none"> <li>• This function creates a function that when called sets the value of the attribute. This function is useful for aliasing attributes to improve execution speed. Calling the <code>setter</code> function will execute faster than accessing the attribute directly.</li> <li>• Creating a <code>setter</code> function is only useful if it is going to be called several times. Otherwise the overhead of creating the <code>setter</code> function outweighs the overhead of accessing the attribute directly.</li> </ul> |                    |                                                 |                            |                                   |                     |                                                |

|         |                                                                                                                                                                                                                                                                                                  |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Example | <p>Creates a setter function called <code>setlevel</code>:</p> <pre>setlevel = makesetter(smua.source, "levelv") for v = 1, 10 do     setlevel(v) end</pre> <p>Using <code>setlevel</code> in the loop sets the value of <code>smua.source.levelv</code>, thereby performing a source sweep.</p> |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## meminfo

|                        |                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>meminfo</b>         |                                                                                                                                                                                                                                                                                                                                                                                        |
| Function               | Returns the current amount of available memory and the total amount of memory in the instrument.                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                          |
| Usage                  | <pre>freemem, totalmem = meminfo()</pre> <p><code>freemem</code>                      Amount of free dynamically allocated memory available.<br/> <code>totalmem</code>                      The total amount of dynamically allocated memory in the instrument.</p>                                                                                                                   |
| Remarks                | <ul style="list-style-type: none"> <li>• This function returns two values: <ul style="list-style-type: none"> <li>• The amount of free dynamically allocated memory available in kilobytes.</li> <li>• The total amount of dynamically allocated memory on the instrument in kilobytes.</li> </ul> </li> <li>• The difference between the two is the amount currently used.</li> </ul> |

## opc

This function sets the OPC bit in the status register when all overlapped commands are completed.

|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>opc</b>             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Function               | Sets the Operation Complete status bit when all overlapped commands are completed.                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Usage                  | <code>opc()</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Remarks                | <ul style="list-style-type: none"> <li>• This function will cause the Operation Complete bit in the Standard Event Status Register to be set when all previously started local overlapped commands are complete. Note that each node will independently set their Operation Complete bits in their own status models.</li> <li>• Any nodes not actively performing overlapped commands will set their bits immediately. All remaining nodes will set their own bits as they complete their own overlapped commands.</li> </ul> |
| Details                | See <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Also see               | <a href="#">waitcomplete</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |



## printbuffer and printnumber

These functions are used to print data and numbers.

| <b>printbuffer</b>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Prints data from tables and reading buffer sub-tables.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Usage                  | <p>There are multiple ways to use this function, the use depends on the number of tables or reading buffer subtables that are specified:</p> <pre>printbuffer(start_index, end_index, st_1) printbuffer(start_index, end_index, st_1, st_2) printbuffer(start_index, end_index, st_1, st_2, ..., st_n)</pre> <p>start_index                      Starting index of values to print.<br/> end_index                          Ending index of values to print.<br/> st_1, st_2, ... st_n              Tables or reading buffer subtables from which to print.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Remarks                | <ul style="list-style-type: none"> <li>• Correct usage when there are no outstanding overlapped commands to acquire data:</li> <li>• <math>1 \leq \text{start\_index} \leq \text{end\_index} \leq n</math></li> <li>• Where <math>n</math> refers to the index of the last entry in the tables to be printed.</li> <li>• If <math>\text{end\_index} &lt; \text{start\_index}</math> or <math>n &lt; \text{start\_index}</math>, no data will be printed. If <math>\text{start\_index} &lt; 1</math>, 1 will be used as the first index. If <math>n &lt; \text{end\_index}</math>, <math>n</math> will be used as the last index.</li> <li>• When any of the given reading buffers are being used in overlapped commands that have not yet completed at least to the desired index, this function will return data as it becomes available.</li> <li>• When there are outstanding overlapped commands to acquire data, <math>n</math> refers to the index that the last entry in the table will have after all the measurements have completed.</li> <li>• If you do not specify a subtable in a reading buffer, default subtables are automatically used. The readings subtable is the default for the Series 2600A reading buffers.</li> <li>• At least one table or subtable must be specified.</li> <li>• This command generates a single response message that contains all data. The response message is stored in the output queue.</li> <li>• The <code>format.data</code> attribute controls the format of the response message.</li> </ul> |
| Also see               | <a href="#">format.data</a> , <a href="#">printnumber</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Example                | <p>This example prints all time stamps and readings in one buffer and all readings from another buffer, where <math>n</math> is 4:</p> <pre>format.data = format.ASCII printbuffer(1, rb1.n, rb1.timestamps, rb1, rb2)</pre> <p>Example of returned data (timestamps, rb1.readings, rb2.readings):</p> <pre>1.02345E-04, 8.76542E-04, 5.29372E-01, 1.02445E-04, 8.66543E-04, 5.24242E-01, 1.02545E-04, 8.56547E-04, 5.19756E-01, 1.02645E-04, 8.44546E-04, 5.14346E-01</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| <b>printnumber</b>     |                                                                                                                                                                                                                                                                                 |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Prints numbers using the format selected for printing reading buffers.                                                                                                                                                                                                          |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                   |
| Usage                  | There are multiple ways to use this function, depending on how many numbers are to be printed:<br><pre>printnumber(v1) printnumber(v1,v2) printnumber(v1,v2, ..., vn)</pre> <p style="text-align: right;">v1, v2, ..., vn                      Numbers to print.</p>            |
| Remarks                | <ul style="list-style-type: none"> <li>This function will print the given numbers using the data format specified by <code>format.data</code> and other associated attributes.</li> <li>At least one number must be given.</li> </ul>                                           |
| Also see               | <a href="#">printbuffer</a> , <a href="#">format.data</a>                                                                                                                                                                                                                       |
| Example                | <p style="text-align: center;">Prints three measurements that were previously performed:</p> <pre>format.data = format.ASCII printnumber(i, v, t)</pre> <p style="text-align: center;">Example of returned data (i, v, t):</p> <pre>1.02345E-04, 8.76542E-02, 5.29372E-01</pre> |

## reset

| <b>reset</b>           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Resets the logical instruments to the default settings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Usage                  | <pre>reset() reset(system)</pre> <p style="text-align: right;">system                      Flag indicating what part of the system to reset. Can be set to <code>true</code> or <code>false</code>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Remarks                | <ul style="list-style-type: none"> <li>If <code>system</code> is set to <code>true</code> and the node is the master, the entire system will be reset.</li> <li>If <code>system</code> is set to <code>false</code>, only the local group will be reset.</li> <li>The default value of <code>system</code> when no value is given is <code>true</code>.</li> <li>This function resets all logical instruments in the system or local group. This function is equivalent to iterating over all the logical instruments and calling the <code>reset</code> method of each.</li> <li>Resetting the entire system is only permitted when the node is the master. If the node is not the master, it generates an error.</li> </ul> |
| Also see               | <a href="#">localnode.reset</a> , <a href="#">smuX.reset</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

## script

Use the following commands to load a script from the front panel and to save a script to the USB flash drive.

| <b>script.load</b>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Creates a script from a specified file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Usage                  | <pre>myscript = script.load(file) myscript = script.load(file, name)</pre> <p>myscript                      The created script, or nil if an error is encountered.<br/> file                              The path and file name of the script file to load.<br/> name                              The name of the script to be created.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Remarks                | <ul style="list-style-type: none"> <li>• If the name parameter is an empty string, or name is absent (or nil) and the script name cannot be extracted from the file, <code>myscript</code> is the only handle to the created script.</li> <li>• If the name parameter is present and not nil, any script name embedded in the file is ignored. Furthermore, if name conflicts with the name of an existing script in the <code>script.user.scripts</code> table, the existing script's name attribute will be set to an empty string before it is replaced in the <code>script.user.scripts</code> table by the newly created script.</li> <li>• If the name parameter is absent or nil, the command attempts to extract the name of the script from the file. Any conflict between the extracted name and that of an existing script in the <code>script.user.scripts</code> table generates an error. If the script name cannot be extracted, the created script's name attribute is initialized to the empty string, and must be set to a valid non-empty string before saving the script to internal memory.</li> <li>• The file path may be absolute or relative to the current working directory.</li> <li>• The script's name attribute is initialized to a value which (if not the empty string) also serves as the key used to access the script through the <code>script.user.scripts</code> table. Optional; if absent or nil, an attempt is made to extract the script's name from the file.</li> <li>• The file to be loaded must contain the <code>loadscript</code> or <code>loadandrunscript</code> keywords, the body of the script, and the <code>endscript</code> keyword.</li> </ul> |

| <b>script.new</b>      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Creates a script from a chunk of Lua code.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Usage                  | <pre>myscript = script.new(code) myscript = script.new(code, name)</pre> <p>myscript                      The created script, or nil if an error is encountered.<br/> code                              A string representing a chunk of Lua code to be used as the script body.<br/> name                              The name of the script to be created.</p>                                                                                                                                                                                                                                                                                                                         |
| Remarks                | <ul style="list-style-type: none"> <li>• If name conflicts with the name of an existing script in the <code>script.user.scripts</code> table, the existing script will be unnamed by setting its name attribute equal to the empty string before it is replaced in the <code>script.user.scripts</code> table by the newly created script.</li> <li>• If the name parameter is an empty string, or name is absent (or nil), <code>myscript</code> is the only handle to the created script.</li> <li>• The script's name attribute also serves as the key used to access the script through the <code>script.user.scripts</code> table. Optional; default is the empty string.</li> </ul> |

## serial

The functions and attributes in this group are used to configure the RS-232 Interface.

| <b>serial.baud</b>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | Baud rate for the RS-232 port.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Default                | 9600                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Usage                  | <pre> baud = serial.baud      -- Reads baud rate. serial.baud = baud     -- Writes baud rate.  baud                    Set to 300, 600, 1200, 2400, 4800, 9600, 19200, 38400,                         57600 or 115200. </pre>                                                                                                                                                                                                                                                                                        |
| Remarks                | <ul style="list-style-type: none"> <li>• A new baud rate setting takes effect when the command to change it is processed.</li> <li>• The user should allow ample time for the command to be processed before attempting to communicate with the instrument again. It is recommended that the baud rate be set from one of the other command interfaces or from the front panel.</li> <li>• The baud rate is stored in nonvolatile memory. The <code>reset</code> function has no effect on the baud rate.</li> </ul> |
| Details                | See <a href="#">RS-232 interface operation</a> in <a href="#">Section 15</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Also see               | <a href="#">serial.databits</a> , <a href="#">serial.flowcontrol</a> , <a href="#">serial.parity</a>                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Example                | Sets the baud rate to 1200:<br><code>serial.baud = 1200</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| <b>serial.databits</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | Character width (data bits) for the RS-232 port.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Default                | 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Usage                  | <pre> bits = serial.databits  -- Reads data width. serial.databits = bits  -- Writes data width.  bits                    Set to 7 or 8. </pre>                                                                                                                                                                                                                                                                                                                                                                          |
| Remarks                | <ul style="list-style-type: none"> <li>• A new data width setting takes effect when the command to change it is processed.</li> <li>• The user should allow ample time for the command to be processed before attempting to communicate with the instrument again. It is recommended that the data width be set from one of the other command interfaces or from the front panel.</li> <li>• The data bits value is stored in nonvolatile memory. The <code>reset</code> function has no effect on data bits.</li> </ul> |
| Details                | See <a href="#">RS-232 interface operation</a> in <a href="#">Section 15</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Also see               | <a href="#">serial.baud</a> , <a href="#">serial.flowcontrol</a> , <a href="#">serial.parity</a>                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Example                | Sets data width to 8:<br><code>serial.databits = 8</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

| <b>serial.flowcontrol</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                 | Flow control for the RS-232 port.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Default                   | "none"                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| TSP-Link accessibility    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Usage                     | <pre>flow = serial.flowcontrol    -- Reads flow control. serial.flowcontrol = flow    -- Writes flow control.</pre> <p>Set <code>flow</code> to one of the following values:</p> <pre>"none" or serial.FLOW_NONE    Selects no flow control. "hardware" or serial.FLOW_HARDWARE  Selects hardware flow control.</pre>                                                                                                                                                                                                              |
| Remarks                   | <ul style="list-style-type: none"> <li>• A new flow control setting takes effect when the command to change it is processed.</li> <li>• The user should allow ample time for the command to be processed before attempting to communicate with the instrument again. It is recommended that the flow control be set from one of the other command interfaces or from the front panel.</li> <li>• The flow control value is stored in nonvolatile memory. The <code>reset</code> function has no effect on flow control.</li> </ul> |
| Details                   | See <a href="#">RS-232 interface operation</a> in <a href="#">Section 15</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Also see                  | <a href="#">serial.baud</a> , <a href="#">serial.databits</a> , <a href="#">serial.parity</a>                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Example                   | Sets flow control to none:<br><pre>serial.flowcontrol = serial.FLOW_NONE</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

| <b>serial.parity</b>   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | Parity for the RS-232 port.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Default                | "none"                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Usage                  | <pre>parity = serial.parity      -- Reads parity. serial.parity = parity      -- Writes parity.</pre> <p>Set <code>parity</code> to one of the following values:</p> <pre>"none" or serial.PARITY_NONE    Selects no parity. "even" or serial.PARITY_EVEN    Selects even parity. "odd" or serial.PARITY_ODD     Selects odd parity.</pre>                                                                                                                                                                   |
| Remarks                | <ul style="list-style-type: none"> <li>• A new parity setting takes effect when the command to change it is processed.</li> <li>• The user should allow ample time for the command to be processed before attempting to communicate with the instrument again. It is recommended that the parity be set from one of the other command interfaces or from the front panel.</li> <li>• The parity setting is stored in nonvolatile memory. The <code>reset</code> function has no effect on parity.</li> </ul> |
| Details                | See <a href="#">RS-232 interface operation</a> in <a href="#">Section 15</a> .                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Also see               | <a href="#">serial.baud</a> , <a href="#">serial.databits</a> , <a href="#">serial.flowcontrol</a>                                                                                                                                                                                                                                                                                                                                                                                                           |
| Example                | Sets parity to none:<br><pre>serial.parity = serial.PARITY_NONE</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| <b>serial.read</b>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Reads data from the serial port.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Usage                  | <pre>data = serial.read(maxchars)</pre> <p> <code>maxchars</code>                      The maximum number of characters to read.<br/> <code>data</code>                                Returns a string consisting of all data read from the serial port. </p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Remarks                | <ul style="list-style-type: none"> <li>• This function will read available characters from the serial port. It will not wait for new characters to arrive. As long as <code>maxchars</code> is a relatively small number (less than several hundred characters), all characters received by the serial port prior to the call will be returned. This might be less than <code>maxchars</code>. If too many characters are received in between calls to this function, the RS-232 buffers will overflow and some characters may be lost.</li> <li>• This function can be called as many times as necessary to receive the required number of characters. For optimal performance, it is suggested that a small delay be used between repeat calls to this function.</li> <li>• The data returned is the raw data stream read from the port. Control characters, terminator characters, etc. will not be interpreted nor will the data stream be altered in any way.</li> <li>• This function cannot be used if the serial port is enabled as a command interface. A settings conflict error will be generated if the serial port is enabled as a command interface when this function is called.</li> </ul> |
| Also see               | <a href="#">serial.write</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Example                | Reads data from the serial port:<br><pre>data = serial.read(200) print(data)</pre> Output: John Doe<br>The above output indicates that the string "John Doe" was read from the serial port.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

| <b>serial.write</b>    |                                                                                                                                                                                                                                                                          |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Writes data to the serial port.                                                                                                                                                                                                                                          |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                               |
| Usage                  | <pre>serial.write(data)</pre> <p> <code>data</code>                                Specify the data string to write. </p>                                                                                                                                                |
| Remarks                | This function will write the given string to the serial port where it can be read by equipment (for example, a component handler) connected to the other end of the serial port. No terminator characters are added to the data. The data will be written exactly as is. |
| Also see               | <a href="#">serial.read</a>                                                                                                                                                                                                                                              |
| Example                | Writes data string "1 2 3 4" to the serial port:<br><pre>serial.write("1 2 3 4")</pre>                                                                                                                                                                                   |

## setup

The functions and attribute in this group are used to save/recall setups and to set the power-on setup.

| <b>setup.poweron</b>   |                                                                                                                                                                                                                                   |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | The saved setup to recall when the unit is turned on.                                                                                                                                                                             |
| Default                | 0                                                                                                                                                                                                                                 |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                       |
| Usage                  | <pre>n = setup.poweron          -- Reads the power-on setup. setup.poweron = n          -- Writes the power-on setup.  n                          Setup number to recall on power up (0 to 5).</pre>                              |
| Remarks                | <ul style="list-style-type: none"> <li>For an <code>n</code> setting of 0, the unit powers up to the factory default (reset) setup. For an <code>n</code> setting of 1 to 5, the unit powers up to a user saved setup.</li> </ul> |
| Details                | See <a href="#">Power-up</a> in <a href="#">Section 1</a> .                                                                                                                                                                       |
| Example                | Sets unit to power on to the factory defaults:<br><code>setup.poweron = 0</code>                                                                                                                                                  |

| <b>setup.recall</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Recalls settings from a saved setup.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Usage                  | <pre>setup.recall(id)  id                          The setup ID.</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Remarks                | <ul style="list-style-type: none"> <li>If a number (<code>n</code>), this parameter is interpreted as a setup number, and the setup is restored from internal memory. If it is a string, this parameter is interpreted as a path and file name, and the setup is restored from the corresponding file on the memory stick. The path may be absolute or relative to the current working directory.</li> <li>For an <code>n</code> setting of 0, the unit recalls the factory default (reset) setup. For an <code>n</code> setting of 1 to 5, the unit recalls a user saved setup from the internal nonvolatile memory.</li> <li>Saved setup settings can also be loaded from a USB memory stick. If <code>id</code> is a string, the setup will be recalled from the memory stick and <code>id</code> is the file name as described above.</li> </ul> |
| Details                | See <a href="#">User setup</a> in <a href="#">Section 3</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Example                | Recalls the user-setup at location 2:<br><code>setup.recall(2)</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |





## smuX

The functions and attributes in this group are used to control basic source-measure operations of the SMUs and perform calibration.

| <b>smuX.abort</b> <span style="float: right;">X= SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                 |
|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                    | Aborts all overlapped operations on an SMU.                                                                                                                                                                                                                                     |
| TSP-Link accessibility                                                       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                     |
| Usage                                                                        | <code>smuX.abort()</code>                                                                                                                                                                                                                                                       |
| Remarks                                                                      | <ul style="list-style-type: none"> <li>If the overlapped operation being aborted is a sweep, the SMU will exit its trigger model immediately when the abort is executed.</li> <li><code>smuX.abort</code> will not turn the output off or change any other settings.</li> </ul> |

| <b>smuX.cal.adjustdate</b> <span style="float: right;">X= SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                             | Adjustment date of the last calibration adjustment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Default                                                                               | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| TSP-Link accessibility                                                                | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Usage                                                                                 | <pre>adjustdate = smuX.cal.adjustdate -- Reads the adjustment date. smuX.cal.adjustdate = adjustdate -- Writes the adjustment date.</pre> <p style="text-align: center;"><code>adjustdate</code>                      The date of the last calibration adjustment.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Remarks                                                                               | <ul style="list-style-type: none"> <li><code>smuX.cal.adjustdate</code> must be set to the date the adjustment was done using the UTC time and date. The date is stored as the number of seconds since UTC, 12:00 am Jan 1, 1970.</li> <li>This attribute stores the adjustment date associated with the active calibration set. The adjustment date can be read at any time, but can only be assigned a new value when calibration has been enabled with the <code>smuX.cal.unlock</code> function.</li> <li>You cannot change the adjust date without first making a change to the calibration constants.</li> <li>Once you change any calibration constants, you must set the adjust date before being allowed to save the calibration data to NV memory.</li> <li>This attribute is stored with the active calibration set. If a different calibration set is restored, this attribute will reflect the date stored with that set.</li> <li>Due to the internal storage format, <code>smuX.cal.adjustdate</code> is only accurate to within a few minutes of the value set.</li> </ul> |
| Details                                                                               | See <a href="#">Calibration</a> in <a href="#">Section 20</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Also see                                                                              | <a href="#">smuX.cal.lock</a> , <a href="#">smuX.cal.unlock</a> , <a href="#">smuX.cal.save</a> , <a href="#">smuX.cal.restore</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Example                                                                               | Set <code>adjustdate</code> to the current time set on the instrument:<br><code>smua.cal.adjustdate = os.time()</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

| <b>smuX.cal.date</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                        | Calibration date for the active calibration set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Default                                                                          | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| TSP-Link accessibility                                                           | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Usage                                                                            | <pre>caldate = smuX.cal.date      -- Reads calibration date. smuX.cal.date = caldate     -- Writes calibration date.</pre> <p style="text-align: center;"><code>caldate</code>                      Sets the current calibration's adjustment date.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Remarks                                                                          | <ul style="list-style-type: none"> <li>• <code>smuX.cal.date</code> must be set to the date the adjustment was done using the UTC time and date. The date is stored as the number of seconds since UTC 12:00 am Jan 1, 1970.</li> <li>• This attribute stores the calibration date associated with the active calibration set. The calibration date can be read at any time but can only be assigned a new value when calibration has been enabled with the <code>smuX.cal.unlock</code> function.</li> <li>• This attribute is stored with the active calibration set. If a different calibration set is restored, this attribute will reflect the date stored with that set.</li> <li>• Due to the internal storage format, <code>smuX.cal.adjustdate</code> is only accurate to within a few minutes of the value set.</li> </ul> |
| Details                                                                          | See <a href="#">Calibration</a> in <a href="#">Section 20</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Also see                                                                         | <a href="#">smuX.cal.adjustdate</a> , <a href="#">smuX.cal.due</a> , <a href="#">smuX.cal.restore</a> , <a href="#">smuX.cal.save</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Example                                                                          | Sets calibration date for SMU A to the current time set on the instrument:<br><pre>smua.cal.date = os.time()</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| <b>smuX.cal.due</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                       | Calibration due date for the next calibration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Default                                                                         | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| TSP-Link accessibility                                                          | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Usage                                                                           | <pre>caldue = smuX.cal.due      -- Reads calibration due date. smuX.cal.due = caldue     -- Writes calibration due date.</pre> <p style="text-align: center;"><code>caldue</code>                      Sets the next calibration due date.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Remarks                                                                         | <ul style="list-style-type: none"> <li>• <code>smuX.cal.due</code> must be set to the date the adjustment was done using the UTC time and date. The date is stored as the number of seconds since UTC 12:00 am Jan 1, 1970.</li> <li>• This attribute stores the calibration due date associated with the active calibration set. The calibration due date can be read at any time but can only be assigned a new value when calibration has been enabled with the <code>smuX.cal.unlock</code> function.</li> <li>• This attribute is stored with the active calibration set. If a different calibration set is restored, this attribute will reflect the due date stored with that set.</li> <li>• Due to the internal storage format, <code>smuX.cal.adjustdate</code> is only accurate to within a few minutes of the value set.</li> </ul> |
| Details                                                                         | See <a href="#">Calibration</a> in <a href="#">Section 20</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Also see                                                                        | <a href="#">smuX.cal.date</a> , <a href="#">smuX.cal.restore</a> , <a href="#">smuX.cal.state</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Example                                                                         | Sets calibration due date for one year from the current time set on the instrument:<br><pre>smua.cal.due = os.time() + 365 * 24 * 60 * 60</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

| <b>smuX.cal.lock</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                                                                         | Disables commands that change calibration settings.                                                                                                                                                                                                                                                                                                                                                        |
| TSP-Link accessibility                                                           | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                 |
| Usage                                                                            | <code>smuX.cal.lock()</code>                                                                                                                                                                                                                                                                                                                                                                               |
| Remarks                                                                          | <ul style="list-style-type: none"> <li>This function will disable the calibration functions that can change the calibration settings. It is an error to call this function while the calibration state is <code>smuX.CALSTATE_CALIBRATING</code>. The calibration constants must be written to nonvolatile memory, or a previous calibration set must be restored prior to locking calibration.</li> </ul> |
| Details                                                                          | See <a href="#">Calibration</a> in <a href="#">Section 20</a> .                                                                                                                                                                                                                                                                                                                                            |
| Also see                                                                         | <a href="#">smuX.cal.restore</a> , <a href="#">smuX.cal.save</a> , <a href="#">smuX.cal.state</a>                                                                                                                                                                                                                                                                                                          |
| Example                                                                          | Disable calibration functions for SMU A:<br><code>smua.cal.lock()</code>                                                                                                                                                                                                                                                                                                                                   |

| <b>smuX.cal.password</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                               |
|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                            | Password to enable calibration.                                                                                                                                                               |
| Default                                                                              | "K10026XX"                                                                                                                                                                                    |
| TSP-Link accessibility                                                               | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                   |
| Usage                                                                                | <pre>smuX.cal.password = newpassword</pre> <p style="text-align: center;"><code>newpassword</code>                      The new password (string).</p>                                        |
| Remarks                                                                              | <ul style="list-style-type: none"> <li>A new password can only be assigned when calibration has been unlocked.</li> <li>The calibration password is write-only and cannot be read.</li> </ul> |
| Details                                                                              | See <a href="#">Calibration</a> in <a href="#">Section 20</a> .                                                                                                                               |
| Example                                                                              | Assign a new calibration password for SMU A:<br><code>smua.cal.password = "LetMeIn"</code>                                                                                                    |

| <b>smuX.cal.polarity</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                            | Control which calibration constants are used for all subsequent measurements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Default                                                                              | smuX.CAL_AUTO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility                                                               | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Usage                                                                                | <pre>calpolarity = smuX.cal.polarity -- Reads cal polarity. smuX.cal.polarity = calpolarity -- Writes cal polarity.</pre> <p>calpolarity                      The polarity to use for measurements.</p> <p>Set calpolarity to one of the following values:</p> <p>0 or smuX.CAL_AUTO              Automatic polarity detection.</p> <p>1 or smuX.CAL_POSITIVE        Measure with positive polarity calibration constants.</p> <p>2 or smuX.CAL_NEGATIVE        Measure with negative polarity calibration constants.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Remarks                                                                              | <ul style="list-style-type: none"> <li>This attribute controls which polarity calibration constants are used to make all subsequent measurements. This attribute does not affect the <code>smuX.measure.calibrateY</code> or the <code>smuX.source.calibrateY</code> function. The polarity for those commands are dictated by the range parameter given to the command.</li> <li>The measurement calibration commands require the measurements provided to have been made using the polarity being calibrated. When the calibration points are sufficiently far away from zero the desired polarity constants are inherently used when making those measurements. When measuring near zero, it is possible for the measurement to be made using the calibration constants from either polarity without knowing which was used. Setting this attribute to positive or negative forces measurements to be made using the calibration constants for a given polarity rather than basing the choice on the raw measurement data.</li> <li>This attribute can only be set to positive or negative when calibration is unlocked. This attribute will automatically be set back to CAL_AUTO when calibration is locked.</li> </ul> |
| Details                                                                              | See <a href="#">Calibration</a> in <a href="#">Section 20</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Also see                                                                             | <a href="#">smuX.measure.calibrateY</a> , <a href="#">smuX.source.calibrateY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Example                                                                              | Selects positive calibration constants for all subsequent measurements:<br><pre>smua.cal.polarity = smua.CAL_POSITIVE</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

| <b>smuX.cal.restore</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                                                                            | Loads a stored set of calibration constants.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility                                                              | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Usage                                                                               | <p>There are two ways to use this function:</p> <pre>smuX.cal.restore() smuX.cal.restore(calset)</pre> <p>calset                              Calibration set to be loaded.</p> <p>Set calset to one of the following values:</p> <p>smuX.CALSET_NOMINAL            A set of calibration constants that are uncalibrated, but set to nominal values to allow rudimentary functioning of the instrument.</p> <p>smuX.CALSET_FACTORY            The calibration constants when the instrument left the factory.</p> <p>smuX.CALSET_DEFAULT            The normal calibration set.</p> <p>smuX.CALSET_PREVIOUS          The calibration set that was used before the last default set was overwritten.</p> <p>If calset is not specified, smuX.CALSET_DEFAULT will be used.</p> |





| <b>smuX.contact.calibratelo</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                                                                                    | Calibrate the low/sense low contact check measurement.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| TSP-Link accessibility                                                                      | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Usage                                                                                       | <pre>smuX.contact.calibratelo(cp1measured, cp1reference, cp2measured, cp2reference)</pre> <p> <code>cp1measured</code>                    The value measured by this SMU for calibration point 1.<br/> <code>cp1reference</code>                    The reference measurement for calibration point 1 as measured externally.<br/> <br/> <code>cp2measured</code>                    The value measured by this SMU for calibration point 2.<br/> <code>cp2reference</code>                    The reference measurement for calibration point 2 as measured externally. </p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Remarks                                                                                     | <ul style="list-style-type: none"> <li>• Contact check measurement calibration does not require range information.</li> <li>• Typically the two calibration points used will be near 0Ω for calibration point 1 and 50Ω for calibration point 2.</li> <li>• All four measurements (<code>cp1measured</code>, <code>cp1reference</code>, <code>cp2measured</code>, and <code>cp2reference</code>) must be made with the active calibration set. Corruption of the calibration constants may result if this is not heeded.</li> <li>• The new calibration constants will be activated immediately but they will not be written to nonvolatile storage. Use <code>smuX.cal.save</code> to commit the new constants to nonvolatile storage. The active calibration constants will stay in effect until the instrument is power cycled or a calibration set is loaded from nonvolatile storage with the <code>smuX.cal.restore</code> function.</li> <li>• This function will be disabled until a successful call to <code>smuX.cal.unlock</code> is made.</li> </ul> |
| Details                                                                                     | See <a href="#">Section 20</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Also see                                                                                    | <a href="#">smuX.contact.calibratehi</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| <b>smuX.contact.check</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                                                                              | Determine if contact resistance is lower than the threshold.                                                                                                                                                                                                                                                                                                                                                                                                         |
| TSP-Link accessibility                                                                | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                           |
| Usage                                                                                 | <pre>flag = smuX.contact.check()</pre> <p style="text-align: center;"><code>flag</code> Indicates whether contact resistance is lower than the threshold.</p>                                                                                                                                                                                                                                                                                                        |
| Remarks                                                                               | <ul style="list-style-type: none"> <li>• This function returns <code>true</code> if the contact resistance is below the threshold, and <code>false</code> if it is above the threshold.</li> <li>• Attempting to perform a contact check measurement when any of the following conditions exist will generate an error: <ul style="list-style-type: none"> <li>• Output is off in High-Z mode.</li> <li>• Current limit set to less than 1mA.</li> </ul> </li> </ul> |
| Details                                                                               | See <a href="#">Section 2</a> for connections.                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Also see                                                                              | <a href="#">smuX.contact.threshold</a> , <a href="#">smuX.contact.speed</a>                                                                                                                                                                                                                                                                                                                                                                                          |
| Example                                                                               | <p>Takes action if contact check on SMU A fails:</p> <pre>if (not smua.contact.check()) then     -- take action end</pre>                                                                                                                                                                                                                                                                                                                                            |

| <b>smuX.contact.r</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                          |
|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                                                                          | Measure contact resistance.                                                                                                                                                                                                                                                              |
| TSP-Link accessibility                                                            | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                               |
| Usage                                                                             | <pre>rhi, rlo = smuX.contact.r()</pre> <p> <span style="margin-left: 2em;">rhi</span>            The measured contact resistance on the high/sense high side.<br/> <span style="margin-left: 2em;">rlo</span>            The measured contact resistance on the low/sense low side. </p> |
| Remarks                                                                           | <ul style="list-style-type: none"> <li>Attempting to perform a contact check measurement when any of the following conditions exist will generate an error:</li> <li>Output is off in High-Z mode.</li> <li>Current limit set to less than 1mA.</li> </ul>                               |
| Details                                                                           | See <a href="#">Section 2</a> for connections.                                                                                                                                                                                                                                           |
| Also see                                                                          | <a href="#">smuX.contact.speed</a>                                                                                                                                                                                                                                                       |

| <b>smuX.contact.speed</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                             | The speed setting for contact check measurements.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Default                                                                               | <code>smuX.CONTACT_FAST</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| TSP-Link accessibility                                                                | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Usage                                                                                 | <pre>speed_opt = smuX.contact.speed            -- Reads speed setting. smuX.contact.speed = speed_opt          -- Writes speed setting.</pre> <p> <span style="margin-left: 2em;">speed_opt</span>                            The speed setting. </p> <p>Set <code>speed_opt</code> to one of the following:</p> <ul style="list-style-type: none"> <li>0 or <code>smuX.CONTACT_FAST</code></li> <li>1 or <code>smuX.CONTACT_MEDIUM</code></li> <li>2 or <code>smuX.CONTACT_SLOW</code></li> </ul> |
| Remarks                                                                               | <ul style="list-style-type: none"> <li>This setting controls the aperture of measurements made for contact check. It does not affect the <code>smuX.measure.nplc</code> aperture setting.</li> <li>The speed setting can have a dramatic effect on the accuracy of the measurement, as reflected in the specifications.</li> </ul>                                                                                                                                                                 |
| Example                                                                               | Set contact check measurements on SMU A for higher accuracy:<br><pre>smua.contact.speed = smua.CONTACT_SLOW</pre>                                                                                                                                                                                                                                                                                                                                                                                  |



| <b>smuX.contact.threshold</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                 | Resistance threshold for the <code>smuX.contact.check</code> function.                                                                                                                                                                                                                                            |
| Default                                                                                   | 50                                                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility                                                                    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                       |
| Usage                                                                                     | <pre>rvalue = smuX.contact.threshold      -- Reads threshold value. smuX.contact.threshold = rvalue      -- Writes threshold value.  smuX.contact.threshold = rvalue rvalue = smuX.contact.threshold  rvalue                                The resistance, in ohms, above which contact check should fail.</pre> |
| Remarks                                                                                   | The default threshold is 50Ω. The threshold should be set to less than 1kΩ.                                                                                                                                                                                                                                       |
| Also see                                                                                  | <a href="#">smuX.contact.check</a>                                                                                                                                                                                                                                                                                |
| Example                                                                                   | Set the contact check threshold for SMU A to 5Ω:<br><pre>smua.contact.threshold = 5</pre>                                                                                                                                                                                                                         |

| <b>smuX.makebuffer</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                                                                           | Creates a reading buffer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Default                                                                            | 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| TSP-Link accessibility                                                             | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Usage                                                                              | <pre>mybuffer = smuX.makebuffer(bufferSize)  bufferSize                                Number of readings that can be stored. mybuffer                                  The reading buffer.</pre>                                                                                                                                                                                                                                                                                                                                                      |
| Remarks                                                                            | <ul style="list-style-type: none"> <li>Reading buffers can be allocated dynamically. These are created and allocated with the <code>smuX.makebuffer(buffer)</code> function, where <code>bufferSize</code> is the number of readings the buffer can store.</li> <li>Dynamically allocated reading buffers can be used interchangeably with the <code>smuX.nvbufferY</code> buffers.</li> <li>A reading buffer can be deleted by setting all references to the reading buffer equal to <code>nil</code>, then running the garbage collector.</li> </ul> |
| Details                                                                            | See <a href="#">Reading Buffers</a> in <a href="#">Section 7</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Also see                                                                           | <a href="#">smuX.nvbufferY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Example                                                                            | Creates a 200 reading RAM buffer named “mybuffer2” for SMUA:<br><pre>mybuffer2 = smua.makebuffer(200)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| <b>smuX.measure.analogfilter</b> <span style="float: right;">X = SMU channel (a or b)<br/>(Models 2635A and 2636A only)</span> |                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                                                      | Controls the use of an analog filter when measuring on the lowest current ranges.                                                                                                                                                                                        |
| TSP-Link accessibility                                                                                                         | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                              |
| Usage                                                                                                                          | <pre>option = smuX.measure.analogfilter -- Reads the filter setting. smuX.measure.analogfilter = option -- Writes the filter setting.</pre> <p style="text-align: center;">option indicates the filter setting<br/>Where option is:<br/>0 filter off<br/>1 filter on</p> |
| Remarks                                                                                                                        | <ul style="list-style-type: none"> <li>This attribute engages an approximately 1Hz analog filter across the current range elements.</li> <li>The analog filter is only active when using the 1nA and 100pA measurement ranges.</li> </ul>                                |
| Example                                                                                                                        | Turns off the analog filter:<br><code>smua.measure.analogfilter = 0</code>                                                                                                                                                                                               |

| <b>smuX.measure.autorangeY</b> <span style="float: right;">X = SMU channel (a or b)<br/>Y = SMU measure function (v or i)<br/>Where: v = voltage, i = current</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                                                                                            | Measurement auto range setting.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Default                                                                                                                                                              | <code>smuX.AUTORANGE_ON</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| TSP-Link accessibility                                                                                                                                               | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Usage                                                                                                                                                                | <pre>autorange = smuX.measure.aurangei -- Reads current measure auto -- range. smuX.measure.aurangei = autorange -- Writes current measure auto -- range. autorange = smuX.measure.aurangev -- Reads voltage measure auto -- range. smuX.measure.aurangev = autorange -- Writes voltage measure auto -- range.</pre> <p style="text-align: center;">autorange Indicates whether measurement auto range is active.<br/>Set autorange to one of the following values:<br/>0 or <code>smuX.AUTORANGE_OFF</code> Disables measurement auto range.<br/>1 or <code>smuX.AUTORANGE_ON</code> Enables measurement auto range.</p>                                                         |
| Remarks                                                                                                                                                              | <ul style="list-style-type: none"> <li>This attribute indicates the measurement auto range state. Its value will be <code>smuX.AUTORANGE_OFF</code> when the SMU measure circuit is on a fixed range and <code>smuX.AUTORANGE_ON</code> when it is in auto range mode.</li> <li>Setting this attribute to <code>smuX.AUTORANGE_OFF</code> puts the SMU on a fixed range. The fixed range used will be the range the SMU measure circuit was currently using.</li> <li>Setting this attribute to <code>smuX.AUTORANGE_ON</code> puts the SMU measure circuit into auto range mode. It will remain on its present measure range until the next measurement is requested.</li> </ul> |
| Details                                                                                                                                                              | See <a href="#">Range</a> in <a href="#">Section 6</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Also see                                                                                                                                                             | <a href="#">smuX.measure.rangeY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Example                                                                                                                                                              | Enables voltage measurement autoranging for SMU A:<br><code>smua.measure.aurangev = smua.AUTORANGE_ON</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

| <b>smuX.measure.autozero</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                     |                    |                                      |                                                 |                                      |                                                                                                 |
|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|--------------------|--------------------------------------|-------------------------------------------------|--------------------------------------|-------------------------------------------------------------------------------------------------|
| Attribute                                                                                | Behavior of the SMU's A/D internal reference measurements (autozero).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                     |                    |                                      |                                                 |                                      |                                                                                                 |
| Default                                                                                  | <code>smuX.AUTOZERO_AUTO</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                     |                    |                                      |                                                 |                                      |                                                                                                 |
| TSP-Link accessibility                                                                   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                     |                    |                                      |                                                 |                                      |                                                                                                 |
| Usage                                                                                    | <pre>azmode = smuX.measure.autozero    -- Reads autozero. smuX.measure.autozero = azmode    -- Writes autozero.</pre> <p style="text-align: center;">azmode <span style="float: right;">Indicates status of autozero.</span></p> <p>Set azmode to be one of the following values:</p> <table style="width: 100%; border: none;"> <tr> <td style="padding-right: 20px;">0 or <code>smuX.AUTOZERO_OFF</code></td> <td>Autozero disabled.</td> </tr> <tr> <td style="padding-right: 20px;">1 or <code>smuX.AUTOZERO_ONCE</code></td> <td>Performs autozero once, then disables autozero.</td> </tr> <tr> <td style="padding-right: 20px;">2 or <code>smuX.AUTOZERO_AUTO</code></td> <td>Automatic checking of reference and zero measurements.<br/>An autozero is performed when needed.</td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0 or <code>smuX.AUTOZERO_OFF</code> | Autozero disabled. | 1 or <code>smuX.AUTOZERO_ONCE</code> | Performs autozero once, then disables autozero. | 2 or <code>smuX.AUTOZERO_AUTO</code> | Automatic checking of reference and zero measurements.<br>An autozero is performed when needed. |
| 0 or <code>smuX.AUTOZERO_OFF</code>                                                      | Autozero disabled.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                     |                    |                                      |                                                 |                                      |                                                                                                 |
| 1 or <code>smuX.AUTOZERO_ONCE</code>                                                     | Performs autozero once, then disables autozero.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                     |                    |                                      |                                                 |                                      |                                                                                                 |
| 2 or <code>smuX.AUTOZERO_AUTO</code>                                                     | Automatic checking of reference and zero measurements.<br>An autozero is performed when needed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                     |                    |                                      |                                                 |                                      |                                                                                                 |
| Remarks                                                                                  | <ul style="list-style-type: none"> <li>• The Series 2600A uses a ratio metric A/D conversion technique. To ensure accuracy of readings, the instrument must periodically obtain fresh measurements of its internal ground and voltage reference. The time interval between needing to update these reference measurements is determined by the integration aperture being used for measurements. Separate reference and zero measurements are used for each aperture.</li> <li>• By default, the instrument automatically checks these reference measurements whenever a signal measurement is made. If the reference measurements have expired when a signal measurement is made, the instrument will automatically take two more A/D conversions, one for the reference and one for the zero, before returning the result. Thus, occasionally, a measurement takes longer than normal.</li> <li>• This extra time can cause problems in sweeps and other test sequences in which measurement timing is critical. To avoid the extra time for the reference measurements in these situations, the <code>smuX.measure.autozero</code> attribute can be used to disable the automatic reference measurements. Keep in mind that with automatic reference measurements disabled, the instrument may gradually drift out of specification.</li> <li>• To minimize the drift, a reference and zero measurement should be made just prior to the critical test sequence. The <code>smuX.AUTOZERO_ONCE</code> setting can be used to force a refresh of the reference and zero measurements used for the current aperture setting.</li> <li>• Autozero reference measurements for the last 10 used NPLC settings are stored in a reference cache. If an NPLC setting is selected and an entry for it is not in the cache, the oldest (least recently used) entry will be discarded to make room for the new entry.</li> </ul> |                                     |                    |                                      |                                                 |                                      |                                                                                                 |
| Example                                                                                  | Perform autozero once for SMU A:<br><code>smua.measure.autozero = smua.AUTOZERO_ONCE</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                     |                    |                                      |                                                 |                                      |                                                                                                 |

| <b>smuX.measure.calibrateY</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | X = SMU channel (a or b)<br>Y = SMU measure function (v or i)<br>Where: v = voltage, i = current |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Function                       | Generates and activates new measurement calibration constants.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                  |
| TSP-Link accessibility         | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                  |
| Usage                          | <pre>smuX.measure.calibratev(range, cp1measured, cp1reference, cp2measured, cp2reference) smuX.measure.calibratei(range, cp1measured, cp1reference, cp2measured, cp2reference)</pre> <p>range                                 The measurement range to calibrate.<br/> cp1measured                         The value measured by this SMU for calibration point 1.<br/> cp1reference                         The reference measurement for calibration point 1 as<br/>                                           measured externally.<br/> cp2measured                         The value measured by this SMU for calibration point 2.<br/> cp2reference                         The reference measurement for calibration measured<br/>                                           externally.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                  |
| Remarks                        | <ul style="list-style-type: none"> <li>This function generates and activates new calibration constants for the given range. The positive and negative polarities of the instrument must be calibrated separately. Use a positive value for <i>range</i> to calibrate the positive polarity and a negative value for <i>range</i> to calibrate the negative polarity.</li> <li>Typically the two calibration points used will be near zero for calibration point 1 and 90% of full-scale for calibration point 2.</li> <li>All four measurements (<i>cp1measured</i>, <i>cp1reference</i>, <i>cp2measured</i>, and <i>cp2reference</i>) <b>must</b> be made with the active calibration set. Corruption of the calibration constants may result if this is not heeded.</li> <li>The new calibration constants will be activated immediately but they will not be written to nonvolatile storage. Use <i>smuX.cal.save</i> to commit the new constants to nonvolatile storage. The active calibration constants will stay in effect until the instrument is power cycled or a calibration set is loaded from nonvolatile storage with the <i>smuX.cal.restore</i> function.</li> <li>This function will be disabled until a successful call to <i>smuX.cal.unlock</i> is made.</li> </ul> |                                                                                                  |
| Details                        | See <a href="#">Section 20</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                  |
| Also see                       | <a href="#">smuX.cal.restore</a> , <a href="#">smuX.cal.save</a> , <a href="#">smuX.makebuffer</a> , <a href="#">smuX.source.calibrateY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                  |

| <b>smuX.measure.count</b> |                                                                                                                                                                                                                                                                                                                                         | X = SMU channel (a or b) |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| Attribute                 | Number of measurements performed when a measurement is requested.                                                                                                                                                                                                                                                                       |                          |
| Default                   | 1                                                                                                                                                                                                                                                                                                                                       |                          |
| TSP-Link accessibility    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                             |                          |
| Usage                     | <pre>count = smuX.measure.count     -- Reads measure count. smuX.measure.count = count     -- Writes measure count.</pre> <p>count                                 Number of measurements.</p>                                                                                                                                          |                          |
| Remarks                   | <ul style="list-style-type: none"> <li>This attribute controls the number of measurements taken any time a measurement is requested. When using a reading buffer with a measure command, the <i>count</i> also controls the number of readings to be stored.</li> <li>The <i>reset</i> function sets the measure count to 1.</li> </ul> |                          |
| Details                   | See <a href="#">Section 8</a> .                                                                                                                                                                                                                                                                                                         |                          |
| Also see                  | <a href="#">smuX.measure.overlappedY</a> , <a href="#">smuX.measure.Y</a>                                                                                                                                                                                                                                                               |                          |
| Example                   | Sets measure count for SMU A:<br><pre>smua.measure.count = 10</pre>                                                                                                                                                                                                                                                                     |                          |

| <b>smuX.measure.delay</b> X= SMU channel (a or b) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |           |                       |                        |            |                       |
|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------|-----------------------|------------------------|------------|-----------------------|
| Attribute                                         | Controls the measurement delay.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |           |                       |                        |            |                       |
| Default                                           | smuX.DELAY_OFF (2601A/2602A/2611A/2612A)<br>smuX.DELAY_AUTO (2635A/2636A)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                     |           |                       |                        |            |                       |
| TSP-Link accessibility                            | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                     |           |                       |                        |            |                       |
| Usage                                             | <pre>mdelay = smuX.measure.delay -- Reads the measure delay.</pre> <pre>smuX.measure.delay = mdelay -- Writes the measure delay.</pre> <p><code>mdelay</code> The measurement delay value.</p> <p>Set <code>mdelay</code> to one of the following values:</p> <table> <tr> <td>0 or smuX.DELAY_OFF</td> <td>No delay.</td> </tr> <tr> <td>-1 or smuX.DELAY_AUTO</td> <td>Automatic delay value.</td> </tr> <tr> <td>user_value</td> <td>Set user delay value.</td> </tr> </table>                                                                                                                                                                                                                                                     | 0 or smuX.DELAY_OFF | No delay. | -1 or smuX.DELAY_AUTO | Automatic delay value. | user_value | Set user delay value. |
| 0 or smuX.DELAY_OFF                               | No delay.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                     |           |                       |                        |            |                       |
| -1 or smuX.DELAY_AUTO                             | Automatic delay value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                     |           |                       |                        |            |                       |
| user_value                                        | Set user delay value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                     |           |                       |                        |            |                       |
| Remarks                                           | <ul style="list-style-type: none"> <li>This attribute allows for additional settling time before taking a measurement.</li> <li>The <code>smuX.DELAY_AUTO</code> setting causes a current range-dependent delay to be inserted when a current measurement is requested. This happens when a current measurement command is executed, when the measure action is being performed in a sweep, or after changing ranges during an auto-ranged measurement.</li> <li>If <code>smuX.measure.count</code> is greater than 1, the measurement delay is only inserted before the first measurement.</li> <li><code>mdelay</code> can be set to a specific user-defined value that sets the delay that is used regardless of range.</li> </ul> |                     |           |                       |                        |            |                       |
| Also see                                          | <a href="#">smuX.measure.delayfactor</a> , <a href="#">smuX.source.delay</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                     |           |                       |                        |            |                       |
| Example                                           | Sets the measurement delay to 10mS:<br><code>smua.measure.delay = 0.010</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |           |                       |                        |            |                       |

| <b>smuX.measure.delayfactor</b> X= SMU channel (a or b) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                               | This attribute is a multiplier to the delays used when <code>smuX.delay</code> is set to <code>smuX.DELAY_AUTO</code> .                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Default                                                 | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| TSP-Link accessibility                                  | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Usage                                                   | <pre>delayfactor = smuX.measure.delayfactor -- Reads the delay factor.</pre> <pre>smuX.measure.delayfactor = delayfactor -- Writes the delay factor.</pre> <p><code>delayfactor</code> The delay factor multiplier.</p>                                                                                                                                                                                                                                                                                                                   |
| Remarks                                                 | <ul style="list-style-type: none"> <li>The delay factor is only applied when <code>smuX.measure.delay = smuX.DELAY_AUTO</code>.</li> <li>The default value is 1.0.</li> <li>This attribute can be set to a value less than 1 (for example, 0.5) to decrease the automatic delay.</li> <li>This attribute can be set to a value greater than 1 (for example, 1.5 or 2.0) to increase the automatic delay.</li> <li>Setting this attribute to zero disables delays, even when <code>smuX.measure.delay = smuX.DELAY_AUTO</code>.</li> </ul> |
| Also see                                                | <a href="#">smuX.measure.delay</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Example                                                 | Increase the automatic delay by 2 times:<br><code>smuX.measure.delayfactor = 2.0</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| <b>smuX.measure.filter.count</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                     |
|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                    | Number of measured readings to yield one filtered measurement.                                                                                                                                                                                      |
| Default                                                                                      | 1                                                                                                                                                                                                                                                   |
| TSP-Link accessibility                                                                       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                         |
| Usage                                                                                        | <pre>count = smuX.measure.filter.count      -- Reads filter count. smuX.measure.filter.count = count      -- Writes filter count.</pre> <p style="text-align: center;">count <span style="float: right;">Set filter count from 1 to 100.</span></p> |
| Remarks                                                                                      | <ul style="list-style-type: none"> <li>This attribute is the number of measurements that will be performed to yield one filtered measurement.</li> <li>The <code>reset</code> function sets the filter count to 1.</li> </ul>                       |
| Details                                                                                      | See <a href="#">Filters</a> in <a href="#">Section 6</a> .                                                                                                                                                                                          |
| Also see                                                                                     | <a href="#">smuX.measure.filter.enable</a> , <a href="#">smuX.measure.filter.type</a>                                                                                                                                                               |
| Example                                                                                      | Sets filter count for SMU A:<br><code>smua.measure.filter.count = 10</code>                                                                                                                                                                         |

| <b>smuX.measure.filter.enable</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                |                      |                                               |                     |
|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|----------------------|-----------------------------------------------|---------------------|
| Attribute                                                                                     | Enables/disables filtered measurements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                |                      |                                               |                     |
| Default                                                                                       | <code>smuX.FILTER_OFF</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                |                      |                                               |                     |
| TSP-Link accessibility                                                                        | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                |                      |                                               |                     |
| Usage                                                                                         | <pre>filter = smuX.measure.filter.enable  --Reads on/off state of the filter. smuX.measure.filter.enable = filter  --Writes on/off state of the filter.</pre> <p style="text-align: center;">filter <span style="float: right;">The filter status.</span></p> <p>Set filter to one of the following values:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;"><code>0</code> or <code>smuX.FILTER_OFF</code></td> <td style="width: 50%;">Disables the filter.</td> </tr> <tr> <td><code>1</code> or <code>smuX.FILTER_ON</code></td> <td>Enables the filter.</td> </tr> </table> | <code>0</code> or <code>smuX.FILTER_OFF</code> | Disables the filter. | <code>1</code> or <code>smuX.FILTER_ON</code> | Enables the filter. |
| <code>0</code> or <code>smuX.FILTER_OFF</code>                                                | Disables the filter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                |                      |                                               |                     |
| <code>1</code> or <code>smuX.FILTER_ON</code>                                                 | Enables the filter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                |                      |                                               |                     |
| Remarks                                                                                       | <ul style="list-style-type: none"> <li>This attribute enables or disables the filter.</li> <li>The <code>reset</code> function disables the filter.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                |                      |                                               |                     |
| Details                                                                                       | See <a href="#">Filters</a> in <a href="#">Section 6</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                |                      |                                               |                     |
| Also see                                                                                      | <a href="#">smuX.measure.filter.count</a> , <a href="#">smuX.measure.filter.type</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                |                      |                                               |                     |
| Example                                                                                       | Enable the filter for SMU A:<br><code>smua.measure.filter.enable = smua.FILTER_ON</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                |                      |                                               |                     |

| <b>smuX.measure.filter.type</b> X = SMU channel (a or b) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                | Type of filter for measurements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Default                                                  | 0 (2601A/2602A/2611A/2612A)<br>1 (2635A/2636A)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| TSP-Link accessibility                                   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Usage                                                    | <pre>type = smuX.measure.filter.type  -- Reads filter type. smuX.measure.filter.type = type  -- Writes filter type.</pre> <p>type                                      The filter type.</p> <p>Set <code>type</code> to one of the following values:</p> <p>0 or <code>smuX.FILTER_MOVING_AVG</code>              Selects the moving average filter.</p> <p>1 or <code>smuX.FILTER_REPEAT_AVG</code>              Selects the repeat filter.</p> <p>2 or <code>smuX.FILTER_MEDIAN</code>                  Selects the median filter.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Remarks                                                  | <ul style="list-style-type: none"> <li>• There are two averaging filter types to choose from: repeating and moving. For the repeating filter (which is the power-on default), the stack (filter count) is filled, and the conversions are averaged to yield a reading. The stack is then cleared, and the process starts over.</li> <li>• The median filter uses a first-in, first-out stack. When the stack (filter count) becomes full, the “middle-most” reading is returned. For each subsequent conversion placed into the stack, the oldest reading is discarded. The stack is then re-sorted, yielding a new reading. If the filter count is an even number, the reading returned is the average of the two middle readings.</li> <li>• The moving average filter uses a first-in, first-out stack. When the stack (filter count) becomes full, the measurement conversions are averaged, yielding a reading. For each subsequent conversion placed into the stack, the oldest conversion is discarded. The stack is re-averaged, yielding a new reading.</li> <li>• The <code>reset</code> function selects the repeat filter.</li> </ul> |
| Details                                                  | See <a href="#">Filters</a> in <a href="#">Section 6</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Also see                                                 | <a href="#">smuX.measure.filter.count</a> , <a href="#">smuX.measure.filter.enable</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Example                                                  | Selects the moving average filter for SMU A:<br><code>smua.measure.filter.type = smua.FILTER_MOVING_AVG</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| <b>smuX.measure.highcrangedelayfactor</b> X = SMU channel (a or b) |                                                                                                                                                                                    |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                          | The multiplier for delays during range change when High-C mode is active.                                                                                                          |
| Default                                                            | 10                                                                                                                                                                                 |
| TSP-Link accessibility                                             | This attribute can be accessed from a remote TSP-Link node.                                                                                                                        |
| Usage                                                              | <pre>smuX.measure.highcrangedelayfactor = delayfactor delayfactor = smuX.measure.highcrangedelayfactor</pre> <p>delayfactor                                  The delay factor.</p> |
| Remarks                                                            | <ul style="list-style-type: none"> <li>• The delay factor must be set to a value between 1 and 99.</li> </ul>                                                                      |
| Details                                                            | For more information on High-C mode, see <a href="#">Section 5</a> .                                                                                                               |
| Also see                                                           | <a href="#">smuX.source.highc</a>                                                                                                                                                  |
| Example                                                            | Set the delay factor for SMU A to 5:<br><code>smua.measure.highcrangedelayfactor = 5</code>                                                                                        |

| <b>smuX.measure.interval</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                | Interval between multiple measurements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Default                                                                                  | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility                                                                   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Usage                                                                                    | <pre>interval = smuX.measure.interval -- Reads measure interval. smuX.measure.interval = interval -- Writes measure interval.</pre> <p style="text-align: center;">interval <span style="float: right;">Set interval (in seconds) from 0 to 1.</span></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Remarks                                                                                  | <ul style="list-style-type: none"> <li>• This attribute sets the time interval between groups of measurements when <code>smua.measure.count</code> is set to a value greater than 1. The SMU will do its best to start the measurement of each group when scheduled.</li> <li>• If filtered measurements are being made, this interval is from the start of the first measurement for the filtered reading to the first measurement for a subsequent filtered reading. Extra measurements made to satisfy a filtered reading are not paced by this interval.</li> <li>• If the SMU cannot keep up with the interval setting, measurements will be made as fast as possible.</li> <li>• The <code>reset</code> function sets the measure interval to 0.</li> </ul> |
| Details                                                                                  | See <a href="#">Section 8</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Also see                                                                                 | <a href="#">smuX.measure.overlappedY</a> , <a href="#">smuX.measure.Y</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Example                                                                                  | Sets measure interval for SMU A:<br><code>smua.measure.interval = 0.5</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

| <b>smuX.measure.lowrangeY</b> <span style="float: right;">X = SMU channel (a or b)<br/>Y = SMU measure function (v or i)<br/>Where: v = voltage, i = current</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                                                                                           | Lowest measure range that will be used during autoranging.                                                                                                                                                                                                                                                                                                                                                                                      |
| Default                                                                                                                                                             | 100e-9 (2601A/2602A/2611A/2612A)<br>100e-12 (2635A/2636A)                                                                                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility                                                                                                                                              | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                     |
| Usage                                                                                                                                                               | <pre>rangeval = smuX.measure.lowrangev -- Reads voltage low range. smuX.measure.lowrangev = rangeval -- Writes voltage low range. rangeval = smuX.measure.lowrangei -- Reads current low range. smuX.measure.lowrangei = rangeval -- Writes current low range.</pre> <p style="text-align: center;">rangeval <span style="float: right;">Set to the lowest voltage or current measure range.</span></p>                                         |
| Remarks                                                                                                                                                             | <ul style="list-style-type: none"> <li>• This attribute is used with auto-ranging to put a lower bound on the range used. Lower ranges generally require greater settling times. By setting a low range value, measurements might be able to be made with less settling time.</li> <li>• If the instrument is set to auto range and it is on a range lower than the one specified, the range will be changed to the range specified.</li> </ul> |
| Details                                                                                                                                                             | See <a href="#">Range</a> in <a href="#">Section 6</a> .                                                                                                                                                                                                                                                                                                                                                                                        |
| Also see                                                                                                                                                            | <a href="#">smuX.measure.autorangeY</a>                                                                                                                                                                                                                                                                                                                                                                                                         |
| Example                                                                                                                                                             | Sets volts low range for Model 2601A/2602A SMU A to 1V:<br><code>smua.measure.lowrangev = 1</code>                                                                                                                                                                                                                                                                                                                                              |



| <b>smuX.measure.nplc</b> |                                                                                                                                                                                                                                                               | X = SMU channel (a or b) |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| Attribute                | Integration aperture for measurements.                                                                                                                                                                                                                        |                          |
| Default                  | 1                                                                                                                                                                                                                                                             |                          |
| TSP-Link accessibility   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                   |                          |
| Usage                    | <pre>nplc = smuX.measure.nplc      -- Reads nplc. smuX.measure.nplc = nplc     -- Writes nplc.  nplc                          Set from 0.001 to 25.</pre>                                                                                                     |                          |
| Remarks                  | <ul style="list-style-type: none"> <li>The integration aperture is based on the number of power line cycles (NPLC), where 1PLC for 60Hz is 16.67ms (1/60) and 1 PLC for 50Hz is 20ms (1/50).</li> <li>The reset function sets the aperture to 1.0.</li> </ul> |                          |
| Details                  | See <a href="#">Speed</a> in <a href="#">Section 6</a> .                                                                                                                                                                                                      |                          |
| Example                  | Sets integration time for SMU A (0.5/60 seconds):<br><code>smua.measure.nplc = 0.5</code>                                                                                                                                                                     |                          |

| <b>smuX.measure.overlappedY</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | X = SMU channel (a or b)<br>Y = SMU measure function ( <i>v, i, iv, r, or p</i> )<br>Where: <i>v</i> = voltage, <i>i</i> = current, <i>r</i> = resistance, <i>p</i> = power |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                        | Starts an asynchronous (background) measurement.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                             |
| TSP-Link accessibility          | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                             |
| Usage                           | <p>There are several ways to use this function:</p> <pre>smuX.measure.overlappedv(rbuffer) smuX.measure.overlappedi(rbuffer) smuX.measure.overlappedr(rbuffer) smuX.measure.overlappedp(rbuffer) smuX.measure.overlappediv(ibuffer, vbuffer)</pre> <p><code>rbuffer</code>                      A reading buffer object where the reading(s) will be stored.<br/> <code>ibuffer</code>                      A reading buffer object where current reading(s) will be stored.<br/> <code>vbuffer</code>                      A reading buffer object where voltage reading(s) will be stored.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                             |
| Remarks                         | <ul style="list-style-type: none"> <li>This function will start a measurement and return immediately. The measurements, as they are performed, are stored in a reading buffer (along with any ancillary information also being acquired). If the instrument is configured to return multiple readings where one is requested, the readings will be available as they are made.</li> <li>The <code>smuX.measure.overlappediv</code> function stores both current and voltage readings in respective buffers (current and then voltage are stored in separate buffers).</li> <li>This function is an overlapped command. Script execution will continue while the measurement(s) is made in the background. Attempts to access result values that have not yet been generated will cause the script to block and wait for the data to become available. The <code>waitcomplete</code> function can also be used to wait for the measurement(s) to complete before continuing.</li> <li>If a given reading buffer contains any data, it will be cleared prior to taking any measurements, unless the reading buffer has been configured to append data.</li> </ul> |                                                                                                                                                                             |
| Details                         | See <a href="#">Reading buffer options</a> in <a href="#">Section 7</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                             |
| Also see                        | <a href="#">smuX.nvbufferY</a> , <a href="#">smuX.nvbufferY</a> , <a href="#">waitcomplete</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                             |
| Example                         | Starts background voltage measurements for SMU A:<br><code>smua.measure.overlappedv(smua.nvbuffer1)</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                             |



|                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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| <b>smuX.measure.rel.enableY</b>                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| X = SMU channel (a or b)<br>Y = SMU measure function (v, i, r or p)<br>Where: v = voltage, i = current, r = resistance, p = power |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Attribute                                                                                                                         | Relative measurement control (on/off).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Default                                                                                                                           | smuX.REL_OFF                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| TSP-Link accessibility                                                                                                            | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Usage                                                                                                                             | <pre>rel = smuX.measure.rel.enablev    -- Reads voltage relative state. smuX.measure.rel.enablev = rel    -- Writes voltage relative state. rel = smuX.measure.rel.enablei    -- Reads current relative state. smuX.measure.rel.enablei = rel    -- Writes current relative state. rel = smuX.measure.rel.enabler    -- Reads resistance relative state. smuX.measure.rel.enabler = rel    -- Writes resistance relative state. rel = smuX.measure.rel.enablep    -- Reads power relative state. smuX.measure.rel.enablep = rel    -- Writes power relative state.</pre> <p>rel                                   Relative measurement control.</p> <p>Set rel to one of the following values:</p> <p>0 or smuX.REL_OFF                   Disables relative measurements.</p> <p>1 or smuX.REL_ON                    Enables relative measurements.</p> |
| Remarks                                                                                                                           | <ul style="list-style-type: none"> <li>When relative measurements are enabled, all subsequent measured readings will be offset by the specified relative offset value (see <code>smuX.measure.rel.levelY</code>). Specifically, each returned measured relative reading will be the result of the following calculation:<br/><i>Relative reading = Actual measured reading – Relative offset value</i></li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Details                                                                                                                           | See <a href="#">Rel</a> in <a href="#">Section 6</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Also see                                                                                                                          | <a href="#">smuX.measure.rel.levelY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Example                                                                                                                           | Enables relative voltage measurements for SMU A:<br><code>smua.measure.rel.enablev = smua.REL_ON</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |



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|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>smuX.measure.Y</b>                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| X = SMU channel (a or b)<br>Y = SMU measure function (v, i, iv, r, or p)<br>Where: v = voltage, i = current, r = resistance, p = power |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Function                                                                                                                               | Performs one or more measurements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility                                                                                                                 | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Usage                                                                                                                                  | <p>There are three ways to use this function:</p> <pre> reading = smuX.measure.v() reading = smuX.measure.v(rbuffer) reading = smuX.measure.i() reading = smuX.measure.i(rbuffer) reading = smuX.measure.r() reading = smuX.measure.r(rbuffer) reading = smuX.measure.p() reading = smuX.measure.p(rbuffer) reading = smuX.measure.iv(ibuffer, vbuffer) </pre> <p> reading                      Returns the last reading of the measurement process.<br/> rbuffer                      A reading buffer object where all the reading(s) will be stored.<br/> ibuffer                      A reading buffer object where current reading(s) will be stored.<br/> vbuffer                      A reading buffer object where voltage reading(s) will be stored. </p>                                                                                                 |
| Remarks                                                                                                                                | <ul style="list-style-type: none"> <li>This function returns only the last actual measurement as <code>reading</code>. To use the additional information acquired while making a measurement, a reading buffer must be used. If the instrument is configured to return multiple readings when a measurement is requested, all readings will be available in <code>rbuffer</code> if one is provided, but only the last measurement will be returned as <code>reading</code>.</li> <li>The <code>smuX.measure.iv</code> function stores both current and voltage readings in respective buffers (current and then voltage are stored in separate buffers).</li> <li>The <code>smuX.measure.count</code> attribute determines how many measurements are performed. When using a buffer, it also determines the number of readings to store in the buffer.</li> </ul> |
| Details                                                                                                                                | See <a href="#">Reading Buffers</a> in <a href="#">Section 7</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Also see                                                                                                                               | <a href="#">smuX.nvbufferY</a> , <a href="#">smuX.nvbufferY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Example                                                                                                                                | <p>Performs ten voltage measurements using SMU A and stores them in a buffer:</p> <pre> smua.measure.count = 10 smua.measure.v(smua.nvbuffer1) </pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

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| <b>smuX.measureYandstep</b>                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| X = SMU channel (a or b)<br>Y = SMU measure function (v, i, iv, r or p)<br>Where: v = voltage, i = current, r = resistance, p = power |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Function                                                                                                                              | Performs one or two measurements and then steps the source.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| TSP-Link accessibility                                                                                                                | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Usage                                                                                                                                 | <p>This function can be used in several ways:</p> <pre> reading = smuX.measurevandstep(sourcevalue) reading = smuX.measureiandstep(sourcevalue) reading = smuX.measurerandstep(sourcevalue) reading = smuX.measurepandstep(sourcevalue) ireading, vreading = smuX.measureivandstep(sourcevalue) </pre> <p> reading                      Returns the measured reading before stepping the source.<br/> ireading                     Returns the current reading before stepping the source.<br/> ireading                     Returns the voltage reading before stepping the source.<br/> sourcevalue                 Source value to be set after the measurement is made. </p>                                                                                                                                                                                                                                                     |
| Remarks                                                                                                                               | <ul style="list-style-type: none"> <li>• The <code>smuX.measureYandstep</code> function performs a measurement and then sets the source to <code>sourcevalue</code>. The <code>smuX.measureivandstep</code> function is similar, but performs two measurements; one for current (i) and one for voltage (v).</li> <li>• The specified source value should be appropriate for the selected source function. For example, if the source voltage function is selected, then <code>sourcevalue</code> is expected to be a new voltage level.</li> <li>• Both source and measure auto range must be disabled before using this function.</li> <li>• This function is provided for very fast execution of source-measure loops. The measurement will be made prior to stepping the source. Prior to using this function, and before any loop this function may be used in, the source value should be set to its initial level.</li> </ul> |
| Also see                                                                                                                              | <a href="#">smuX.measure.Y</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Example                                                                                                                               | <p>This Model 2601A/2602A measure and step function measures current starting at a source value of 0V. After each current measurement, the source is stepped 100mV for the next current measurement. The final source level is 1V where current is again measured.</p> <pre> local ivalues = {} smua.source.rangev = 1 smua.source.levelv = 0 smua.measure.rangei = 0.01 smua.source.output = smua.OUTPUT_ON for index = 1, 10 do   ivalues[index] = smua.measureiandstep(index / 10) end ivalues[11] = smua.measure.i() </pre>                                                                                                                                                                                                                                                                                                                                                                                                      |



| <b>smuX.nvbufferY.basetimestamp</b> X = SMU channel (a or b)<br>Y = NV buffer (1 or 2) |                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                              | Timestamp of when the first reading was stored.                                                                                                                                                                                                                                                                                              |
| TSP-Link accessibility                                                                 | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                  |
| Usage                                                                                  | <pre>basetime = smuX.nvbufferY.basetimestamp</pre> <p style="text-align: right;">basetime                                      The timestamp of the first stored reading.</p>                                                                                                                                                                |
| Remarks                                                                                | <ul style="list-style-type: none"> <li>Reading this attribute returns the timestamp (in seconds) for the first reading (<code>rb[1]</code>) stored in a buffer. The timestamp is the number of seconds since 12:00am January 1, 1970 (UTC) that the measurement was performed and stored.</li> <li>This is a read-only attribute.</li> </ul> |
| Details                                                                                | See <a href="#">Reading buffers</a> in this section and in <a href="#">Section 7</a> .                                                                                                                                                                                                                                                       |
| Also see                                                                               | <a href="#">smuX.measure.overlappedY</a> , <a href="#">smuX.measure.Y</a> , <a href="#">smuX.nvbufferY</a>                                                                                                                                                                                                                                   |
| Example                                                                                | Read the timestamp for the first reading stored in Buffer 1 of SMU A:<br><pre>basetime = smua.nvbuffer1.basetimestamp</pre> <pre>print(basetime)</pre> Output: 1.2143e+09<br>The above output indicates that the timestamp is 1,214,300,000 seconds.                                                                                         |

| <b>smuX.nvbufferY.capacity</b> X = SMU channel (a or b)<br>Y = NV buffer (1 or 2) |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                         | Capacity of the buffer.                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| TSP-Link accessibility                                                            | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                               |
| Usage                                                                             | <pre>capacity = smuX.nvbufferY.capacity</pre> <p style="text-align: right;">capacity                                      The maximum number of readings the buffer can store.</p>                                                                                                                                                                                                                                                                        |
| Remarks                                                                           | <ul style="list-style-type: none"> <li>Reading this attribute returns the number of readings that can be stored in the buffer.</li> <li>A buffer with only basic collection items turned on can store over 140,000 readings. Capacity does not change as readings fill the buffer. Turning on additional collection items, such as timestamps and source values, decreases the capacity of the buffer.</li> <li>This is a read-only attribute.</li> </ul> |
| Details                                                                           | See <a href="#">Reading buffers</a> in this section and in <a href="#">Section 7</a> .                                                                                                                                                                                                                                                                                                                                                                    |
| Also see                                                                          | <a href="#">smuX.measure.overlappedY</a> , <a href="#">smuX.measure.Y</a> , <a href="#">smuX.nvbufferY</a>                                                                                                                                                                                                                                                                                                                                                |
| Example                                                                           | Read the capacity of SMU A Buffer 1:<br><pre>capacity = smua.nvbuffer1.capacity</pre> <pre>print(capacity)</pre> Output: 1.49789e+05                                                                                                                                                                                                                                                                                                                      |



|                             |                                                                                                            |                                                    |
|-----------------------------|------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| <b>smuX.nvbufferY.clear</b> |                                                                                                            | X = SMU channel (a or b)<br>Y = NV buffer (1 or 2) |
| Function                    | Clears the buffer.                                                                                         |                                                    |
| TSP-Link accessibility      | This function can be accessed from a remote TSP-Link node.                                                 |                                                    |
| Usage                       | <code>smuX.nvbufferY.clear()</code>                                                                        |                                                    |
| Remarks                     | This function clears all readings from the indicated buffer.                                               |                                                    |
| Details                     | See <a href="#">Reading buffers</a> in this section and in <a href="#">Section 7</a> .                     |                                                    |
| Also see                    | <a href="#">smuX.measure.overlappedY</a> , <a href="#">smuX.measure.Y</a> , <a href="#">smuX.nvbufferY</a> |                                                    |
| Example                     | Clears SMU A Buffer 1:<br><code>smua.nvbuffer1.clear()</code>                                              |                                                    |

|                                  |                                                                                         |                                                    |
|----------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------|
| <b>smuX.nvbufferY.clearcache</b> |                                                                                         | X = SMU channel (a or b)<br>Y = NV buffer (1 or 2) |
| Function                         | Clears the cache.                                                                       |                                                    |
| TSP-Link accessibility           | This function can be accessed from a remote TSP-Link node.                              |                                                    |
| Usage                            | <code>smuX.nvbufferY.clearcache()</code>                                                |                                                    |
| Remarks                          | This function clears all readings from the indicated cache.                             |                                                    |
| Details                          | See <a href="#">Reading buffers</a> in this section and in <a href="#">Section 14</a> . |                                                    |
| Also see                         | <a href="#">smuX.nvbufferY</a>                                                          |                                                    |
| Example                          | Clears SMU A reading Buffer 1 cache:<br><code>smua.nvbuffer1.clearcache()</code>        |                                                    |

|                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                    |
|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| <b>smuX.nvbufferY.collectsourcevalues</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | X = SMU channel (a or b)<br>Y = NV buffer (1 or 2) |
| Attribute                                 | Source value collection for the buffer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                    |
| Default                                   | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                    |
| TSP-Link accessibility                    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                    |
| Usage                                     | <pre>state = smuX.nvbufferY.collectsourcevalues -- Reads collection state. smuX.nvbufferY.collectsourcevalues = state -- Writes collection state.</pre> <p><code>state</code> Source value collection status.</p> <p>Set <code>state</code> to one of the following values:</p> <ul style="list-style-type: none"> <li>0 Source value collection disabled (off).</li> <li>1 Source value collection enabled (on).</li> </ul>                                                                                                                           |                                                    |
| Remarks                                   | <ul style="list-style-type: none"> <li>• Assigning a <code>state</code> value to this attribute enables or disables the storage of source values. Reading this attribute returns the <code>state</code> of source value collection.</li> <li>• When on, source values will be stored with readings in the buffer. This requires four extra bytes of storage per reading.</li> <li>• This value, off or on, can only be changed when the buffer is empty. The buffer can be emptied using the <a href="#">smuX.nvbufferY.clear</a> function.</li> </ul> |                                                    |
| Details                                   | See <a href="#">Reading buffers</a> in this section and in <a href="#">Section 7</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                    |
| Also see                                  | <a href="#">smuX.measure.overlappedY</a> , <a href="#">smuX.measure.Y</a> , <a href="#">smuX.nvbufferY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                    |
| Example                                   | Include source values with readings for SMU A Buffer 1:<br><code>smua.nvbuffer1.collectsourcevalues = 1</code>                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                    |

| <b>smuX.nvbufferY.collecttimestamps</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| X = SMU channel (a or b)<br>Y = NV buffer (1 or 2) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Attribute                                          | Timestamp collection for the buffer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Default                                            | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| TSP-Link accessibility                             | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Usage                                              | <pre>state = smuX.nvbufferY.collecttimestamps -- Reads collection state. smuX.nvbufferY.collecttimestamps = state -- Writes collection state.</pre> <p>Set <code>state</code> to one of the following values:</p> <ul style="list-style-type: none"> <li>0 Timestamp collection disabled (off).</li> <li>1 Timestamp collection enabled (on).</li> </ul>                                                                                                                                                                                                                                                                                                           |
| Remarks                                            | <ul style="list-style-type: none"> <li>• Assigning a <code>state</code> value to this attribute enables or disables the storage of timestamps. Reading this attribute returns the state of timestamp collection.</li> <li>• When on, timestamps will be stored with readings in the buffer. This requires four extra bytes of storage per reading. The first reading is time stamped at zero seconds. Subsequent readings are time stamped relative to the time storage was started.</li> <li>• This value, off or on, can only be changed when the buffer is empty. The buffer can be emptied using the <a href="#">smuX.nvbufferY.clear</a> function.</li> </ul> |
| Details                                            | See <a href="#">Reading buffers</a> in this section and in <a href="#">Section 7</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Also see                                           | <a href="#">smuX.measure.overlappedY</a> , <a href="#">smuX.measure.Y</a> , <a href="#">smuX.nvbufferY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Example                                            | <p>Include timestamps with readings for SMU A Buffer 1:</p> <pre>smua.nvbuffer1.collecttimestamps = 1</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| <b>smuX.nvbufferY.n</b>                            |                                                                                                                                                                                                                                                |
|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| X = SMU channel (a or b)<br>Y = NV buffer (1 or 2) |                                                                                                                                                                                                                                                |
| Attribute                                          | Number of readings in the buffer.                                                                                                                                                                                                              |
| TSP-Link accessibility                             | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                    |
| Usage                                              | <pre>bufferreadings = smuX.nvbufferY.n</pre> <p><code>bufferreadings</code> Returns the number of readings stored in the buffer.</p>                                                                                                           |
| Remarks                                            | <ul style="list-style-type: none"> <li>• Reading this attribute returns the number of readings that are stored in the buffer.</li> <li>• This is a read-only attribute.</li> </ul>                                                             |
| Details                                            | See <a href="#">Reading buffers</a> in this section and in <a href="#">Section 7</a> .                                                                                                                                                         |
| Also see                                           | <a href="#">smuX.measure.overlappedY</a> , <a href="#">smuX.measure.Y</a> , <a href="#">smuX.nvbufferY</a>                                                                                                                                     |
| Example                                            | <p>Read the number of readings stored in SMU A Buffer 1:</p> <pre>bufferreadings = smua.nvbuffer1.n print(bufferreadings)</pre> <p>Output: 1.250000+02</p> <p>The above output indicates that there are 125 readings stored in the buffer.</p> |



| <b>smuX.sense</b>      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | X = SMU channel (a or b) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| Attribute              | Remote/local sense mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                          |
| Default                | smuX.SENSE_LOCAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                          |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                          |
| Usage                  | <pre>sense = smuX.sense           -- Reads sense mode. smuX.sense = sense          -- Writes sense mode.</pre> <p>sense                           The sense mode.</p> <p>Set <i>sense</i> to one of the following values:</p> <p>0 or smuX.SENSE_LOCAL       Selects local sense (2-wire).</p> <p>1 or smuX.SENSE_REMOTE      Selects remote sense (4-wire).</p> <p>3 or smuX.SENSE_CALA        Selects calibration sense mode.</p>                                                                                                                                                            |                          |
| Remarks                | <ul style="list-style-type: none"> <li>Source-measure operations are performed using either 2-wire local sense connections or 4-wire remote sense connections. Writing to this attribute selects the sense mode.</li> <li>The smuX.SENSE_CALA mode is only used for calibration and may only be selected when calibration is enabled.</li> <li>The sense mode can be changed between local and remote while the output is on.</li> <li>The calibration sense mode cannot be selected while the output is on.</li> <li>The <code>reset</code> function selects the local sense mode.</li> </ul> |                          |
| Details                | See <a href="#">Sensing methods</a> in <a href="#">Section 2</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                          |
| Example                | Selects remote sensing for SMU A:<br>smua.sense = smua.SENSE_REMOTE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                          |

| <b>smuX.source.autorangeY</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | X = SMU channel (a or b)<br>Y = SMU measure function (v or i)<br>Where: v = voltage, i = current |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Attribute                     | Source auto range control (on/off).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                  |
| Default                       | smuX.AUTORANGE_ON                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                  |
| TSP-Link accessibility        | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                  |
| Usage                         | <pre>sautorange = smuX.source.autorangev -- Reads voltage source auto range. smuX.source.autorangev = sautorange -- Writes voltage source auto range. sautorange = smuX.source.autorangei -- Reads current source auto range. smuX.source.autorangei = sautorange -- Writes current source auto range.</pre> <p>sautorange                           The auto range status.</p> <p>Set <i>sautorange</i> to one of the following values:</p> <p>0 or smuX.AUTORANGE_OFF      Disables source auto range.</p> <p>1 or smuX.AUTORANGE_ON       Enables source auto range.</p>                                                                                                                                                                                                                             |                                                                                                  |
| Remarks                       | <ul style="list-style-type: none"> <li>This attribute indicates the source auto range state. Its value will be smuX.AUTORANGE_OFF when the SMU source circuit is on a fixed range and smuX.AUTORANGE_ON when it is in auto range mode.</li> <li>Setting this attribute to smuX.AUTORANGE_OFF puts the SMU on a fixed source range. The fixed range used will be the range the SMU source circuit was currently using.</li> <li>Setting this attribute to smuX.AUTORANGE_ON puts the SMU source circuit into auto range mode. If the source output is on, the SMU will immediately change range to the range most appropriate for the value being sourced if that range is different from the SMU range.</li> <li>Auto range will disable if the source level is edited from the front panel.</li> </ul> |                                                                                                  |
| Details                       | See <a href="#">Range</a> in <a href="#">Section 6</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                  |
| Also see                      | <a href="#">smuX.measure.autorangeY</a> , <a href="#">smuX.source.rangeY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                  |
| Example                       | Enables volts source auto range for SMU A:<br>smua.source.autorangev = smua.AUTORANGE_ON                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                  |

| <b>smuX.source.calibrateY</b>                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| X = SMU channel (a or b)<br>Y = SMU measure function (v or i)<br>Where: v = voltage, i = current |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Function                                                                                         | Generates and activates new source calibration constants.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| TSP-Link accessibility                                                                           | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Usage                                                                                            | <pre>smuX.source.calibratev(range, cp1expected, cp1reference, cp2expected, cp2reference) smuX.source.calibratei(range, cp1expected, cp1reference, cp2expected, cp2reference)</pre> <p>range                                   The measurement range to calibrate.<br/> cp1expected                            The source value programmed for calibration point 1.<br/> cp1reference                            The reference measurement for calibration point 1<br/> as measured externally.<br/> cp2expected                            The source value programmed for calibration point 2.<br/> cp2reference                            The reference measurement for calibration point 2<br/> as measured externally.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Remarks                                                                                          | <ul style="list-style-type: none"> <li>• This function generates and activates new calibration constants for the given range. The positive and negative polarities of the source must be calibrated separately. Use a positive value for <code>range</code> to calibrate the positive polarity and a negative value for <code>range</code> to calibrate the negative polarity.</li> <li>• Typically the two calibration points used will be near zero for calibration point 1 and 90% of full-scale for calibration point 2. Full scale for calibration point 2 should be avoided if the SMU's source is substantially out of calibration.</li> <li>• Do not use 0.0 for a negative calibration point as 0.0 is considered a positive number.</li> <li>• The two reference measurements must be made with the source using the active calibration set. For example, source a value, measure it, and do not change the active calibration set before issuing this command.</li> <li>• The new calibration constants will be activated immediately but they will not be written to nonvolatile storage. Use <code>smuX.cal.save</code> to commit the new constants to nonvolatile storage. The active calibration constants will stay in effect until the instrument is power cycled or a calibration set is loaded from nonvolatile storage with the <code>smuX.cal.restore</code> function.</li> <li>• This function will be disabled until a successful call to <code>smuX.cal.unlock</code> is made.</li> </ul> |
| Details                                                                                          | See <a href="#">Section 20</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Also see                                                                                         | <a href="#">smuX.cal.restore</a> , <a href="#">smuX.cal.save</a> , <a href="#">smuX.makebuffer</a> ,<br><a href="#">smuX.measure.calibrateY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| <b>smuX.source.compliance</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                 | Source compliance state.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| TSP-Link accessibility                                                                    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Usage                                                                                     | <pre>compliance = smuX.source.compliance</pre> <p style="text-align: right;">compliance                      The state of source compliance.</p>                                                                                                                                                                                                                                                                                                                                                                                                      |
| Remarks                                                                                   | <ul style="list-style-type: none"> <li>Use this attribute to read the state of source compliance. <code>true</code> indicates that the limit function is in control of the source (source in compliance). <code>false</code> indicates that the source function is in control of the output (source not in compliance).</li> <li>This is a read-only attribute. Writing to this attribute will generate an error.</li> <li>Reading this attribute also updates the status model and the front panel with generated compliance information.</li> </ul> |
| Details                                                                                   | See <a href="#">Section 3</a> and <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Also see                                                                                  | <a href="#">smuX.source.limITY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Example                                                                                   | <p>Reads the source compliance state for SMU A:</p> <pre>compliance = smua.source.compliance print(compliance)</pre> <p>Output: true</p> <p>The above output indicates that the voltage limit has been reached (if configured as a current source), or that the current limit has been reached (if configured as a voltage source).</p>                                                                                                                                                                                                               |

| <b>smuX.source.delay</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                  |           |                                    |             |                         |                       |
|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-----------|------------------------------------|-------------|-------------------------|-----------------------|
| Attribute                                                                            | Source delay.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                  |           |                                    |             |                         |                       |
| Default                                                                              | <code>smuX.DELAY_OFF</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                  |           |                                    |             |                         |                       |
| TSP-Link accessibility                                                               | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                  |           |                                    |             |                         |                       |
| Usage                                                                                | <pre>delayval = smuX.source.delay    -- Reads source delay. smuX.source.delay = delayval    -- Writes source delay.</pre> <p style="text-align: right;">delayval                      The source delay value.</p> <p>Set delayval to one of the following values:</p> <table style="width: 100%; border: none;"> <tr> <td style="padding-right: 20px;">0 or <code>smuX.DELAY_OFF</code></td> <td>No delay.</td> </tr> <tr> <td style="padding-right: 20px;">-1 or <code>smuX.DELAY_AUTO</code></td> <td>Auto delay.</td> </tr> <tr> <td style="padding-right: 20px;"><code>User_value</code></td> <td>Set user delay value.</td> </tr> </table> | 0 or <code>smuX.DELAY_OFF</code> | No delay. | -1 or <code>smuX.DELAY_AUTO</code> | Auto delay. | <code>User_value</code> | Set user delay value. |
| 0 or <code>smuX.DELAY_OFF</code>                                                     | No delay.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                  |           |                                    |             |                         |                       |
| -1 or <code>smuX.DELAY_AUTO</code>                                                   | Auto delay.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                  |           |                                    |             |                         |                       |
| <code>User_value</code>                                                              | Set user delay value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                  |           |                                    |             |                         |                       |
| Remarks                                                                              | <ul style="list-style-type: none"> <li>This attribute allows for additional source settling time after an output step.</li> <li>The default is 0, no delays.</li> <li>Setting this attribute to <code>smuX.DELAY_AUTO</code> will cause a range dependent delay to be inserted when ever the source is changed.</li> <li><code>delayval</code> can be set to a specific user-defined value (<code>User_value</code>) that will set the delay that is used regardless of range.</li> </ul>                                                                                                                                                       |                                  |           |                                    |             |                         |                       |
| Example                                                                              | <p>Selects the delay to auto SMU A:</p> <pre>smua.source.delay = smua.DELAY_AUTO</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                  |           |                                    |             |                         |                       |

| <b>smuX.source.func</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                   |                                  |                                                    |                                  |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|----------------------------------|----------------------------------------------------|----------------------------------|
| Attribute                                                                           | Source function.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                   |                                  |                                                    |                                  |
| Default                                                                             | <code>smuX.OUTPUT_DCVOLTS</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                   |                                  |                                                    |                                  |
| TSP-Link accessibility                                                              | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                   |                                  |                                                    |                                  |
| Usage                                                                               | <pre>iv = smuX.source.func      -- Reads source function. smuX.source.func = iv     -- Writes source function.</pre> <p style="text-align: right;">The source function.</p> <p>Set <code>iv</code> to one of the following values:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;"><code>0</code> or <code>smuX.OUTPUT_DCAMPS</code></td> <td>Selects current source function.</td> </tr> <tr> <td style="width: 50%;"><code>1</code> or <code>smuX.OUTPUT_DCVOLTS</code></td> <td>Selects voltage source function.</td> </tr> </table> | <code>0</code> or <code>smuX.OUTPUT_DCAMPS</code> | Selects current source function. | <code>1</code> or <code>smuX.OUTPUT_DCVOLTS</code> | Selects voltage source function. |
| <code>0</code> or <code>smuX.OUTPUT_DCAMPS</code>                                   | Selects current source function.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                   |                                  |                                                    |                                  |
| <code>1</code> or <code>smuX.OUTPUT_DCVOLTS</code>                                  | Selects voltage source function.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                   |                                  |                                                    |                                  |
| Remarks                                                                             | <ul style="list-style-type: none"> <li>Reading this attribute gives the output function of the source. Setting this attribute configures the SMU as either a voltage source or a current source.</li> <li>The <code>reset</code> function selects the voltage function.</li> </ul>                                                                                                                                                                                                                                                                                  |                                                   |                                  |                                                    |                                  |
| Details                                                                             | See <a href="#">Section 4</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                   |                                  |                                                    |                                  |
| Also see                                                                            | <a href="#">smuX.source.output</a> , <a href="#">smuX.source.levelY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                   |                                  |                                                    |                                  |
| Example                                                                             | Selects the source amps function for SMU A:<br><code>smua.source.func = smua.OUTPUT_DCAMPS</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                   |                                  |                                                    |                                  |

| <b>smuX.source.highc</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                            |                                 |                                             |                                  |
|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|---------------------------------|---------------------------------------------|----------------------------------|
| Attribute                                                                            | High capacitance mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                            |                                 |                                             |                                  |
| Default                                                                              | <code>smuX.DISABLE</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                            |                                 |                                             |                                  |
| TSP-Link accessibility                                                               | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                            |                                 |                                             |                                  |
| Usage                                                                                | <pre>highc = smuX.source.highc  -- Reads the High-C setting. smuX.source.highc = highc  -- Writes the High-C mode.</pre> <p style="text-align: right;">The High-C mode.</p> <p>Set <code>highc</code> to one of the following values:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;"><code>1</code> or <code>smuX.ENABLE</code></td> <td>Turns on high capacitance mode.</td> </tr> <tr> <td style="width: 50%;"><code>0</code> or <code>smuX.DISABLE</code></td> <td>Turns off high capacitance mode.</td> </tr> </table>                                                                                                                                           | <code>1</code> or <code>smuX.ENABLE</code> | Turns on high capacitance mode. | <code>0</code> or <code>smuX.DISABLE</code> | Turns off high capacitance mode. |
| <code>1</code> or <code>smuX.ENABLE</code>                                           | Turns on high capacitance mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                            |                                 |                                             |                                  |
| <code>0</code> or <code>smuX.DISABLE</code>                                          | Turns off high capacitance mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                            |                                 |                                             |                                  |
| Remarks                                                                              | <ul style="list-style-type: none"> <li>Turning on High-C mode has the following effects on the SMU settings: <ul style="list-style-type: none"> <li><code>smuX.measure.autorangei</code> is set to <code>smuX.AUTORANGE_FOLLOW_LIMIT</code> and cannot be changed.</li> <li>Current ranges below 1uA are not accessible</li> <li>If <code>smuX.source.limiti</code> is less than 1uA, it is raised to 1uA.</li> <li>If <code>smuX.source.rangei</code> is less than 1uA, it is raised to 1uA.</li> <li>If <code>smuX.source.lowrangei</code> is less than 1uA, it is raised to 1uA.</li> <li>If <code>smuX.measure.lowrangei</code> is less than 1uA, it is raised to 1uA.</li> </ul> </li> </ul> |                                            |                                 |                                             |                                  |
| Details                                                                              | For more information on High-C mode, see <a href="#">Section 5</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                            |                                 |                                             |                                  |
| Example                                                                              | Activate high capacitance mode for SMU A:<br><code>smua.source.highc = smua.ENABLE</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                            |                                 |                                             |                                  |

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                  |
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| <b>smuX.source.levelY</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | X = SMU channel (a or b)<br>Y = SMU measure function (v or i)<br>Where: v = voltage, i = current |
| Attribute                 | Source levels.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                  |
| Default                   | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                  |
| TSP-Link accessibility    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                  |
| Usage                     | <pre>sourceval = smuX.source.levelv -- Reads voltage source value. smuX.source.levelv = sourceval -- Writes voltage source value. sourceval = smuX.source.leveli -- Reads current source value. smuX.source.leveli = sourceval -- Writes current source value.</pre> <p>sourceval                      Set 2601A/2602A voltage from 0 to ±40 (volts).<br/> Set 2601A/2602A current from 0 to ±3 (amps).<br/> Set 2611A/2612A/2635A/2636A voltage from 0 to ±200 (volts).<br/> Set 2611A/2612A/2635A/2636A current from 0 to ±1.5 (amps).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                  |
| Remarks                   | <ul style="list-style-type: none"> <li>• This attribute configures the source level of the voltage or current source.</li> <li>• If the source is configured as a voltage source and the output is on, the new <code>smuX.source.levelv</code> setting will be sourced immediately. If the output is off or if the source is configured as a current source, the voltage level will be sourced when the source is configured as a voltage source and the output is turned on.</li> <li>• If the source is configured as a current source and the output is on, the new <code>smuX.source.leveli</code> setting will be sourced immediately. If the output is off or if the source is configured as a voltage source, the current level will be sourced when the source is configured as a current source and the output is turned on.</li> <li>• The sign of <code>sourceval</code> dictates the polarity of the source. Positive values generate positive voltage or current from the high terminal of the source relative to the low terminal. Negative values generate negative voltage or current from the high terminal of the source relative to the low terminal.</li> <li>• The <code>reset</code> function sets the source levels to 0V and 0A.</li> </ul> |                                                                                                  |
| Details                   | See <a href="#">Section 4</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                  |
| Also see                  | <a href="#">smuX.source.func</a> , <a href="#">smuX.source.output</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                  |
| Example                   | Sets V-source to 1V for SMU A:<br><code>smua.source.levelv = 1</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                  |



|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                  |
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| <b>smuX.source.limitY</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | X = SMU channel (a or b)<br>Y = SMU measure function (v or i)<br>Where: v = voltage, i = current |
| Attribute                 | Compliance limits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                  |
| Default                   | limit/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1 (2601A/2602A)<br>100e-3 (2611A/2612A/2635A/2636A)                                              |
|                           | limitv                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 40 (2601A/2602A)<br>20 (2611A/2612A/2635A/2636A)                                                 |
| TSP-Link accessibility    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                  |
| Usage                     | <pre>limit = smuX.source.limitv -- Reads voltage compliance limit. smuX.source.limitv = limit -- Writes voltage compliance limit. limit = smuX.source.limiti -- Reads current compliance limit. smuX.source.limiti = limit -- Writes current compliance limit.</pre> <p>limit                                   2601A/2602A voltage compliance from 10 mV to ±40 (volts).<br/>                                         2601A/2602A/2611A/2612A current compliance from<br/>                                         10 nA to ±3 A.<br/>                                         2611A/2612A/2635A/2636A voltage compliance from<br/>                                         20 mV to ±200 (volts).<br/>                                         2635A/2636A current compliance from 100 pA to ±1.5 A.</p> |                                                                                                  |
| Remarks                   | <ul style="list-style-type: none"> <li>• Use the <code>smuX.source.limiti</code> attribute to limit the current output of the voltage source. Use <code>smuX.source.limitv</code> to limit the voltage output of the current source. The SMU will always choose (auto range) the source range for the limit setting.</li> <li>• This attribute should be set in the test sequence before the turning the source on.</li> <li>• Using a <code>limit</code> value of 0 will result in a parameter too small error.</li> <li>• Reading this attribute indicates the presently set compliance value. Use <code>smuX.source.compliance</code> to read the state of source compliance.</li> </ul>                                                                                                                |                                                                                                  |
| Details                   | See <a href="#">Section 2</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                  |
| Also see                  | <a href="#">smuX.source.compliance</a> , <a href="#">smuX.source.func</a> , <a href="#">smuX.source.output</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                  |
| Example                   | Sets V-compliance to 30V for SMU A:<br><code>smua.source.limitv = 30</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                  |

| <b>smuX.source.lowrangeY</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | X = SMU channel (a or b)<br>Y = SMU measure function (v or i)<br>Where: v = voltage, i = current |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Attribute                    | Lowest source range that will be used during autoranging.                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                  |
| Default                      | lowrangei 100e-9 (2601A/2602A/2611A/2612A)<br>1e-9 (2635A/2636A)<br>lowrangev 100e-3 (2601A/2602A)<br>200e-3 (2611A/2612A/2635A/2636A)                                                                                                                                                                                                                                                                                                                                                    |                                                                                                  |
| TSP-Link accessibility       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                  |
| Usage                        | <pre>rangeval = smuX.source.lowrangev  -- Reads voltage low range. smuX.source.lowrangev = rangeval  -- Writes voltage low range. rangeval = smuX.source.lowrangei  -- Reads current low range. smuX.source.lowrangei = rangeval  -- Writes current low range.</pre> <p>rangeval                                  Set to the lowest voltage or current range to be used.</p>                                                                                                              |                                                                                                  |
| Remarks                      | <ul style="list-style-type: none"> <li>This attribute is used with source autoranging to put a lower bound on the range used. Lower ranges generally require greater settling times. By setting a low range value, sourcing small values might be able to be made with less settling time.</li> <li>If the instrument is set to auto range and it is on a range lower than the one specified by rangeval, the source range will be changed to the range specified by rangeval.</li> </ul> |                                                                                                  |
| Details                      | See <a href="#">Range</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                  |
| Also see                     | <a href="#">smuX.source.autorangeY</a> , <a href="#">smuX.source.rangeY</a>                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                  |
| Example                      | Sets volts low range for Model 2601A/2602A SMU A to 1V. This prevents the source from using the 100mV range when sourcing voltage:<br>smua.source.lowrangev = 1                                                                                                                                                                                                                                                                                                                           |                                                                                                  |

| <b>smuX.source.offlimiti</b> |                                                                                                                                                                                            | X = SMU channel (a or b) |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| Attribute                    | The current limit used when the SMU is in output off normal mode.                                                                                                                          |                          |
| Default                      | 1e-3                                                                                                                                                                                       |                          |
| TSP-Link accessibility       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                |                          |
| Usage                        | <pre>ivalue = smuX.source.offlimiti  -- Read the limit. smuX.source.offlimiti = ivalue  -- Write the limit.</pre> <p>ivalue                                  The current limit to use.</p> |                          |
| Remarks                      | <ul style="list-style-type: none"> <li>Setting this limit to lower than 1mA will not allow the contact check function to operate when the output is off in normal mode.</li> </ul>         |                          |
| Details                      | See <a href="#">Output-off states</a> in <a href="#">Section 2</a> .                                                                                                                       |                          |
| Also see                     | <a href="#">smuX.source.offmode</a>                                                                                                                                                        |                          |
| Example                      | Change the off normal limit to 10mA for SMU A:<br>smua.source.offlimiti = 10e-3                                                                                                            |                          |



|                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>smuX.source.outputenableaction</b> X = SMU channel (a or b)<br>(2601A/2602A only) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Attribute                                                                            | Output enable action for the source.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Default                                                                              | smuX.OE_NONE (2601A/2602A only)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| TSP-Link accessibility                                                               | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Usage                                                                                | <pre>action = smuX.source.outputenableaction  -- Reads enable action. smuX.source.outputenableaction = action  -- Writes enable action.</pre> <p>    action                                    The source output action.</p> <p>Set action to one of the following values:</p> <pre>0 or smuX.OE_NONE                        No action. 1 or smuX.OE_OUTPUT_OFF                Turns the source output off.</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Remarks                                                                              | <ul style="list-style-type: none"> <li>• This attribute controls the SMU action taken when the output enable line is asserted/deasserted. The default setting is <code>smuX.OE_NONE</code>.</li> <li>• When set to <code>smuX.OE_NONE</code>, the SMU will take no action when the output enable line goes low (deasserted).</li> <li>• When set to <code>smuX.OE_OUTPUT_OFF</code> and the output enable line is de-asserted, the SMU will turn its output off as if the <code>smuX.source.output = smuX.OUTPUT_OFF</code> command had been received.</li> <li>• The SMU will not automatically turn its output on when the output enable line returns to the high state.</li> <li>• If the output enable line is not asserted when this attribute is set to <code>smuX.OE_OUTPUT_OFF</code> and the output is on, the output will turn off immediately.</li> <li>• Detection of the output enable line going low will not abort any running scripts. This may cause execution errors.</li> </ul> |
| Details                                                                              | See <a href="#">Output enable (Models 2601A/2602A)</a> in <a href="#">Section 8</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Also see                                                                             | <a href="#">smuX.source.offmode</a> , <a href="#">smuX.source.output</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Example                                                                              | Reconfigures the SMU to turn the output off if the output enable line goes low (deasserted):<br><code>smua.source.outputenableaction = smua.OE_OUTPUT_OFF</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| <b>smuX.source.rangeY</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | X = SMU channel (a or b)<br>Y = SMU measure function (v or i)<br>Where: v = voltage, i = current |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Attribute                 | Source range.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                  |
| Default                   | rangei      100e-9 (2601A/2602A/2611A/2612A)<br>1e-9 (2635A/2636A)<br>rangev      100e-3 (2601A/2602A)<br>200e-3 (2611A/2612A/2635A/2636A)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                  |
| TSP-Link accessibility    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                  |
| Usage                     | <pre>rangeval = smuX.source.rangev -- Reads voltage source range. smuX.source.rangev = rangeval -- Writes voltage source range. rangeval = smuX.source.rangei -- Reads current source range. smuX.source.rangei = rangeval -- Writes current source range.</pre> <p>rangeval                                      The expected voltage or current to be sourced.</p>                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                  |
| Remarks                   | <ul style="list-style-type: none"> <li>Reading this attribute returns the positive full-scale value of the source range the SMU is currently using. Assigning to this attribute sets the SMU on a fixed range large enough to source the given value. The instrument will select the best range for sourcing a value of <code>rangeval</code>.</li> <li><code>smuX.source.rangeX</code> is primarily intended to eliminate the time required by the automatic range selection performed by a sourcing instrument. Because selecting a fixed range will prevent auto-ranging, an over-range condition can occur, for example, sourcing 10.0V on the Model 2601A/2602A 6.0V range, or sourcing 5.0V on the Model 2611A/2612A/2635A/2636A 2.0V range.</li> </ul> |                                                                                                  |
| Details                   | See <a href="#">Range</a> in <a href="#">Section 6</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                  |
| Also see                  | <a href="#">smuX.source.autorangeY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                  |
| Example                   | Selects 1V source range for Model 2601A/2602A SMU A:<br><code>smua.source.rangev = 1</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                  |

| <b>smuX.source.settling</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | X = SMU channel (a or b) |                                      |                                              |                                          |                                                                   |                                             |                                                             |                                             |                                                      |                                            |                                                        |                                          |                                                         |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------------------|----------------------------------------------|------------------------------------------|-------------------------------------------------------------------|---------------------------------------------|-------------------------------------------------------------|---------------------------------------------|------------------------------------------------------|--------------------------------------------|--------------------------------------------------------|------------------------------------------|---------------------------------------------------------|
| Attribute                                   | The source settling mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                          |                                      |                                              |                                          |                                                                   |                                             |                                                             |                                             |                                                      |                                            |                                                        |                                          |                                                         |
| Default                                     | <code>smuX.SETTLE_SMOOTH</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                          |                                      |                                              |                                          |                                                                   |                                             |                                                             |                                             |                                                      |                                            |                                                        |                                          |                                                         |
| TSP-Link accessibility                      | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                          |                                      |                                              |                                          |                                                                   |                                             |                                                             |                                             |                                                      |                                            |                                                        |                                          |                                                         |
| Usage                                       | <pre>settle_option = smuX.source.settling -- Reads source settling option. smuX.source.settling = settle_option -- Writes source settling option.</pre> <p>settle_option                                      The source settling mode.</p> <p>Set <code>settle_option</code> to one of the following values:</p> <table> <tr> <td>0 or <code>smuX.SETTLE_SMOOTH</code></td> <td>Turns off all settling operations (default).</td> </tr> <tr> <td>1 or <code>smuX.SETTLE_FAST_RANGE</code></td> <td>Instructs the SMU to use a faster procedure when changing ranges.</td> </tr> <tr> <td>2 or <code>smuX.SETTLE_FAST_POLARITY</code></td> <td>Instructs the SMU to change polarity without going to zero.</td> </tr> <tr> <td>3 or <code>smuX.SETTLE_DIRECT_IRANGE</code></td> <td>Instructs the SMU to change the amps range directly.</td> </tr> <tr> <td>4 or <code>smuX.SETTLE_SMOOTH_100NA</code></td> <td>Enables the use of range rampers for the 100 nA range.</td> </tr> <tr> <td>128 or <code>smuX.SETTLE_FAST_ALL</code></td> <td>Enables all <code>smuX.SETTLE_FAST_*</code> operations.</td> </tr> </table> |                          | 0 or <code>smuX.SETTLE_SMOOTH</code> | Turns off all settling operations (default). | 1 or <code>smuX.SETTLE_FAST_RANGE</code> | Instructs the SMU to use a faster procedure when changing ranges. | 2 or <code>smuX.SETTLE_FAST_POLARITY</code> | Instructs the SMU to change polarity without going to zero. | 3 or <code>smuX.SETTLE_DIRECT_IRANGE</code> | Instructs the SMU to change the amps range directly. | 4 or <code>smuX.SETTLE_SMOOTH_100NA</code> | Enables the use of range rampers for the 100 nA range. | 128 or <code>smuX.SETTLE_FAST_ALL</code> | Enables all <code>smuX.SETTLE_FAST_*</code> operations. |
| 0 or <code>smuX.SETTLE_SMOOTH</code>        | Turns off all settling operations (default).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                          |                                      |                                              |                                          |                                                                   |                                             |                                                             |                                             |                                                      |                                            |                                                        |                                          |                                                         |
| 1 or <code>smuX.SETTLE_FAST_RANGE</code>    | Instructs the SMU to use a faster procedure when changing ranges.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                          |                                      |                                              |                                          |                                                                   |                                             |                                                             |                                             |                                                      |                                            |                                                        |                                          |                                                         |
| 2 or <code>smuX.SETTLE_FAST_POLARITY</code> | Instructs the SMU to change polarity without going to zero.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                          |                                      |                                              |                                          |                                                                   |                                             |                                                             |                                             |                                                      |                                            |                                                        |                                          |                                                         |
| 3 or <code>smuX.SETTLE_DIRECT_IRANGE</code> | Instructs the SMU to change the amps range directly.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                          |                                      |                                              |                                          |                                                                   |                                             |                                                             |                                             |                                                      |                                            |                                                        |                                          |                                                         |
| 4 or <code>smuX.SETTLE_SMOOTH_100NA</code>  | Enables the use of range rampers for the 100 nA range.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                          |                                      |                                              |                                          |                                                                   |                                             |                                                             |                                             |                                                      |                                            |                                                        |                                          |                                                         |
| 128 or <code>smuX.SETTLE_FAST_ALL</code>    | Enables all <code>smuX.SETTLE_FAST_*</code> operations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                          |                                      |                                              |                                          |                                                                   |                                             |                                                             |                                             |                                                      |                                            |                                                        |                                          |                                                         |

|         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>Using <code>smuX.SETTLE_FAST_RANGE</code> may cause the SMU to exceed the range change overshoot specification.</li> <li><code>smuX.SETTLE_FAST_POLARITY</code> does not go to zero when changing polarity and may create inconsistencies at the zero crossing.</li> <li><code>smuX.SETTLE_DIRECT_IRANGE</code> switches the SMU directly to the target range instead of the default “range-by-range” method. This option is mutually exclusive of any other <code>smuX.SETTLE_FAST_*</code> commands.</li> <li><code>smuX.SETTLE_SMOOTH_100NA</code> is disabled by default in Models 2602A and 2612A. In Model 2636A, it is always enabled.</li> </ul> |
| Example | <p>Selects fast polarity changing for SMU A:</p> <pre>smua.source.settling = smua.SETTLE_FAST_POLARITY</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| <b>smuX.source.sink</b> <span style="float:right">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                               |                       |                                |                        |
|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-----------------------|--------------------------------|------------------------|
| Attribute                                                                         | The SMU sink mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                               |                       |                                |                        |
| Default                                                                           | <code>smuX.DISABLE</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                               |                       |                                |                        |
| TSP-Link accessibility                                                            | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                               |                       |                                |                        |
| Usage                                                                             | <pre>sink = smuX.source.sink      -- Reads the sink mode. smuX.source.sink = sink     -- Writes the sink mode.</pre> <p><code>sink</code>                                          The sink mode.</p> <p>Set <code>sink</code> to one of the following values:</p> <table style="width:100%; border:none;"> <tr> <td style="padding-right:20px;">1 or <code>smuX.ENABLE</code></td> <td>Turns on source sink.</td> </tr> <tr> <td>0 or <code>smuX.DISABLE</code></td> <td>Turns off sink source.</td> </tr> </table> | 1 or <code>smuX.ENABLE</code> | Turns on source sink. | 0 or <code>smuX.DISABLE</code> | Turns off sink source. |
| 1 or <code>smuX.ENABLE</code>                                                     | Turns on source sink.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |                       |                                |                        |
| 0 or <code>smuX.DISABLE</code>                                                    | Turns off sink source.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                               |                       |                                |                        |
| Remarks                                                                           | <ul style="list-style-type: none"> <li>Sink mode reduces the source limit inaccuracy seen when operating in quadrants II and IV.</li> <li>When sink mode is active, quadrants I and III will show this source limit inaccuracy.</li> </ul>                                                                                                                                                                                                                                                                           |                               |                       |                                |                        |
| Example                                                                           | <p>Activate sink mode for SMU A:</p> <pre>smua.source.sink = smua.ENABLE</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                       |                               |                       |                                |                        |

| <b>smuX.trigger.arm.count</b> <span style="float:right">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                               | Sets the arm count in the trigger model.                                                                                                                                                                                                                                                                                                                                                |
| Default                                                                                 | 1                                                                                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility                                                                  | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                             |
| Usage                                                                                   | <pre>count = smuX.trigger.arm.count smuX.trigger.arm.count = count</pre> <p><code>count</code>                                          The arm count.</p>                                                                                                                                                                                                                              |
| Remarks                                                                                 | <ul style="list-style-type: none"> <li>During a sweep, the SMU will iterate through the arm layer of the trigger model this many times. After performing this many iterations, the SMU will return to idle.</li> <li>If this count is set to zero, the SMU will stay in the trigger model indefinitely (or until aborted).</li> <li>The reset value for this attribute is 1.</li> </ul> |

| <b>smuX.trigger.arm.set</b> X = SMU channel (a or b) |                                                                                                                                                                                                                                           |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                                             | Sets the arm event detector to the detected state.                                                                                                                                                                                        |
| TSP-Link accessibility                               | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                |
| Usage                                                | <code>smuX.trigger.arm.set()</code>                                                                                                                                                                                                       |
| Remarks                                              | <ul style="list-style-type: none"> <li>The SMU will automatically clear all the event detectors when the <code>smuX.trigger.initiate</code> function is executed. This function should be called after the sweep is initiated.</li> </ul> |
| Also see                                             | <a href="#">smuX.trigger.initiate</a>                                                                                                                                                                                                     |

| <b>smuX.trigger.arm.stimulus</b> X = SMU channel (a or b) |                                                                                                                                                                                                                 |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                 | Selects which event will cause the arm event detector to enter the detected state.                                                                                                                              |
| Default                                                   | 0                                                                                                                                                                                                               |
| TSP-Link accessibility                                    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                     |
| Usage                                                     | <pre>eventid = smuX.trigger.arm.stimulus smuX.trigger.arm.stimulus = eventid  eventid                                Event that triggers the arm detector.</pre>                                                |
| Remarks                                                   | <ul style="list-style-type: none"> <li>Set this attribute to zero to bypass waiting for an event.</li> <li>Set this attribute to the event ID of any trigger event generator to wait for that event.</li> </ul> |

| <b>smuX.trigger.ARMED_EVENT_ID</b> X = SMU channel (a or b) |                                                                                                                                                                                  |
|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                   | The armed event number.                                                                                                                                                          |
| TSP-Link accessibility                                      | This attribute can be accessed from a remote TSP-Link node.                                                                                                                      |
| Usage                                                       | <pre>event_id = smuX.trigger.ARMED_EVENT_ID  event_id                                Armed event number.</pre>                                                                   |
| Remarks                                                     | <ul style="list-style-type: none"> <li>Set the stimulus of any trigger event detector to the value of this constant to have it respond to armed events from this SMU.</li> </ul> |

| <b>smuX.trigger.autoclear</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                 | Enable automatic clearing of the event detectors.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Default                                                                                   | <code>smuX.DISABLE</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| TSP-Link accessibility                                                                    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Usage                                                                                     | <pre>autoclear = smuX.trigger.autoclear smuX.trigger.autoclear = autoclear</pre> <p style="text-align: center;"><code>autoclear</code>                      Auto clear setting.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Remarks                                                                                   | <ul style="list-style-type: none"> <li>This attribute is used to enable or disable automatic clearing of the trigger model state machine event detectors when the SMU transitions from the arm layer to the trigger layer. <code>autoclear</code> can be set to one of the following values: <ul style="list-style-type: none"> <li><code>smuX.DISABLE</code>: Do not clear the event detectors.</li> <li><code>smuX.ENABLE</code>: Clear the event detectors when transitioning from the arm layer to the trigger layer.</li> </ul> </li> <li>Only the detected state of the event detectors will be cleared.</li> <li>The overrun status of the event detectors are not automatically cleared when the SMU transitions from the arm layer to the trigger layer.</li> <li>The event detectors are always cleared when a sweep is initiated.</li> </ul> |

| <b>smuX.trigger.count</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                             | Sets the trigger count in a trigger model.                                                                                                                                                                                                                                                                                                                                                       |
| Default                                                                               | 1                                                                                                                                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility                                                                | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                      |
| Usage                                                                                 | <pre>count = smuX.trigger.count smuX.trigger.count = count</pre> <p style="text-align: center;"><code>count</code>                                      The trigger count.</p>                                                                                                                                                                                                                   |
| Remarks                                                                               | <ul style="list-style-type: none"> <li>During a sweep, the SMU will iterate through the trigger layer of the trigger model this many times. After performing this many iterations, SMU will return to the arm layer.</li> <li>If this count is set to zero, the SMU will stay in the trigger model indefinitely (or until aborted).</li> <li>The reset value for this attribute is 1.</li> </ul> |

| <b>smuX.trigger.endpulse.action</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                       | Enables or disables pulse mode sweeps.                                                                                                                                                                                                                                                                                                                                                                                      |
| Default                                                                                         | <code>smuX.SOURCE_HOLD</code>                                                                                                                                                                                                                                                                                                                                                                                               |
| TSP-Link accessibility                                                                          | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                 |
| Usage                                                                                           | <pre>pulseaction = smuX.trigger.endpulse.action -- Reads pulse mode setting. smuX.trigger.endpulse.action = pulseaction -- Writes pulse mode setting.</pre> <p style="text-align: center;"><code>pulseaction</code>                                      The pulse mode setting.</p>                                                                                                                                        |
| Remarks                                                                                         | <ul style="list-style-type: none"> <li><code>pulseaction</code> can be set to one of the following values: <ul style="list-style-type: none"> <li><code>smuX.SOURCE_HOLD</code> Disables pulse mode sweep (holds source level for remainder of step).</li> <li><code>smuX.SOURCE_IDLE</code> Enables pulse mode sweep. Sets the source level to the programmed (idle) level at the end of the pulse.</li> </ul> </li> </ul> |



| <b>smuX.trigger.endpulse.set</b> X = SMU channel (a or b) |                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                                                  | Sets the end pulse event detector to the detected state.                                                                                                                                                                                                                                                                  |
| TSP-Link accessibility                                    | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                |
| Usage                                                     | <code>smuX.trigger.endpulse.set()</code>                                                                                                                                                                                                                                                                                  |
| Remarks                                                   | <ul style="list-style-type: none"> <li>This function sets the end pulse event detector to the detected state.</li> <li>The SMU will automatically clear all the event detectors when the <code>smuX.trigger.initiate</code> function is executed. This function should be called after the sweep is initiated.</li> </ul> |
| Also see                                                  | <a href="#">smuX.trigger.initiate</a>                                                                                                                                                                                                                                                                                     |

| <b>smuX.trigger.endpulse.stimulus</b> X = SMU channel (a or b) |                                                                                                                                                                                                                                                    |
|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                      | Selects which event will cause the end pulse event detector to enter the detected state.                                                                                                                                                           |
| Default                                                        | 0                                                                                                                                                                                                                                                  |
| TSP-Link accessibility                                         | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                        |
| Usage                                                          | <pre>eventid = smuX.trigger.endpulse.stimulus -- Reads trigger event. smuX.trigger.endpulse.stimulus = eventid -- Writes trigger event.</pre> <p>eventid                                  Event that triggers the end pulse source off action.</p> |
| Remarks                                                        | <ul style="list-style-type: none"> <li>Set this attribute to zero to bypass waiting for an event.</li> <li>Set this attribute to the event ID of any trigger event generator to wait for that event.</li> </ul>                                    |

| <b>smuX.trigger.endsweep.action</b> X = SMU channel (a or b) |                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                    | Controls the source action at the end of a sweep.                                                                                                                                                                                                                                                                                                                                   |
| Default                                                      | <code>smuX.SOURCE_HOLD</code>                                                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility                                       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                         |
| Usage                                                        | <pre>action = smuX.trigger.endsweep.action -- Reads source action. smuX.trigger.endsweep.action = action -- Writes source action.</pre> <p>action                                          The source action at the end of a sweep.</p>                                                                                                                                             |
| Remarks                                                      | <ul style="list-style-type: none"> <li>action can be set to one of the following values: <ul style="list-style-type: none"> <li><code>smuX.SOURCE_HOLD</code>: Leaves the source at the existing level for the last step in the sweep.</li> <li><code>smuX.SOURCE_IDLE</code>: Sets the source level to the programmed (idle) level at the end of the sweep.</li> </ul> </li> </ul> |

| <b>smuX.trigger.IDLE_EVENT_ID</b> X = SMU channel (a or b) |                                                                                                                                                                                 |
|------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                  | The idle event number.                                                                                                                                                          |
| TSP-Link accessibility                                     | This attribute can be accessed from a remote TSP-Link node.                                                                                                                     |
| Usage                                                      | <pre>event_id = smuX.trigger.IDLE_EVENT_ID</pre> <p>event_id                                          The idle event number.</p>                                                |
| Remarks                                                    | <ul style="list-style-type: none"> <li>Set the stimulus of any trigger event detector to the value of this constant to have it respond to idle events from this SMU.</li> </ul> |

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| <b>smuX.trigger.initiate</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Function                                                                                 | Initiates a sweep operation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| TSP-Link accessibility                                                                   | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Usage                                                                                    | <code>smuX.trigger.initiate()</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Remarks                                                                                  | <ul style="list-style-type: none"> <li>• This function causes the SMU to clear the four trigger model event detectors and enter its trigger model state machine.</li> <li>• To perform source actions during the sweep, it is necessary to configure and enable one of the sweep source actions (<code>smuX.trigger.source.linearY</code>, <code>smuX.trigger.source.listY</code>, or <code>smuX.trigger.source.logY</code>) and measure actions (<code>smuX.trigger.measure.Y</code>) prior to calling this function.</li> <li>• To perform measure actions during the sweep it is necessary to configure and enable a sweep measurement action before calling this function.</li> <li>• This function initiates an overlapped operation.</li> </ul> |

|                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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| <b>smuX.trigger.measure.action</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Attribute                                                                                      | Enables or disables measurements during a sweep.                                                                                                                                                                                                                                                                                                                                                                                              |
| Default                                                                                        | <code>smuX.DISABLE</code>                                                                                                                                                                                                                                                                                                                                                                                                                     |
| TSP-Link accessibility                                                                         | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                   |
| Usage                                                                                          | <pre> action = smuX.trigger.measure.action      -- Reads measure action. smuX.trigger.measure.action = action     -- Writes measure action.                 </pre> <p style="text-align: center;"><code>action</code>                                      The sweep measure action.</p>                                                                                                                                                      |
| Remarks                                                                                        | <ul style="list-style-type: none"> <li>• <code>action</code> can be set to one of the following values:<br/> <code>smuX.DISABLE</code>: Do not make measurements during the sweep.<br/> <code>smuX.ENABLE</code>: Make measurements during the sweep.<br/> <b>Note:</b> When setting the action to <code>smuX.ENABLE</code>, the measurement needs to be configured with one of the <code>smuX.trigger.measure.Y</code> functions.</li> </ul> |
| Also see                                                                                       | <a href="#">smuX.trigger.measure.Y</a>                                                                                                                                                                                                                                                                                                                                                                                                        |

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| <b>smuX.trigger.measure.set</b> <span style="float: right;">X = SMU channel (a or b)</span> |                                                                                                                          |
| Function                                                                                    | Sets the measure event detector to the detected state.                                                                   |
| TSP-Link accessibility                                                                      | This function can be accessed from a remote TSP-Link node.                                                               |
| Usage                                                                                       | <code>smuX.trigger.measure.set()</code>                                                                                  |
| Remarks                                                                                     | <ul style="list-style-type: none"> <li>• This function sets the measure event detector to the detected state.</li> </ul> |

|                                                               |                                                                                                                                                                                                                                                                                                |
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| <b>smuX.trigger.measure.stimulus</b> X = SMU channel (a or b) |                                                                                                                                                                                                                                                                                                |
| Attribute                                                     | Selects which event will cause the measure event detector to enter the detected state.                                                                                                                                                                                                         |
| Default                                                       | 0                                                                                                                                                                                                                                                                                              |
| TSP-Link accessibility                                        | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                    |
| Usage                                                         | <pre>eventid = smuX.trigger.measure.stimulus --Reads measure action trigger.</pre> <pre>smuX.trigger.measure.stimulus = eventid --Writes measure action trigger.</pre> <p style="text-align: center;">eventid                                      Event that triggers the measure action.</p> |
| Remarks                                                       | <ul style="list-style-type: none"> <li>Set this attribute to zero to bypass waiting for an event.</li> <li>Set this attribute to the event ID of any trigger event generator to wait for that event.</li> </ul>                                                                                |

|                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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| <b>smuX.trigger.measure.Y</b> X = SMU channel (a or b)<br>Y = SMU measure function ( <i>i, iv, v, r or p</i> )<br>Where: <i>v</i> = voltage, <i>i</i> = current, <i>r</i> = resistance, <i>p</i> = power |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Function                                                                                                                                                                                                 | Configures the measurements to be made in a subsequent sweep.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| TSP-Link accessibility                                                                                                                                                                                   | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Usage                                                                                                                                                                                                    | <pre>smuX.trigger.measure.i(rbuffer)</pre> <pre>smuX.trigger.measure.iv(ibuffer, vbuffer)</pre> <pre>smuX.trigger.measure.p(rbuffer)</pre> <pre>smuX.trigger.measure.r(rbuffer)</pre> <pre>smuX.trigger.measure.v(rbuffer)</pre> <p style="text-align: center;"> <i>ibuffer</i>                                      Reading buffer to hold the current readings made.<br/> <i>rbuffer</i>                                      Reading buffer to store the measurements.<br/> <i>Vbuffer</i>                                      Reading buffer to hold the voltage readings made.         </p> |
| Remarks                                                                                                                                                                                                  | <ul style="list-style-type: none"> <li>The given reading buffer(s) will be filled as the measurements complete.</li> <li>The SMU will only store the last call to any one of these functions and only that measure action will be performed.</li> </ul>                                                                                                                                                                                                                                                                                                                                           |

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| <b>smuX.trigger.MEASURE_COMPLETE_EVENT_ID</b> X = SMU channel (a or b) |                                                                                                                                                                                             |
| Attribute                                                              | The measure completed event number.                                                                                                                                                         |
| TSP-Link accessibility                                                 | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                 |
| Usage                                                                  | <pre>event_id = smuX.trigger.MEASURE_COMPLETE_EVENT_ID</pre> <p style="text-align: center;">event_id                                      The measure complete event number.</p>            |
| Remarks                                                                | <ul style="list-style-type: none"> <li>Set the stimulus of any trigger event detector to the value of this constant to have it respond to measure complete events from this SMU.</li> </ul> |

| <b>smuX.trigger.PULSE_COMPLETE_EVENT_ID</b> <span style="float: right;"><b>X = SMU channel (a or b)</b></span> |                                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                                      | The pulse complete event number.                                                                                                                                                          |
| TSP-Link accessibility                                                                                         | This attribute can be accessed from a remote TSP-Link node.                                                                                                                               |
| Usage                                                                                                          | <pre>event_id = smuX.trigger.PULSE_COMPLETE_EVENT_ID</pre> <p style="text-align: center;">event_id                                          Pulse complete event number.</p>              |
| Remarks                                                                                                        | <ul style="list-style-type: none"> <li>Set the stimulus of any trigger event detector to the value of this constant to have it respond to pulse complete events from this SMU.</li> </ul> |

| <b>smuX.trigger.source.action</b> <span style="float: right;"><b>X = SMU channel (a or b)</b></span> |                                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                            | Sweep source action enable.                                                                                                                                                                                                                                           |
| Default                                                                                              | smuX.DISABLE                                                                                                                                                                                                                                                          |
| TSP-Link accessibility                                                                               | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                           |
| Usage                                                                                                | <pre>action = smuX.trigger.source.action        -- Reads sweep source action. smuX.trigger.source.action = action        -- Writes sweep source action.</pre> <p style="text-align: center;">action                                          Sweep source action.</p> |
| Remarks                                                                                              | <ul style="list-style-type: none"> <li>This attribute is used to enable or disable source level changes during a sweep. action can be set to one of the following values:<br/> smuX.DISABLE: Do not sweep the source.<br/> smuX.ENABLE: Sweep the source.</li> </ul>  |

| <b>smuX.trigger.source.limitY</b> <span style="float: right;"><b>X = SMU channel (a or b)</b><br/><b>Y = SMU measure function (i or v)</b><br/>Where: v = voltage, i = current</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                                                                                                             | Sets the sweep source limit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Default                                                                                                                                                                               | <pre>limit/                  smuX.LIMIT_AUTO limitv                 smuX.LIMIT_AUTO</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| TSP-Link accessibility                                                                                                                                                                | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Usage                                                                                                                                                                                 | <pre>limit = smuX.trigger.source.limiti        -- Reads current source limit. limit = smuX.trigger.source.limitv        -- Reads voltage source limit. smuX.trigger.source.limiti = limit        -- Writes current source limit. smuX.trigger.source.limitv = limit        -- Writes voltage source limit.</pre> <p style="text-align: center;">limit                                          Source limit during triggered operation.</p>                                                                                                                                                                                                                                                                                        |
| Remarks                                                                                                                                                                               | <ul style="list-style-type: none"> <li>Use this attribute to perform extended operating area (EOA) pulse mode sweeps.</li> <li>If this attribute is set to smuX.LIMIT_AUTO, the SMU will use the normal limit setting during sweeping. If this attribute is set to any other value, the SMU will switch in this limit at the start of the source action and will switch back to the normal limit setting at the end of the end pulse action.</li> <li>When using the EOA, the SMU will automatically start the end pulse action if the SMU is not triggered before its maximum pulse width. It will also delay the source action if necessary to limit the pulse duty cycle to stay within the capabilities of the SMU.</li> </ul> |

|                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <b>smuX.trigger.source.linearY</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | X = SMU channel (a or b)<br>Y = SMU measure function ( <i>i</i> or <i>v</i> )<br>Where: <i>v</i> = voltage, <i>i</i> = current |
| Function                           | Configures a linear source sweep.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                |
| TSP-Link accessibility             | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                |
| Usage                              | <pre>smuX.trigger.source.linear<i>i</i>(startvalue, endvalue, points) smuX.trigger.source.linear<i>v</i>(startvalue, endvalue, points)</pre> <p>startvalue                      Source value of the first point.<br/>endvalue                         Source value of the last point.<br/>points                             The number of points used to calculate the step size.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                |
| Remarks                            | <ul style="list-style-type: none"> <li>This function configures a source action to be a linear source sweep in a subsequent sweep.</li> <li>During the sweep, the source will generate a uniform series of ascending or descending voltage or current changes called steps. The number of source steps is one less than the number of sourced data points.</li> <li>The <code>points</code> parameter does not set the number of steps in a sweep. It is only used to calculate source values within a subsequent sweep. If the subsequent sweep has more points than specified here, the source will restart at the beginning. If the subsequent sweep has fewer points than specified here, <code>endvalue</code> will not be reached during the sweep.</li> <li>In cases where the first sweep point is non-zero, it may be necessary to pre-charge the circuit so that the sweep will return a stable value for the first measured point without penalizing remaining points in the sweep.</li> <li>With linear sweeps it is acceptable to maintain a fixed source resolution over the entire sweep. To prevent source range changes during the sweep (especially when sweeping through 0.0), set the source range to a fixed range appropriate for the larger of either <code>startvalue</code> or <code>endvalue</code>.</li> <li>The SMU will only store the most recent configured source action. The last call to <code>smuX.trigger.source.linearY</code>, <code>smuX.trigger.source.listY</code>, or <code>smuX.trigger.source.logY</code> is used for the source action.</li> </ul> |                                                                                                                                |
| Also see                           | <a href="#">smuX.trigger.source.listY</a> , <a href="#">smuX.trigger.source.logY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                |

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| <b>smuX.trigger.source.listY</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | X = SMU channel (a or b)<br>Y = SMU measure function ( <i>i</i> or <i>v</i> )<br>Where: <i>v</i> = voltage, <i>i</i> = current |
| Function                         | Configures an array-based source sweep.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                |
| TSP-Link accessibility           | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                |
| Usage                            | <pre>smuX.trigger.source.list<i>i</i>(sweeplist) smuX.trigger.source.list<i>v</i>(sweeplist)</pre> <p>sweeplist                         The array of source values.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                |
| Remarks                          | <ul style="list-style-type: none"> <li>This function configures the source action to be a list sweep in a subsequent sweep.</li> <li>During the sweep, the source will output the sequence of source values given in the <code>sweeplist</code> array.</li> <li>If the subsequent sweep has more points than given in <code>sweeplist</code>, the source will restart at the beginning of the list for the extra points. If the subsequent sweep has less points than given in <code>sweeplist</code>, the extra values will be ignored.</li> <li>In cases where the first sweep point is non-zero, it may be necessary to pre-charge the circuit so that the sweep will return a stable value for the first measured point without penalizing remaining points in the sweep.</li> <li>The SMU will only store the most recent configured source action. The last call to <code>smuX.trigger.source.linearY</code>, <code>smuX.trigger.source.listY</code>, or <code>smuX.trigger.source.logY</code> is used for the source action.</li> </ul> |                                                                                                                                |
| Also see                         | <a href="#">smuX.trigger.source.linearY</a> , <a href="#">smuX.trigger.source.logY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                |

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| <b>smuX.trigger.source.logY</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | X = SMU channel (a or b)<br>Y = SMU measure function ( <i>i</i> or <i>v</i> )<br>Where: <i>v</i> = voltage, <i>i</i> = current |
| Function                        | Configures an exponential (geometric) source sweep.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                |
| TSP-Link accessibility          | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                |
| Usage                           | <pre>smuX.trigger.source.logi(startvalue, endvalue, points, asymptote) smuX.trigger.source.logv(startvalue, endvalue, points, asymptote)</pre> <p>startvalue                      Source value of the first point.<br/>endvalue                         Source value of the last point.<br/>points                            Used to calculate the step sizes during the sweep.<br/>asymptote                        The asymptotic offset value.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                |
| Remarks                         | <ul style="list-style-type: none"> <li>• This function configures a geometric source sweep.</li> <li>• During the sweep, the source will generate a geometric series of ascending or descending voltage or current changes called steps. Each step is larger or smaller than the previous step by a fixed proportion. The constant of proportionality is determined by the starting value, the ending value, the asymptote, and the number of steps in the sweep. The number of source steps is one less than the number of sourced data points.</li> <li>• The <code>points</code> parameter does not set the number of steps in a sweep. It is only used to calculate source values within a subsequent sweep. If the subsequent sweep has more points than specified here, the source will restart at the beginning. If the subsequent sweep has less points than specified here, <code>endvalue</code> will not be reached during the sweep.</li> <li>• In cases where the first sweep point is non-zero, it may be necessary to pre-charge the circuit so that the sweep will return a stable value for the first measured point without penalizing remaining points in the sweep.</li> <li>• With logarithmic sweeps it is usually necessary to allow the source to auto range to maintain good source accuracy when sweeping over more than one decade or across range boundaries.</li> <li>• The <code>asymptote</code> parameter can be used to customize the inflection and/or offset of the source value curve. This allows log sweeps to cross zero. Setting this parameter to zero provides a conventional logarithmic sweep. The <code>asymptote</code> value is the value that the curve would have at either positive or negative infinity depending on the direction of the sweep.</li> <li>• The <code>asymptote</code> value must not be equal to or between the starting and ending values. It must be outside the range defined by the starting and ending values.</li> <li>• The SMU will only store the most recent configured source action. The last call to <code>smuX.trigger.source.linearY</code>, <code>smuX.trigger.source.listY</code>, or <code>smuX.trigger.source.logY</code> is used for the source action.</li> </ul> |                                                                                                                                |
| Also see                        | <a href="#">smuX.trigger.source.linearY</a> , <a href="#">smuX.trigger.source.listY</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                |

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|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b>smuX.trigger.source.set</b> |                                                                                                                                                                                                                                                                                                                        | X = SMU channel (a or b) |
| Function                       | Sets the source event detector to the detected state.                                                                                                                                                                                                                                                                  |                          |
| TSP-Link accessibility         | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                             |                          |
| Usage                          | <code>smuX.trigger.source.set()</code>                                                                                                                                                                                                                                                                                 |                          |
| Remarks                        | <ul style="list-style-type: none"> <li>• This function sets the source event detector to the detected state.</li> <li>• The SMU will automatically clear all event detectors when the <code>smuX.trigger.initiate</code> function is executed. This function should be called after the sweep is initiated.</li> </ul> |                          |
| Also see                       | <a href="#">smuX.trigger.initiate</a>                                                                                                                                                                                                                                                                                  |                          |

| <b>smuX.trigger.source.stimulus</b> X = SMU channel (a or b) |                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                    | Selects the event which causes the source event detector to enter the detected state.                                                                                                                                                                                                                                                                                                                              |
| Default                                                      | 0                                                                                                                                                                                                                                                                                                                                                                                                                  |
| TSP-Link accessibility                                       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                        |
| Usage                                                        | <pre>eventid = smuX.trigger.source.stimulus -- Reads source action trigger.</pre> <pre>smuX.trigger.source.stimulus = eventid -- Writes source action trigger.</pre> <p style="text-align: center;">eventid                                      Event that triggers the source action.</p>                                                                                                                        |
| Remarks                                                      | <ul style="list-style-type: none"> <li>• Set this attribute to zero to bypass waiting for an event.</li> <li>• Set this attribute to the event ID of any trigger event generator to wait for that event.</li> <li>• The SMU will automatically clear all event detectors when the <code>smuX.trigger.initiate</code> function is executed. This function should be called after the sweep is initiated.</li> </ul> |
| Also see                                                     | <a href="#">smuX.trigger.initiate</a>                                                                                                                                                                                                                                                                                                                                                                              |

| <b>smuX.trigger.SOURCE_COMPLETE_EVENT_ID</b> X = SMU channel (a or b) |                                                                                                                                                                                              |
|-----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                             | The source complete event number.                                                                                                                                                            |
| TSP-Link accessibility                                                | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                  |
| Usage                                                                 | <pre>event_id = smuX.trigger.SOURCE_COMPLETE_EVENT_ID</pre> <p style="text-align: center;">event_id                                      Source action complete event number.</p>            |
| Remarks                                                               | <ul style="list-style-type: none"> <li>• Set the stimulus of any trigger event detector to the value of this constant to have it respond to source complete events from this SMU.</li> </ul> |

| <b>smuX.trigger.SWEEP_COMPLETE_EVENT_ID</b> X = SMU channel (a or b) |                                                                                                                                                                                             |
|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                            | The sweep complete event number.                                                                                                                                                            |
| TSP-Link accessibility                                               | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                 |
| Usage                                                                | <pre>event_id = smuX.trigger.SWEEP_COMPLETE_EVENT_ID</pre> <p style="text-align: center;">event_id                                      Sweep complete event number.</p>                    |
| Remarks                                                              | <ul style="list-style-type: none"> <li>• Set the stimulus of any trigger event detector to the value of this constant to have it respond to sweep complete events from this SMU.</li> </ul> |

| <b>smuX.trigger.SWEEPING_EVENT_ID</b> X = SMU channel (a or b) |                                                                                                                                                                                       |
|----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                      | The sweeping event number.                                                                                                                                                            |
| TSP-Link accessibility                                         | This attribute can be accessed from a remote TSP-Link node.                                                                                                                           |
| Usage                                                          | <pre>event_id = smuX.trigger.SWEEPING_EVENT_ID</pre> <p style="text-align: center;">event_id                                      Sweeping event number.</p>                          |
| Remarks                                                        | <ul style="list-style-type: none"> <li>• Set the stimulus of any trigger event detector to the value of this constant to have it respond to sweeping events from this SMU.</li> </ul> |

## Status

The following provides a brief overview of the status model. Details on the status model are provided in [Appendix C](#) of this manual.

### Status register sets

A typical status register set is made up of a condition register, an event register, an event enable register, a negative transition register, and a positive transition register. A condition register is a read-only register that constantly updates to reflect the present operating conditions of the instrument. When an event occurs, and the appropriate NTR or PTR bit is set, the matching event register bit is set to 1. The bit remains latched to 1 until the register is read or reset. When an event register bit is set and its corresponding enable bit is set (as programmed by the user), the output (summary) of the register will set to 1, which in turn sets the condition bit in a higher-level register, and can ultimately cascade to the summary bit of the Status Byte Register.

### Negative and positive transition registers

- **Negative-transition register (NTR):** When a bit in an NTR register is set by the user, the corresponding bit in the event register will set when the corresponding bit in the condition register transitions from 1 to 0.
- **Positive-transition register (PTR):** When a bit in a PTR register is set by the user, the corresponding bit in the event register will set when the corresponding bit in the condition register transitions from 0 to 1.

### Status byte and SRQ

The Status Byte Register receives the summary bits of the five status register sets and two queues. The register sets and queues monitor the various instrument events. When an enabled event occurs, it sets a summary bit in the Status Byte Register. When a summary bit of the Status Byte is set and its corresponding enable bit is set (as programmed by the user), the RQS/MSS bit will set to indicate that an SRQ has occurred.

SRQs will affect both the GPIB and the VXI-11 connections. On the GPIB, the SRQ line will be asserted. On a VXI-11 connection, an SRQ event will be generated.



| <b>status.condition</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute               | Status byte register.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| TSP-Link accessibility  | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Usage                   | Reads the status byte register:<br><code>statbyte = status.condition</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Remarks                 | <ul style="list-style-type: none"> <li>• This attribute is used to read the status byte, which is returned as a numeric value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 7.</li> <li>• For example, assume value 129 is returned for the condition register. The binary equivalent is 10000001. This value indicates that bit B0 (MSB) and bit B7 (OSB) are set.</li> <li>• The bits of the status byte register are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B0, Measurement Summary Bit (MSB):</b> Set summary bit indicates that an enabled measurement event has occurred.</li> <li>• <b>Bit B1, System Summary Bit (SSB):</b> Set summary bit indicates that an enabled system event has occurred.</li> <li>• <b>Bit B2, Error Available (EAV):</b> Set summary bit indicates that an error or status message is present in the Error Queue.</li> <li>• <b>Bit B3, Questionable Summary Bit (QSB):</b> Set summary bit indicates that an enabled questionable event has occurred.</li> <li>• <b>Bit B4, Message Available (MAV):</b> Set summary bit indicates that a response message is present in the Output Queue.</li> <li>• <b>Bit B5, Event Summary Bit (ESB):</b> Set summary bit indicates that an enabled standard event has occurred.</li> <li>• <b>Bit B6, Request Service (RQS)/Master Summary Status (MSS):</b> Set bit indicates that an enabled summary bit of the Status Byte Register is set. Depending on how it is used, Bit B6 of the Status Byte Register is either the Request for Service (RQS) bit or the Master Summary Status (MSS) bit: <ul style="list-style-type: none"> <li>- When using the GPIB or VXI-11 serial poll sequence of the SourceMeter instrument to obtain the status byte (serial poll byte), B6 is the RQS bit.</li> <li>- When using <code>status.condition</code> or the <code>*STB?</code> common command to read the status byte, B6 is the MSS bit.</li> </ul> </li> <li>• <b>Bit B7, Operation Summary (OSB):</b> Set summary bit indicates that an enabled operation event has occurred.</li> </ul> </li> </ul> |
| Details                 | See <a href="#">Status byte and service request (SRQ)</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Example                 | Reads the status byte:<br><pre>statbyte = status.condition print(statbyte)</pre> Output: 1.29000e+02<br>The above output indicates that bits B0 (MSS) and B7 (OSB) are set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

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| <b>status.measurement.condition</b><br><b>status.measurement.enable</b><br><b>status.measurement.event</b><br><b>status.measurement.ntr</b><br><b>status.measurement.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| Attribute                                                                                                                                                                    | Measurement event register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| Default                                                                                                                                                                      | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| TSP-Link accessibility                                                                                                                                                       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| Usage                                                                                                                                                                        | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre> measreg = status.measurement.condition measreg = status.measurement.enable measreg = status.measurement.event measreg = status.measurement.ntr measreg = status.measurement.ptr </pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre> status.measurement.enable = measreg status.measurement.ntr = measreg status.measurement.ptr = measreg </pre> <p>Set measreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.measurement.VOLTAGE_LIMIT</td> <td>Sets VLMT bit (B0).</td> </tr> <tr> <td>status.measurement.VLMT</td> <td>Sets VLMT bit (B0).</td> </tr> <tr> <td>status.measurement.CURRENT_LIMIT</td> <td>Sets ILMT bit (B1).</td> </tr> <tr> <td>status.measurement.ILMT</td> <td>Sets ILMT bit (B1).</td> </tr> <tr> <td>status.measurement.READING_OVERFLOW</td> <td>Sets ROF bit (B7).</td> </tr> <tr> <td>status.measurement.ROF</td> <td>Sets ROF bit (B7).</td> </tr> <tr> <td>status.measurement.BUFFER_AVAILABLE</td> <td>Sets BAV bit (B8).</td> </tr> <tr> <td>status.measurement.BAV</td> <td>Sets BAV bit (B8).</td> </tr> <tr> <td>status.measurement.OUTPUT_ENABLE</td> <td>Sets OE bit (B11).</td> </tr> <tr> <td>status.measurement.OE</td> <td>Sets OE bit (B11).</td> </tr> <tr> <td>status.measurement.INSTRUMENT_SUMMARY</td> <td>Sets INST bit (B13).</td> </tr> <tr> <td>status.measurement.INST</td> <td>Sets INST bit (B13).</td> </tr> </table> <p>measreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B0 (VLMT), set measreg to 1 (<math>2^0</math>).</li> <li>To set bit B1 (ILMT), set measreg to 2 (<math>2^1</math>).</li> <li>To set bit B8 (BAV), set measreg to 256 (<math>2^8</math>).</li> <li>To set more than one bit of the register, set measreg to the sum of their decimal weights. For example, to set bits B0 and B8, set measreg to 257 (1 + 256).</li> </ul> | 0 | Clears all bits. | status.measurement.VOLTAGE_LIMIT | Sets VLMT bit (B0). | status.measurement.VLMT | Sets VLMT bit (B0). | status.measurement.CURRENT_LIMIT | Sets ILMT bit (B1). | status.measurement.ILMT | Sets ILMT bit (B1). | status.measurement.READING_OVERFLOW | Sets ROF bit (B7). | status.measurement.ROF | Sets ROF bit (B7). | status.measurement.BUFFER_AVAILABLE | Sets BAV bit (B8). | status.measurement.BAV | Sets BAV bit (B8). | status.measurement.OUTPUT_ENABLE | Sets OE bit (B11). | status.measurement.OE | Sets OE bit (B11). | status.measurement.INSTRUMENT_SUMMARY | Sets INST bit (B13). | status.measurement.INST | Sets INST bit (B13). |
| 0                                                                                                                                                                            | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| status.measurement.VOLTAGE_LIMIT                                                                                                                                             | Sets VLMT bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| status.measurement.VLMT                                                                                                                                                      | Sets VLMT bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| status.measurement.CURRENT_LIMIT                                                                                                                                             | Sets ILMT bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| status.measurement.ILMT                                                                                                                                                      | Sets ILMT bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| status.measurement.READING_OVERFLOW                                                                                                                                          | Sets ROF bit (B7).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| status.measurement.ROF                                                                                                                                                       | Sets ROF bit (B7).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| status.measurement.BUFFER_AVAILABLE                                                                                                                                          | Sets BAV bit (B8).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| status.measurement.BAV                                                                                                                                                       | Sets BAV bit (B8).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| status.measurement.OUTPUT_ENABLE                                                                                                                                             | Sets OE bit (B11).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| status.measurement.OE                                                                                                                                                        | Sets OE bit (B11).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| status.measurement.INSTRUMENT_SUMMARY                                                                                                                                        | Sets INST bit (B13).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |
| status.measurement.INST                                                                                                                                                      | Sets INST bit (B13).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                  |                     |                         |                     |                                  |                     |                         |                     |                                     |                    |                        |                    |                                     |                    |                        |                    |                                  |                    |                       |                    |                                       |                      |                         |                      |

|         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>This attribute is used to read or write to the measurement event registers.</li> <li>Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>For example, assume value 257 is returned for the register. The binary equivalent is 0000000100000001. This value indicates that bit B1(VLMT) and bit B8 (BAV) are set.</li> <li>The used bits of the measurement event registers are described as follows: <ul style="list-style-type: none"> <li><b>Bit B0, VLMT:</b> Set bit is a summary of the <code>status.measurement.voltage_limit</code> register.</li> <li><b>Bit B1, ILMT:</b> Set bit is a summary of the <code>status.measurement.current_limit</code> register.</li> <li><b>Bit B7, ROF:</b> Set bit is a summary of the <code>status.measurement.reading_overflow</code> register.</li> <li><b>Bit B8, BAV:</b> Set bit is a summary of the <code>status.measurement.buffer_available</code> register.</li> <li><b>Bit B11, OE:</b> Set bit indicates that output enable has been asserted.</li> <li><b>Bit B13, INST:</b> Set bit indicates that a bit in the measurement instrument summary register is set.</li> </ul> </li> </ul> |
| Details | See <a href="#">Status model (measurement event registers)</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Example | Set the BAV bit of the measurement event enable register:<br><pre>status.measurement.enable = status.measurement.BAV</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

`status.measurement.buffer_available`

|                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                       |                     |                                                       |                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|-------------------------------------------------------|---------------------|-------------------------------------------------------|---------------------|
| <b>status.measurement.buffer_available.condition</b><br><b>status.measurement.buffer_available.enable</b><br><b>status.measurement.buffer_available.event</b><br><b>status.measurement.buffer_available.ntr</b><br><b>status.measurement.buffer_available.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                       |                     |                                                       |                     |
| Attribute                                                                                                                                                                                                                                                         | Measurement event buffer available summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                                       |                     |                                                       |                     |
| Default                                                                                                                                                                                                                                                           | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                                       |                     |                                                       |                     |
| TSP-Link accessibility                                                                                                                                                                                                                                            | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                  |                                                       |                     |                                                       |                     |
| Usage                                                                                                                                                                                                                                                             | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>measreg = status.measurement.buffer_available.condition measreg = status.measurement.buffer_available.enable measreg = status.measurement.buffer_available.event measreg = status.measurement.buffer_available.ntr measreg = status.measurement.buffer_available.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.measurement.buffer_available.enable = measreg status.measurement.buffer_available.ntr = measreg status.measurement.buffer_available.ptr = measreg</pre> <p>Set <code>operreg</code> to one of the following values:</p> <table> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td><code>status.measurement.buffer_available.SMUA</code></td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td><code>status.measurement.buffer_available.SMUB</code></td> <td>Sets SMUB bit (B2).</td> </tr> </table> <p><code>measreg</code> can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B1 (SMUA), set <code>measreg</code> to 2 (<math>2^1</math>).</li> <li>To set bit B2 (SMUB), set <code>measreg</code> to 4 (<math>2^2</math>).</li> <li>To set both bits, set <code>measreg</code> to the sum of the decimal weights of both bits.</li> <li>To set bits B1 and B2, set <code>measreg</code> to 6 (<math>2 + 4</math>).</li> </ul> | 0 | Clears all bits. | <code>status.measurement.buffer_available.SMUA</code> | Sets SMUA bit (B1). | <code>status.measurement.buffer_available.SMUB</code> | Sets SMUB bit (B2). |
| 0                                                                                                                                                                                                                                                                 | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                                       |                     |                                                       |                     |
| <code>status.measurement.buffer_available.SMUA</code>                                                                                                                                                                                                             | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                                       |                     |                                                       |                     |
| <code>status.measurement.buffer_available.SMUB</code>                                                                                                                                                                                                             | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                                       |                     |                                                       |                     |

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|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the measurement event buffer available summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 000000000000110. This value indicates that bit B1(SMUA) and bit B2 (SMUB) are set.</li> <li>• The used bits of the measurement event buffer available summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, SMUA:</b> Set bit indicates the enabled BAV bit for the SMU A measurement event register is set.</li> <li>• <b>Bit B2, SMUB:</b> Set bit indicates the enabled BAV bit for the SMU B measurement event register is set.</li> </ul> </li> </ul> |
| Details | See <a href="#">Status model (measurement event registers)</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Example | Sets the SMUA bit of the measurement event buffer available summary enable register:<br><pre>status.measurement.buffer_available.enable = status.measurement.buffer_available.SMUA</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

|                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                       |                     |                                       |                     |
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| <b>status.measurement.current_limit.condition</b><br><b>status.measurement.current_limit.enable</b><br><b>status.measurement.current_limit.event</b><br><b>status.measurement.current_limit.ntr</b><br><b>status.measurement.current_limit.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                       |                     |                                       |                     |
| Attribute                                                                                                                                                                                                                                          | Measurement event current limit summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                       |                     |                                       |                     |
| Default                                                                                                                                                                                                                                            | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                       |                     |                                       |                     |
| TSP-Link accessibility                                                                                                                                                                                                                             | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |                  |                                       |                     |                                       |                     |
| Usage                                                                                                                                                                                                                                              | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>measreg = status.measurement.current_limit.condition measreg = status.measurement.current_limit.enable measreg = status.measurement.current_limit.event measreg = status.measurement.current_limit.ntr measreg = status.measurement.current_limit.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.measurement.current_limit.enable = measreg status.measurement.current_limit.ntr = measreg status.measurement.current_limit.ptr = measreg</pre> <p>Set measreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.measurement.current_limit.SMUA</td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td>status.measurement.current_limit.SMUB</td> <td>Sets SMUB bit (B2).</td> </tr> </table> <p>measreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B1 (SMUA), set measreg to 2 (2<sup>1</sup>).</li> <li>To set bit B2 (SMUB), set measreg to 4 (2<sup>2</sup>).</li> <li>To set both bits, set measreg to the sum of the decimal weights of both bits.</li> <li>To set bits B1 and B2, set measreg to 6 (2 + 4).</li> </ul> | 0 | Clears all bits. | status.measurement.current_limit.SMUA | Sets SMUA bit (B1). | status.measurement.current_limit.SMUB | Sets SMUB bit (B2). |
| 0                                                                                                                                                                                                                                                  | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |                  |                                       |                     |                                       |                     |
| status.measurement.current_limit.SMUA                                                                                                                                                                                                              | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                       |                     |                                       |                     |
| status.measurement.current_limit.SMUB                                                                                                                                                                                                              | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                       |                     |                                       |                     |

|         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the measurement event current limit summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 000000000000110. This value indicates that bit B1(SMUA) and bit B2 (SMUB) are set.</li> <li>• The used bits of the measurement event current limit summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, SMUA:</b> Set bit indicates the enabled ILMT bit for the SMU A measurement register is set.</li> <li>• <b>Bit B2, SMUB:</b> Set bit indicates the enabled ILMT bit for the SMU B measurement register is set.</li> </ul> </li> </ul> |
| Details | See <a href="#">Status model (measurement event registers)</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Example | Sets the SMUA bit of the measurement event current limit summary enable register:<br><pre>status.measurement.current_limit.enable = status.measurement.current_limit.SMUA</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

|                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                    |                     |                                    |                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|------------------------------------|---------------------|------------------------------------|---------------------|
| <b>status.measurement.instrument.condition</b><br><b>status.measurement.instrument.enable</b><br><b>status.measurement.instrument.event</b><br><b>status.measurement.instrument.ntr</b><br><b>status.measurement.instrument.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                    |                     |                                    |                     |
| Attribute                                                                                                                                                                                                                           | Measurement event instrument summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                    |                     |                                    |                     |
| Default                                                                                                                                                                                                                             | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                    |                     |                                    |                     |
| TSP-Link accessibility                                                                                                                                                                                                              | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                     |                                    |                     |
| Usage                                                                                                                                                                                                                               | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>measreg = status.measurement.instrument.condition measreg = status.measurement.instrument.enable measreg = status.measurement.instrument.event measreg = status.measurement.instrument.ntr measreg = status.measurement.instrument.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.measurement.instrument.enable = measreg status.measurement.instrument.ntr = measreg status.measurement.instrument.ptr = measreg</pre> <p>Set measreg to one of the following values:</p> <table> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.measurement.instrument.SMUA</td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td>status.measurement.instrument.SMUB</td> <td>Sets SMUB bit (B2).</td> </tr> </table> <p>measreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B1 (SMUA), set measreg to 2 (<math>2^1</math>).</li> <li>To set bit B2 (SMUB), set measreg to 4 (<math>2^2</math>).</li> <li>To set both bits, set measreg to the sum of the decimal weights of both bits.</li> <li>To set bits B1 and B2, set measreg to 6 (<math>2 + 4</math>).</li> </ul> | 0 | Clears all bits. | status.measurement.instrument.SMUA | Sets SMUA bit (B1). | status.measurement.instrument.SMUB | Sets SMUB bit (B2). |
| 0                                                                                                                                                                                                                                   | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                    |                     |                                    |                     |
| status.measurement.instrument.SMUA                                                                                                                                                                                                  | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                    |                     |                                    |                     |
| status.measurement.instrument.SMUB                                                                                                                                                                                                  | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                    |                     |                                    |                     |

|         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the measurement event instrument summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 000000000000110. This value indicates that bit B1 (SMUA) and bit B2 (SMUB) are set.</li> <li>• The used bits of the measurement event instrument summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, SMUA:</b> Set bit indicates one or more enabled bits for the SMU A measurement register is set.</li> <li>• <b>Bit B2, SMUB:</b> Set bit indicates one or more enabled bits for the SMU B measurement register is set.</li> </ul> </li> </ul> |
| Details | See <a href="#">Status model (measurement event registers)</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Example | Sets the SMUA bit of the measurement event instrument summary enable register:<br><pre>status.measurement.instrument.enable = status.measurement.instrument.SMUA</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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|                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---|------------------|--------------------------------------------------|---------------------|-----------------------------------------|---------------------|--------------------------------------------------|---------------------|-----------------------------------------|---------------------|-----------------------------------------------------|--------------------|----------------------------------------|--------------------|-----------------------------------------------------|--------------------|----------------------------------------|--------------------|
| <b>status.measurement.instrument.smuX.condition</b><br><b>status.measurement.instrument.smuX.enable</b><br><b>status.measurement.instrument.smuX.event</b><br><b>status.measurement.instrument.smuX.ntr</b><br><b>status.measurement.instrument.smuX.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | smuX = smua or smub |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| Attribute                                                                                                                                                                                                                                                    | Measurement event SMU X summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| Default                                                                                                                                                                                                                                                      | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| TSP-Link accessibility                                                                                                                                                                                                                                       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| Usage                                                                                                                                                                                                                                                        | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>measreg = status.measurement.instrument.smuX.condition measreg = status.measurement.instrument.smuX.enable measreg = status.measurement.instrument.smuX.event measreg = status.measurement.instrument.smuX.ntr measreg = status.measurement.instrument.smuX.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.measurement.instrument.smuX.enable = measreg status.measurement.instrument.smuX.ntr = measreg status.measurement.instrument.smuX.ptr = measreg</pre> <p>Set measreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.measurement.instrument.smuX.VOLTAGE_LIMIT</td> <td>Sets VLMT bit (B0).</td> </tr> <tr> <td>status.measurement.instrument.smuX.VLMT</td> <td>Sets VLMT bit (B0).</td> </tr> <tr> <td>status.measurement.instrument.smuX.CURRENT_LIMIT</td> <td>Sets ILMT bit (B1).</td> </tr> <tr> <td>status.measurement.instrument.smuX.ILMT</td> <td>Sets ILMT bit (B1).</td> </tr> <tr> <td>status.measurement.instrument.smuX.READING_OVERFLOW</td> <td>Sets ROF bit (B7).</td> </tr> <tr> <td>status.measurement.instrument.smuX.ROF</td> <td>Sets ROF bit (B7).</td> </tr> <tr> <td>status.measurement.instrument.smuX.BUFFER_AVAILABLE</td> <td>Sets BAV bit (B8).</td> </tr> <tr> <td>status.measurement.instrument.smuX.BAV</td> <td>Sets BAV bit (B8).</td> </tr> </table> <p>measreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B0 (VLMT), set measreg to 1 (<math>2^0</math>).</li> <li>To set bit B1 (ILMT), set measreg to 2 (<math>2^1</math>).</li> <li>To set bit B8 (BAV), set measreg to 256 (<math>2^8</math>).</li> <li>To set more than one bit of the register, set measreg to the sum of their decimal weights. For example, to set bits B0 and B8, set measreg to 257 (1 + 256).</li> </ul> |                     | 0 | Clears all bits. | status.measurement.instrument.smuX.VOLTAGE_LIMIT | Sets VLMT bit (B0). | status.measurement.instrument.smuX.VLMT | Sets VLMT bit (B0). | status.measurement.instrument.smuX.CURRENT_LIMIT | Sets ILMT bit (B1). | status.measurement.instrument.smuX.ILMT | Sets ILMT bit (B1). | status.measurement.instrument.smuX.READING_OVERFLOW | Sets ROF bit (B7). | status.measurement.instrument.smuX.ROF | Sets ROF bit (B7). | status.measurement.instrument.smuX.BUFFER_AVAILABLE | Sets BAV bit (B8). | status.measurement.instrument.smuX.BAV | Sets BAV bit (B8). |
| 0                                                                                                                                                                                                                                                            | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| status.measurement.instrument.smuX.VOLTAGE_LIMIT                                                                                                                                                                                                             | Sets VLMT bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| status.measurement.instrument.smuX.VLMT                                                                                                                                                                                                                      | Sets VLMT bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| status.measurement.instrument.smuX.CURRENT_LIMIT                                                                                                                                                                                                             | Sets ILMT bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| status.measurement.instrument.smuX.ILMT                                                                                                                                                                                                                      | Sets ILMT bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| status.measurement.instrument.smuX.READING_OVERFLOW                                                                                                                                                                                                          | Sets ROF bit (B7).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| status.measurement.instrument.smuX.ROF                                                                                                                                                                                                                       | Sets ROF bit (B7).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| status.measurement.instrument.smuX.BUFFER_AVAILABLE                                                                                                                                                                                                          | Sets BAV bit (B8).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| status.measurement.instrument.smuX.BAV                                                                                                                                                                                                                       | Sets BAV bit (B8).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| Remarks                                                                                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the measurement event SMU X summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 257 is returned for the enable register. The binary equivalent is 0000000100000001. This value indicates that bit B0 (VLMT) and bit B8 (BAV) are set.</li> <li>• The used bits of the measurement event SMU X summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B0, VLMT:</b> Set bit indicates that the voltage limit was exceeded. This bit will be updated only when a measurement is taken or <code>smuX.source.compliance</code> is invoked.</li> <li>• <b>Bit B1, ILMT:</b> Set bit indicates that the current limit was exceeded. This bit will be updated only when a measurement is taken or <code>smuX.source.compliance</code> is invoked.</li> <li>• <b>Bit B7, ROF:</b> Set bit indicates that an overflow reading has been detected.</li> <li>• <b>Bit B8, BAV:</b> Set bit indicates that there is at least one reading stored in either or both of the dedicated reading buffers.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| Details                                                                                                                                                                                                                                                      | See <a href="#">Status model (measurement event registers)</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |
| Example                                                                                                                                                                                                                                                      | Sets the BAV bit of the measurement event SMU X summary enable register:<br><pre>status.measurement.instrument.smua.enable = status.measurement.instrument.smua.BAV</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                     |   |                  |                                                  |                     |                                         |                     |                                                  |                     |                                         |                     |                                                     |                    |                                        |                    |                                                     |                    |                                        |                    |



| <b>status.measurement.reading_overflow.condition</b><br><b>status.measurement.reading_overflow.enable</b><br><b>status.measurement.reading_overflow.event</b><br><b>status.measurement.reading_overflow.ntr</b><br><b>status.measurement.reading_overflow.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                          |                     |                                          |                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|------------------------------------------|---------------------|------------------------------------------|---------------------|
| Attribute                                                                                                                                                                                                                                                         | Measurement event reading overflow summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                          |                     |                                          |                     |
| Default                                                                                                                                                                                                                                                           | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                          |                     |                                          |                     |
| TSP-Link accessibility                                                                                                                                                                                                                                            | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                          |                     |                                          |                     |
| Usage                                                                                                                                                                                                                                                             | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre> measreg = status.measurement.reading_overflow.condition measreg = status.measurement.reading_overflow.enable measreg = status.measurement.reading_overflow.event measreg = status.measurement.reading_overflow.ntr measreg = status.measurement.reading_overflow.ptr </pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre> status.measurement.reading_overflow.enable = measreg status.measurement.reading_overflow.ntr = measreg status.measurement.reading_overflow.ptr = measreg </pre> <p>Set measreg to one of the following values:</p> <table> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.measurement.reading_overflow.SMUA</td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td>status.measurement.reading_overflow.SMUB</td> <td>Sets SMUB bit (B2).</td> </tr> </table> <p>measreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B1 (SMUA), set measreg to 2 (<math>2^1</math>).</li> <li>To set bit B2 (SMUB), set measreg to 4 (<math>2^2</math>).</li> <li>To set both bits, set measreg to the sum of the decimal weights of both bits.</li> <li>To set bits B1 and B2, set measreg to 6 (<math>2 + 4</math>).</li> </ul> | 0 | Clears all bits. | status.measurement.reading_overflow.SMUA | Sets SMUA bit (B1). | status.measurement.reading_overflow.SMUB | Sets SMUB bit (B2). |
| 0                                                                                                                                                                                                                                                                 | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                          |                     |                                          |                     |
| status.measurement.reading_overflow.SMUA                                                                                                                                                                                                                          | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                          |                     |                                          |                     |
| status.measurement.reading_overflow.SMUB                                                                                                                                                                                                                          | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                          |                     |                                          |                     |
| Remarks                                                                                                                                                                                                                                                           | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the measurement event reading overflow summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 0000000000000110. This value indicates that bit B1(SMUA) and bit B2 (SMUB) are set.</li> <li>• The used bits of the measurement event reading overflow summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, SMUA:</b> Set bit indicates the enabled ROF bit for the SMU A measurement register is set.</li> <li>• <b>Bit B2, SMUB:</b> Set bit indicates the enabled ROF bit for the SMU B measurement register is set.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                           |   |                  |                                          |                     |                                          |                     |
| Details                                                                                                                                                                                                                                                           | See <a href="#">Status model (measurement event registers)</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                          |                     |                                          |                     |
| Example                                                                                                                                                                                                                                                           | <p>Sets the SMUA bit of the measurement reading overflow summary enable register:</p> <pre> status.measurement.reading_overflow.enable = status.measurement.reading_overflow.SMUA </pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                          |                     |                                          |                     |

|                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                       |                     |                                       |                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|---------------------------------------|---------------------|---------------------------------------|---------------------|
| <b>status.measurement.voltage_limit.condition</b><br><b>status.measurement.voltage_limit.enable</b><br><b>status.measurement.voltage_limit.event</b><br><b>status.measurement.voltage_limit.ntr</b><br><b>status.measurement.voltage_limit.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                       |                     |                                       |                     |
| Attribute                                                                                                                                                                                                                                          | Measurement event voltage limit summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                       |                     |                                       |                     |
| Default                                                                                                                                                                                                                                            | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                       |                     |                                       |                     |
| TSP-Link accessibility                                                                                                                                                                                                                             | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                       |                     |                                       |                     |
| Usage                                                                                                                                                                                                                                              | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre> measreg = status.measurement.voltage_limit.condition measreg = status.measurement.voltage_limit.enable measreg = status.measurement.voltage_limit.event measreg = status.measurement.voltage_limit.ntr measreg = status.measurement.voltage_limit.ptr </pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre> status.measurement.voltage_limit.enable = measreg status.measurement.voltage_limit.ntr = measreg status.measurement.voltage_limit.ptr = measreg </pre> <p>Set measreg to one of the following values:</p> <table> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.measurement.voltage_limit.SMUA</td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td>status.measurement.voltage_limit.SMUB</td> <td>Sets SMUB bit (B2).</td> </tr> </table> <p>measreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B1 (SMUA), set measreg to 2 (<math>2^1</math>).</li> <li>To set bit B2 (SMUB), set measreg to 4 (<math>2^2</math>).</li> <li>To set both bits, set measreg to the sum of the decimal weights of both bits.</li> <li>To set bits B1 and B2, set measreg to 6 (<math>2 + 4</math>).</li> </ul> | 0 | Clears all bits. | status.measurement.voltage_limit.SMUA | Sets SMUA bit (B1). | status.measurement.voltage_limit.SMUB | Sets SMUB bit (B2). |
| 0                                                                                                                                                                                                                                                  | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                       |                     |                                       |                     |
| status.measurement.voltage_limit.SMUA                                                                                                                                                                                                              | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                       |                     |                                       |                     |
| status.measurement.voltage_limit.SMUB                                                                                                                                                                                                              | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                       |                     |                                       |                     |
| Remarks                                                                                                                                                                                                                                            | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the measurement event voltage limit summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 0000000000000110. This value indicates that bit B1(SMUA) and bit B2 (SMUB) are set.</li> <li>• The used bits of the measurement event voltage limit summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, SMUA:</b> Set bit indicates the enabled VLMT bit for the SMU A measurement register is set.</li> <li>• <b>Bit B2, SMUB:</b> Set bit indicates the enabled VLMT bit for the SMU B measurement register is set.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                 |   |                  |                                       |                     |                                       |                     |
| Details                                                                                                                                                                                                                                            | See <a href="#">Status model (measurement event registers)</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                       |                     |                                       |                     |
| Example                                                                                                                                                                                                                                            | Sets the SMUA bit of the measurement event voltage limit summary enable register:<br><pre> status.measurement.voltage_limit.enable = status.measurement.voltage_limit.SMUA </pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                       |                     |                                       |                     |

| <b>status.node_enable</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|---------------------------------------------|------------------------------|-------------------------|------------------------------|-------------------------------------|------------------------------|-------------------------|------------------------------|----------------------------------------------|------------------------------|-------------------------|------------------------------|---------------------------------------|------------------------------|-------------------------|------------------------------|---------------------------------------|------------------------------|-------------------------|------------------------------|-------------------------------------------|------------------------------|-------------------------|------------------------------|-------------------------------------------|------------------------------|-------------------------|------------------------------|
| Attribute                                    | Status node enable register.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| Default                                      | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| TSP-Link accessibility                       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| Usage                                        | <p>Reads status node enable register:<br/> <code>nodeenabreg = status.node_enable</code></p> <p>Writes to system enable register:<br/> <code>status.node_enable = nodeenabreg</code><br/> Set <code>nodeenabreg</code> to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td><code>status.MEASUREMENT_SUMMARY_BIT</code></td> <td>Sets (enables) MSB bit (B0).</td> </tr> <tr> <td><code>status.MSB</code></td> <td>Sets (enables) MSB bit (B0).</td> </tr> <tr> <td><code>status.ERROR_AVAILABLE</code></td> <td>Sets (enables) EAV bit (B2).</td> </tr> <tr> <td><code>status.EAV</code></td> <td>Sets (enables) EAV bit (B2).</td> </tr> <tr> <td><code>status.QUESTIONABLE_SUMMARY_BIT</code></td> <td>Sets (enables) QSB bit (B3).</td> </tr> <tr> <td><code>status.QSB</code></td> <td>Sets (enables) QSB bit (B3).</td> </tr> <tr> <td><code>status.MESSAGE_AVAILABLE</code></td> <td>Sets (enables) MAV bit (B4).</td> </tr> <tr> <td><code>status.MAV</code></td> <td>Sets (enables) MAV bit (B4).</td> </tr> <tr> <td><code>status.EVENT_SUMMARY_BIT</code></td> <td>Sets (enables) ESB bit (B5).</td> </tr> <tr> <td><code>status.ESB</code></td> <td>Sets (enables) ESB bit (B5).</td> </tr> <tr> <td><code>status.MASTER_SUMMARY_STATUS</code></td> <td>Sets (enables) MSS bit (B6).</td> </tr> <tr> <td><code>status.MSS</code></td> <td>Sets (enables) MSS bit (B6).</td> </tr> <tr> <td><code>status.OPERATION_SUMMARY_BIT</code></td> <td>Sets (enables) OSB bit (B7).</td> </tr> <tr> <td><code>status.OSB</code></td> <td>Sets (enables) OSB bit (B7).</td> </tr> </table> <p><code>nodeenabreg</code> can also be set to the decimal weight of the bit to be set. Examples:<br/> To set bit B0 (MSB), set <code>nodeenabreg</code> to 1 (<math>2^0</math>).<br/> To set bit B2 (EAV), set <code>nodeenabreg</code> to 4 (<math>2^2</math>).<br/> To set bit B7 (OSB), set <code>nodeenabreg</code> to 128 (<math>2^7</math>).<br/> To set more than one bit of the register, set <code>nodeenabreg</code> to the sum of their decimal weights. For example, to set bits B0 and B7, set <code>nodeenabreg</code> to 129 (1 + 128).</p> | 0 | Clears all bits. | <code>status.MEASUREMENT_SUMMARY_BIT</code> | Sets (enables) MSB bit (B0). | <code>status.MSB</code> | Sets (enables) MSB bit (B0). | <code>status.ERROR_AVAILABLE</code> | Sets (enables) EAV bit (B2). | <code>status.EAV</code> | Sets (enables) EAV bit (B2). | <code>status.QUESTIONABLE_SUMMARY_BIT</code> | Sets (enables) QSB bit (B3). | <code>status.QSB</code> | Sets (enables) QSB bit (B3). | <code>status.MESSAGE_AVAILABLE</code> | Sets (enables) MAV bit (B4). | <code>status.MAV</code> | Sets (enables) MAV bit (B4). | <code>status.EVENT_SUMMARY_BIT</code> | Sets (enables) ESB bit (B5). | <code>status.ESB</code> | Sets (enables) ESB bit (B5). | <code>status.MASTER_SUMMARY_STATUS</code> | Sets (enables) MSS bit (B6). | <code>status.MSS</code> | Sets (enables) MSS bit (B6). | <code>status.OPERATION_SUMMARY_BIT</code> | Sets (enables) OSB bit (B7). | <code>status.OSB</code> | Sets (enables) OSB bit (B7). |
| 0                                            | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.MEASUREMENT_SUMMARY_BIT</code>  | Sets (enables) MSB bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.MSB</code>                      | Sets (enables) MSB bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.ERROR_AVAILABLE</code>          | Sets (enables) EAV bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.EAV</code>                      | Sets (enables) EAV bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.QUESTIONABLE_SUMMARY_BIT</code> | Sets (enables) QSB bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.QSB</code>                      | Sets (enables) QSB bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.MESSAGE_AVAILABLE</code>        | Sets (enables) MAV bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.MAV</code>                      | Sets (enables) MAV bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.EVENT_SUMMARY_BIT</code>        | Sets (enables) ESB bit (B5).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.ESB</code>                      | Sets (enables) ESB bit (B5).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.MASTER_SUMMARY_STATUS</code>    | Sets (enables) MSS bit (B6).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.MSS</code>                      | Sets (enables) MSS bit (B6).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.OPERATION_SUMMARY_BIT</code>    | Sets (enables) OSB bit (B7).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.OSB</code>                      | Sets (enables) OSB bit (B7).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| Remarks                                      | <ul style="list-style-type: none"> <li>This attribute is used to read or write to the status node enable register.</li> <li>Reading the node enable status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is Bit 7.</li> <li>For example, assume the value 129 is returned for the node enable register. The binary equivalent is 10000001. This value indicates that bit B0 (MSB) and bit B7 (OSB) are set.</li> <li>Assigning a value to this attribute enables one or more status events. When an enabled status event occurs, a summary bit is set in the appropriate system summary register. The register and bit that is set depends on the TSP-Link node number assigned to this instrument.</li> <li>The status node enable register uses most of the same summary events as the status byte. Bit B1 (MSB) is not used, and bit B6 is used as Master Summary Status (MSS). For details, see <a href="#">status.condition</a> register.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| Details                                      | See <a href="#">Status byte and service request (SRQ)</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |
| Example                                      | Sets the MSB bit of the status node enable register:<br><code>status.node_enable = status.MSB</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                             |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |                                           |                              |                         |                              |

| <b>status.node_event</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                | Status node event register.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| TSP-Link accessibility   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Usage                    | Reads the status node event register:<br><code>nodeeventreg = status.node_event</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Remarks                  | <ul style="list-style-type: none"> <li>• This attribute is used to read the status node event register, which is returned as a numeric value. Reading this register returns a value. The binary equivalent of the returned value. The least significant bit of the binary number is bit 0, and the most significant bit is bit 7.</li> <li>• For example, assume value 129 is returned for the event register. The binary equivalent is 10000001. This value indicates that bit B0 (MSB) and bit B7 (OSB) are set.</li> <li>• The status node event register uses most of the same summary events as the status byte. Bit B1(MSB) is not used, and bit B6 is used as Master Summary Status (MSS). For details, see <a href="#">status.condition</a> register.</li> </ul> |
| Details                  | See <a href="#">Status byte and service request (SRQ)</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Example                  | Reads the status node event register:<br><pre>nodeeventreg = status.node_event print(nodeeventreg)</pre> Output: 1.29000e+02<br>The above output indicates that bits B0 (MSS) and B7 (OSB) are set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

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| <b>status.operation.condition</b><br><b>status.operation.enable</b><br><b>status.operation.event</b><br><b>status.operation.ntr</b><br><b>status.operation.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| Attribute                                                                                                                                                          | Operation status register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| Default                                                                                                                                                            | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| TSP-Link accessibility                                                                                                                                             | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| Usage                                                                                                                                                              | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.condition operreg = status.operation.enable operreg = status.operation.event operreg = status.operation.ntr operreg = status.operation.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.enable = operreg status.operation.ntr = operreg status.operation.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.CALIBRATING</td> <td>Sets CAL bit (B0).</td> </tr> <tr> <td>status.operation.CAL</td> <td>Sets CAL bit (B0).</td> </tr> <tr> <td>status.operation.SWEEPING</td> <td>Sets SWE bit (B3).</td> </tr> <tr> <td>status.operation.SWE</td> <td>Sets SWE bit (B3).</td> </tr> <tr> <td>status.operation.MEASURING</td> <td>Sets MEAS bit (B4).</td> </tr> <tr> <td>status.operation.MEAS</td> <td>Sets MEAS bit (B4).</td> </tr> <tr> <td>status.operation.TRIGGER_OVERRUN</td> <td>Sets TRGOVR bit (B10).</td> </tr> <tr> <td>status.operation.TRGOVR</td> <td>Sets TRGOVR bit (B10).</td> </tr> <tr> <td>status.operation.REMOTE_SUMMARY</td> <td>Sets REM bit (B11).</td> </tr> <tr> <td>status.operation.REM</td> <td>Sets REM bit (B11).</td> </tr> <tr> <td>status.operation.USER</td> <td>Sets USER bit (B12).</td> </tr> <tr> <td>status.operation.INSTRUMENT_SUMMARY</td> <td>Sets INST bit (B13).</td> </tr> <tr> <td>status.operation.INST</td> <td>Sets INST bit (B13).</td> </tr> <tr> <td>status.operation.PROGRAM_RUNNING</td> <td>Sets PROG bit (B14).</td> </tr> <tr> <td>status.operation.PROG</td> <td>Sets PROG bit (B14).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Examples:<br/> To set bit B0 (CAL), set operreg to 1 (<math>2^0</math>).<br/> To set bit B4 (MEAS), set operreg to 16 (<math>2^4</math>).<br/> To set bit B11 (REM), set operreg to 2048 (<math>2^{11}</math>).<br/> To set more than one bit of the register, set operreg to the sum of their decimal weights.<br/> For example, to set bits B0 and B4, set operreg to 17 (1 + 16).</p> | 0 | Clears all bits. | status.operation.CALIBRATING | Sets CAL bit (B0). | status.operation.CAL | Sets CAL bit (B0). | status.operation.SWEEPING | Sets SWE bit (B3). | status.operation.SWE | Sets SWE bit (B3). | status.operation.MEASURING | Sets MEAS bit (B4). | status.operation.MEAS | Sets MEAS bit (B4). | status.operation.TRIGGER_OVERRUN | Sets TRGOVR bit (B10). | status.operation.TRGOVR | Sets TRGOVR bit (B10). | status.operation.REMOTE_SUMMARY | Sets REM bit (B11). | status.operation.REM | Sets REM bit (B11). | status.operation.USER | Sets USER bit (B12). | status.operation.INSTRUMENT_SUMMARY | Sets INST bit (B13). | status.operation.INST | Sets INST bit (B13). | status.operation.PROGRAM_RUNNING | Sets PROG bit (B14). | status.operation.PROG | Sets PROG bit (B14). |
| 0                                                                                                                                                                  | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.CALIBRATING                                                                                                                                       | Sets CAL bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.CAL                                                                                                                                               | Sets CAL bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.SWEEPING                                                                                                                                          | Sets SWE bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.SWE                                                                                                                                               | Sets SWE bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.MEASURING                                                                                                                                         | Sets MEAS bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.MEAS                                                                                                                                              | Sets MEAS bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.TRIGGER_OVERRUN                                                                                                                                   | Sets TRGOVR bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.TRGOVR                                                                                                                                            | Sets TRGOVR bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.REMOTE_SUMMARY                                                                                                                                    | Sets REM bit (B11).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.REM                                                                                                                                               | Sets REM bit (B11).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.USER                                                                                                                                              | Sets USER bit (B12).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.INSTRUMENT_SUMMARY                                                                                                                                | Sets INST bit (B13).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.INST                                                                                                                                              | Sets INST bit (B13).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.PROGRAM_RUNNING                                                                                                                                   | Sets PROG bit (B14).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |
| status.operation.PROG                                                                                                                                              | Sets PROG bit (B14).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                              |                    |                      |                    |                           |                    |                      |                    |                            |                     |                       |                     |                                  |                        |                         |                        |                                 |                     |                      |                     |                       |                      |                                     |                      |                       |                      |                                  |                      |                       |                      |

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|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>• This attribute is used to read or write to the operation status registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 17 is returned for the enable register. The binary equivalent is 0000000000010001. This value indicates that bit B0 (CAL) and bit B4 (MEAS) are set.</li> <li>• The used bits of the operation status registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B0, CAL:</b> Set bit indicates that the summary bit of the <code>status.operation.calibrating</code> register has been set.</li> <li>• <b>Bit B3, SWE:</b> Set bit indicates that the summary bit from the <code>status.operation.sweeping</code> register is set.</li> <li>• <b>Bit B4, MEAS:</b> Set bit indicates that the summary bit of the <code>status.operation.measuring</code> register is set.</li> <li>• <b>Bit B10, TRGOVR:</b> Set bit indicates that the summary bit from the <code>status.operation.trigger_overrun</code> register is set.</li> <li>• <b>Bit B11, REM:</b> Set bit indicates that the summary bit of the <code>status.operation.remote</code> register is set.</li> <li>• <b>Bit B12, USER:</b> Set bit indicates that an enabled bit in the <code>status.operation.user</code> register is set.</li> <li>• <b>Bit B13, INST:</b> Set bit indicates that an enabled bit in the <code>status.operation.instrument</code> register is set.</li> <li>• <b>Bit B14, PROG:</b> Set bit indicates that a program is running.</li> </ul> </li> </ul> |
| Details | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Example | Sets the MEAS bit of the operation status enable register:<br><code>status.operation.enable = status.operation.MEAS</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

| <b>status.operation.calibrating.condition</b><br><b>status.operation.calibrating.enable</b><br><b>status.operation.calibrating.event</b><br><b>status.operation.calibrating.ntr</b><br><b>status.operation.calibrating.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                   |                     |                                   |                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|-----------------------------------|---------------------|-----------------------------------|---------------------|
| Attribute                                                                                                                                                                                                                      | Operation status calibration summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                   |                     |                                   |                     |
| Default                                                                                                                                                                                                                        | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                   |                     |                                   |                     |
| TSP-Link accessibility                                                                                                                                                                                                         | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |                  |                                   |                     |                                   |                     |
| Usage                                                                                                                                                                                                                          | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.calibrating.condition operreg = status.operation.calibrating.enable operreg = status.operation.calibrating.event operreg = status.operation.calibrating.ntr operreg = status.operation.calibrating.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.calibrating.enable = operreg status.operation.calibrating.ntr = operreg status.operation.calibrating.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.calibrating.SMUA</td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td>status.operation.calibrating.SMUB</td> <td>Sets SMUB bit (B2).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B1 (SMUA), set operreg to 2 (<math>2^1</math>).</li> <li>To set bit B2 (SMUB), set operreg to 4 (<math>2^2</math>).</li> <li>To set both bits, set operreg to the sum of the decimal weights of both bits.</li> <li>To set bits B1 and B2, set operreg to 6 (<math>2 + 4</math>).</li> </ul> | 0 | Clears all bits. | status.operation.calibrating.SMUA | Sets SMUA bit (B1). | status.operation.calibrating.SMUB | Sets SMUB bit (B2). |
| 0                                                                                                                                                                                                                              | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                   |                     |                                   |                     |
| status.operation.calibrating.SMUA                                                                                                                                                                                              | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                   |                     |                                   |                     |
| status.operation.calibrating.SMUB                                                                                                                                                                                              | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                   |                     |                                   |                     |
| Remarks                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>These attributes are used to read or write to the operation status calibration summary registers.</li> <li>Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>For example, assume value 6 is returned for the enable register. The binary equivalent is 0000000000000110. This value indicates that bit B1(SMUA) and bit B2 (SMUB) are set.</li> <li>The used bits of the operation status calibration summary registers are described as follows: <ul style="list-style-type: none"> <li><b>Bit B1, SMUA:</b> Set bit indicates the enabled CAL bit for the SMU A operation register is set.</li> <li><b>Bit B2, SMUB:</b> Set bit indicates the enabled CAL bit for the SMU B operation register is set.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                        |   |                  |                                   |                     |                                   |                     |
| Details                                                                                                                                                                                                                        | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                   |                     |                                   |                     |
| Example                                                                                                                                                                                                                        | Sets the SMUA bit of the operation status calibration summary enable register:<br><pre>status.operation.calibrating.enable = status.operation.calibrating.SMUA</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                   |                     |                                   |                     |

| <b>status.operation.instrument.condition</b><br><b>status.operation.instrument.enable</b><br><b>status.operation.instrument.event</b><br><b>status.operation.instrument.ntr</b><br><b>status.operation.instrument.ptr</b> |                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| Attribute                                                                                                                                                                                                                 | Operation status instrument summary register set. |
| Default                                                                                                                                                                                                                   | 0                                                 |

|                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|-----------------------------------------------|---------------------|-----------------------------------------------|---------------------|----------------------------------------------------------|--------------------------|--------------------------------------------------|-------------------------|--------------------------------------------------------|------------------------|-------------------------------------------------|------------------------|-----------------------------------------------------|-----------------------|------------------------------------------------|-----------------------|--------------------------------------------------|-------------------------|----------------------------------------------|---------------------|
| TSP-Link accessibility                                   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |
| Usage                                                    | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.instrument.condition operreg = status.operation.instrument.enable operreg = status.operation.instrument.event operreg = status.operation.instrument.ntr operreg = status.operation.instrument.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.instrument.enable = operreg status.operation.instrument.ntr = operreg status.operation.instrument.ptr = operreg</pre> <p>Set <code>operreg</code> to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td><code>status.operation.instrument.SMUA</code></td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td><code>status.operation.instrument.SMUB</code></td> <td>Sets SMUB bit (B2).</td> </tr> <tr> <td><code>status.operation.instrument.TRIGGER_BLENDER</code></td> <td>Sets TRIGBLND bit (B10).</td> </tr> <tr> <td><code>status.operation.instrument.TRGBLND</code></td> <td>Sets TRGBLND bit (B10).</td> </tr> <tr> <td><code>status.operation.instrument.TRIGGER_TIMER</code></td> <td>Sets TRGTMR bit (B11).</td> </tr> <tr> <td><code>status.operation.instrument.TRGTMR</code></td> <td>Sets TRGTMR bit (B11).</td> </tr> <tr> <td><code>status.operation.instrument.DIGITAL_IO</code></td> <td>Sets DIGIO bit (B12).</td> </tr> <tr> <td><code>status.operation.instrument.DIGIO</code></td> <td>Sets DIGIO bit (B12).</td> </tr> <tr> <td><code>status.operation.instrument.TSPLINK</code></td> <td>Sets TSPLINK bit (B13).</td> </tr> <tr> <td><code>status.operation.instrument.LAN</code></td> <td>Sets LAN bit (B14).</td> </tr> </table> <p><code>operreg</code> can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B1 (SMUA), set <code>operreg</code> to 2 (<math>2^1</math>).</li> <li>To set bit B2 (SMUB), set <code>operreg</code> to 4 (<math>2^2</math>).</li> <li>To set bit B12 (DIGIO), set <code>operreg</code> to 4096 (<math>2^{12}</math>).</li> <li>To set two bits, set <code>operreg</code> to the sum of the decimal weights of both bits:</li> <li>To set bits B1 and B2, set <code>operreg</code> to 6 (<math>2 + 4</math>).</li> </ul> | 0 | Clears all bits. | <code>status.operation.instrument.SMUA</code> | Sets SMUA bit (B1). | <code>status.operation.instrument.SMUB</code> | Sets SMUB bit (B2). | <code>status.operation.instrument.TRIGGER_BLENDER</code> | Sets TRIGBLND bit (B10). | <code>status.operation.instrument.TRGBLND</code> | Sets TRGBLND bit (B10). | <code>status.operation.instrument.TRIGGER_TIMER</code> | Sets TRGTMR bit (B11). | <code>status.operation.instrument.TRGTMR</code> | Sets TRGTMR bit (B11). | <code>status.operation.instrument.DIGITAL_IO</code> | Sets DIGIO bit (B12). | <code>status.operation.instrument.DIGIO</code> | Sets DIGIO bit (B12). | <code>status.operation.instrument.TSPLINK</code> | Sets TSPLINK bit (B13). | <code>status.operation.instrument.LAN</code> | Sets LAN bit (B14). |
| 0                                                        | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |
| <code>status.operation.instrument.SMUA</code>            | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |
| <code>status.operation.instrument.SMUB</code>            | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |
| <code>status.operation.instrument.TRIGGER_BLENDER</code> | Sets TRIGBLND bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |
| <code>status.operation.instrument.TRGBLND</code>         | Sets TRGBLND bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |
| <code>status.operation.instrument.TRIGGER_TIMER</code>   | Sets TRGTMR bit (B11).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |
| <code>status.operation.instrument.TRGTMR</code>          | Sets TRGTMR bit (B11).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |
| <code>status.operation.instrument.DIGITAL_IO</code>      | Sets DIGIO bit (B12).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |
| <code>status.operation.instrument.DIGIO</code>           | Sets DIGIO bit (B12).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |
| <code>status.operation.instrument.TSPLINK</code>         | Sets TSPLINK bit (B13).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |
| <code>status.operation.instrument.LAN</code>             | Sets LAN bit (B14).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |
| Remarks                                                  | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status instrument summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 000000000000110. This value indicates that bit B1 (SMUA) and bit B2 (SMUB) are set.</li> <li>• The used bits of the operation status instrument summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, SMUA:</b> Set bit indicates one or more enabled bits for the operation status SMU A summary register is set.</li> <li>• <b>Bit B2, SMUB:</b> Set bit indicates one or more enabled bits for the operation status SMU B summary register is set.</li> <li>• <b>Bit B10, TRGBLND:</b> Set bit indicates one or more enabled bits for the operation status trigger blender summary register is set (see <a href="#">status.operation.instrument.trigger_blender.condition</a>).</li> <li>• <b>Bit B11, TRGTMR:</b> Set bit indicates one or more enabled bits for the operation status trigger timer summary register is set (see <a href="#">status.operation.instrument.trigger_timer.condition</a>).</li> <li>• <b>Bit B12, DIGIO:</b> Set bit indicates one or more enabled bits for the operation status digital I/O summary register (see <a href="#">status.operation.instrument.digio.condition</a>) is set.</li> <li>• <b>Bit B13, TSPLINK:</b> Set bit indicates one or more enabled bits for the operation status TSP-Link summary register is set (see <a href="#">status.operation.instrument.tsplink.condition</a>).</li> <li>• <b>Bit B14, LAN:</b> Set bit indicates one or more enabled bits for the operation status LAN summary is set (see <a href="#">status.operation.instrument.lan.condition</a>).</li> </ul> </li> </ul>                                                                                                                                                                                                     |   |                  |                                               |                     |                                               |                     |                                                          |                          |                                                  |                         |                                                        |                        |                                                 |                        |                                                     |                       |                                                |                       |                                                  |                         |                                              |                     |



|         |                                                                                                                                                                     |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Details | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                       |
| Example | Sets the SMUA bit of the operation status instrument summary enable register:<br><code>status.operation.instrument.enable = status.operation.instrument.SMUA</code> |

|                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                                                |                        |                                                       |                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|----------------------------------------------------------------|------------------------|-------------------------------------------------------|------------------------|
| <b>status.operation.instrument.digio.condition</b><br><b>status.operation.instrument.digio.enable</b><br><b>status.operation.instrument.digio.event</b><br><b>status.operation.instrument.digio.ntr</b><br><b>status.operation.instrument.digio.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                                                |                        |                                                       |                        |
| Attribute                                                                                                                                                                                                                                               | Operation status digital I/O summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                                                |                        |                                                       |                        |
| Default                                                                                                                                                                                                                                                 | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                                                |                        |                                                       |                        |
| TSP-Link accessibility                                                                                                                                                                                                                                  | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                                |                        |                                                       |                        |
| Usage                                                                                                                                                                                                                                                   | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.instrument.digio.condition operreg = status.operation.instrument.digio.enable operreg = status.operation.instrument.digio.event operreg = status.operation.instrument.digio.ntr operreg = status.operation.instrument.digio.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.instrument.digio.enable = operreg status.operation.instrument.digio.ntr = operreg status.operation.instrument.digio.ptr = operreg</pre> <p>Set <code>operreg</code> to one of the following values:</p> <table style="width: 100%; border: none;"> <tr> <td style="padding-right: 20px;">0</td> <td>Clears all bits.</td> </tr> <tr> <td style="padding-right: 20px;"><code>status.operation.instrument.digio.TRIGGER_OVERRUN</code></td> <td>Sets TRGOVR bit (B10).</td> </tr> <tr> <td style="padding-right: 20px;"><code>status.operation.instrument.digio.TRGOVR</code></td> <td>Sets TRGOVR bit (B10).</td> </tr> </table> <p><code>operreg</code> can also be set to the decimal weight of the bit to be set. Examples:<br/> To set bit B10 (TRGOVR), set <code>operreg</code> to 1024 (<math>2^{10}</math>).</p> | 0 | Clears all bits. | <code>status.operation.instrument.digio.TRIGGER_OVERRUN</code> | Sets TRGOVR bit (B10). | <code>status.operation.instrument.digio.TRGOVR</code> | Sets TRGOVR bit (B10). |
| 0                                                                                                                                                                                                                                                       | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                                                |                        |                                                       |                        |
| <code>status.operation.instrument.digio.TRIGGER_OVERRUN</code>                                                                                                                                                                                          | Sets TRGOVR bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                  |                                                                |                        |                                                       |                        |
| <code>status.operation.instrument.digio.TRGOVR</code>                                                                                                                                                                                                   | Sets TRGOVR bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                  |                                                                |                        |                                                       |                        |
| Remarks                                                                                                                                                                                                                                                 | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status digital I/O summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• The used bits of the operation status digital I/O summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B10, TRGOVR:</b> Set bit indicates that trigger overrun is enabled.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                                                |                        |                                                       |                        |
| Details                                                                                                                                                                                                                                                 | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                                                |                        |                                                       |                        |
| Example                                                                                                                                                                                                                                                 | Sets the TRGOVR bit of the operation status digital I/O summary enable register:<br><code>status.operation.instrument.digio.enable = status.operation.instrument.digio.TRGOVR</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                                                |                        |                                                       |                        |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <b>status.operation.instrument.digio.trigger_overnrun.condition</b><br><b>status.operation.instrument.digio.trigger_overnrun.enable</b><br><b>status.operation.instrument.digio.trigger_overnrun.event</b><br><b>status.operation.instrument.digio.trigger_overnrun.ntr</b><br><b>status.operation.instrument.digio.trigger_overnrun.ptr</b> |                                                             |
| Attribute                                                                                                                                                                                                                                                                                                                                    | Operation status digital I/O overrun register set.          |
| Default                                                                                                                                                                                                                                                                                                                                      | 0                                                           |
| TSP-Link accessibility                                                                                                                                                                                                                                                                                                                       | This attribute can be accessed from a remote TSP-Link node. |

|                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
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| Usage                                                     | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.instrument.digio.trigger_overnrun.condition operreg = status.operation.instrument.digio.trigger_overnrun.enable operreg = status.operation.instrument.digio.trigger_overnrun.event operreg = status.operation.instrument.digio.trigger_overnrun.ntr operreg = status.operation.instrument.digio.trigger_overnrun.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.instrument.digio.trigger_overnrun.enable = operreg status.operation.instrument.digio.trigger_overnrun.ntr = operreg status.operation.instrument.digio.trigger_overnrun.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table style="width: 100%; border: none;"> <tr> <td style="padding-right: 20px;">0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE1</td> <td>Sets LINE1 bit (B1).</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE2</td> <td>Sets LINE2 bit (B2).</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE3</td> <td>Sets LINE3 bit (B3).</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE4</td> <td>Sets LINE4 bit (B4).</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE5</td> <td>Sets LINE5 bit (B5).</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE6</td> <td>Sets LINE6 bit (B6).</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE7</td> <td>Sets LINE7 bit (B7).</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE8</td> <td>Sets LINE8 bit (B8).</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE9</td> <td>Sets LINE9 bit (B9).</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE10</td> <td>Sets LINE10 bit (B10).</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE11</td> <td>Sets LINE11 bit (B11).</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE12</td> <td>Sets LINE12 bit (B12).</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE13</td> <td>Sets LINE13 bit (B13).</td> </tr> <tr> <td>status.operation.instrument.digio.trigger_overnrun.LINE14</td> <td>Sets LINE14 bit (B14).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Examples:<br/> To set bit B1 (LINE1), set operreg to 2 (<math>2^1</math>).<br/> To set bit B11 (LINE11), set operreg to 2048 (<math>2^{11}</math>).<br/> To set more than one bit of the register, set operreg to the sum of their decimal weights.<br/> For example, to set bits B2 and B4, set operreg to 20 (4 + 16).</p> | 0 | Clears all bits. | status.operation.instrument.digio.trigger_overnrun.LINE1 | Sets LINE1 bit (B1). | status.operation.instrument.digio.trigger_overnrun.LINE2 | Sets LINE2 bit (B2). | status.operation.instrument.digio.trigger_overnrun.LINE3 | Sets LINE3 bit (B3). | status.operation.instrument.digio.trigger_overnrun.LINE4 | Sets LINE4 bit (B4). | status.operation.instrument.digio.trigger_overnrun.LINE5 | Sets LINE5 bit (B5). | status.operation.instrument.digio.trigger_overnrun.LINE6 | Sets LINE6 bit (B6). | status.operation.instrument.digio.trigger_overnrun.LINE7 | Sets LINE7 bit (B7). | status.operation.instrument.digio.trigger_overnrun.LINE8 | Sets LINE8 bit (B8). | status.operation.instrument.digio.trigger_overnrun.LINE9 | Sets LINE9 bit (B9). | status.operation.instrument.digio.trigger_overnrun.LINE10 | Sets LINE10 bit (B10). | status.operation.instrument.digio.trigger_overnrun.LINE11 | Sets LINE11 bit (B11). | status.operation.instrument.digio.trigger_overnrun.LINE12 | Sets LINE12 bit (B12). | status.operation.instrument.digio.trigger_overnrun.LINE13 | Sets LINE13 bit (B13). | status.operation.instrument.digio.trigger_overnrun.LINE14 | Sets LINE14 bit (B14). |
| 0                                                         | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE1  | Sets LINE1 bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE2  | Sets LINE2 bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE3  | Sets LINE3 bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE4  | Sets LINE4 bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE5  | Sets LINE5 bit (B5).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE6  | Sets LINE6 bit (B6).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE7  | Sets LINE7 bit (B7).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE8  | Sets LINE8 bit (B8).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE9  | Sets LINE9 bit (B9).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE10 | Sets LINE10 bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE11 | Sets LINE11 bit (B11).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE12 | Sets LINE12 bit (B12).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE13 | Sets LINE13 bit (B13).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |
| status.operation.instrument.digio.trigger_overnrun.LINE14 | Sets LINE14 bit (B14).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                          |                      |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |                                                           |                        |

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|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status digital I/O overrun registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• The used bits of the operation status digital I/O overrun registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, LINE1:</b> Set bit indicates that Line 1 generated an action overrun when it was triggered to generate an output trigger.</li> <li>• <b>Bit B2, LINE2:</b> Set bit indicates that Line 2 generated an action overrun when it was triggered to generate an output trigger.</li> <li>• <b>Bit B3, LINE3:</b> Set bit indicates that Line 3 generated an action overrun when it was triggered to generate an output trigger.</li> <li>• <b>Bit B4, LINE4:</b> Set bit indicates that Line 4 generated an action overrun when it was triggered to generate an output trigger.</li> <li>• <b>Bit B5, LINE5:</b> Set bit indicates that Line 5 generated an action overrun when it was triggered to generate an output trigger.</li> <li>• <b>Bit B6, LINE6:</b> Set bit indicates that Line 6 generated an action overrun when it was triggered to generate an output trigger.</li> <li>• <b>Bit B7, LINE7:</b> Set bit indicates that Line 7 generated an action overrun when it was triggered to generate an output trigger.</li> <li>• <b>Bit B8, LINE8:</b> Set bit indicates that Line 8 generated an action overrun when it was triggered to generate an output trigger.</li> <li>• <b>Bit B9, LINE9:</b> Set bit indicates that Line 9 generated an action overrun when it was triggered to generate an output trigger.</li> <li>• <b>Bit B10, LINE10:</b> Set bit indicates that Line 10 generated an action overrun when it was triggered to generate an output trigger.</li> <li>• <b>Bit B11, LINE11:</b> Set bit indicates that Line 11 generated an action overrun when it was triggered to generate an output trigger.</li> <li>• <b>Bit B12, LINE12:</b> Set bit indicates that Line 12 generated an action overrun when it was triggered to generate an output trigger.</li> <li>• <b>Bit B13, LINE13:</b> Set bit indicates that Line 13 generated an action overrun when it was triggered to generate an output trigger.</li> <li>• <b>Bit B14, LINE14:</b> Set bit indicates that Line 14 generated an action overrun when it was triggered to generate an output trigger.</li> </ul> </li> </ul> |
| Details | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Example | Sets the LINE1 bit of the operation status digital I/O overrun enable register:<br><pre>status.operation.instrument.digio.trigger_overrun.enable = status.operation.instrument.digio.trigger_overrun.LINE1</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------|--------------------------------------------|--------------------|-------------------------------------|--------------------|---------------------------------------------|---------------------|--------------------------------------|---------------------|-------------------------------------------------|------------------------|----------------------------------------|------------------------|
| <b>status.operation.instrument.lan.condition</b><br><b>status.operation.instrument.lan.enable</b><br><b>status.operation.instrument.lan.event</b><br><b>status.operation.instrument.lan.ntr</b><br><b>status.operation.instrument.lan.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |
| Attribute                                                                                                                                                                                                                                     | Operation status LAN summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |
| Default                                                                                                                                                                                                                                       | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |
| TSP-Link accessibility                                                                                                                                                                                                                        | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |
| Usage                                                                                                                                                                                                                                         | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.instrument.lan.condition operreg = status.operation.instrument.lan.enable operreg = status.operation.instrument.lan.event operreg = status.operation.instrument.lan.ntr operreg = status.operation.instrument.lan.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.instrument.lan.enable = operreg status.operation.instrument.lan.ntr = operreg status.operation.instrument.lan.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits</td> </tr> <tr> <td>status.operation.instrument.lan.CONNECTION</td> <td>Sets CON bit (B0).</td> </tr> <tr> <td>status.operation.instrument.lan.CON</td> <td>Sets CON bit (B0).</td> </tr> <tr> <td>status.operation.instrument.lan.CONFIGURING</td> <td>Sets CONF bit (B1).</td> </tr> <tr> <td>status.operation.instrument.lan.CONF</td> <td>Sets CONF bit (B1).</td> </tr> <tr> <td>status.operation.instrument.lan.TRIGGER_OVERRUN</td> <td>Sets TRGOVR bit (B10).</td> </tr> <tr> <td>status.operation.instrument.lan.TRGOVR</td> <td>Sets TRGOVR bit (B10).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B0 (CON), set operreg to 1 (<math>2^0</math>).</li> <li>To set bit B1 (SMUB), set operreg to 2 (<math>2^1</math>).</li> <li>To set bit B10 (TRGOVR), set operreg to 1024 (<math>2^{10}</math>).</li> <li>To set two bits, set operreg to the sum of the decimal weights of both bits:</li> <li>To set bits B0 and B1, set operreg to 3 (<math>1 + 2</math>).</li> </ul> | 0 | Clears all bits | status.operation.instrument.lan.CONNECTION | Sets CON bit (B0). | status.operation.instrument.lan.CON | Sets CON bit (B0). | status.operation.instrument.lan.CONFIGURING | Sets CONF bit (B1). | status.operation.instrument.lan.CONF | Sets CONF bit (B1). | status.operation.instrument.lan.TRIGGER_OVERRUN | Sets TRGOVR bit (B10). | status.operation.instrument.lan.TRGOVR | Sets TRGOVR bit (B10). |
| 0                                                                                                                                                                                                                                             | Clears all bits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |
| status.operation.instrument.lan.CONNECTION                                                                                                                                                                                                    | Sets CON bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |
| status.operation.instrument.lan.CON                                                                                                                                                                                                           | Sets CON bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |
| status.operation.instrument.lan.CONFIGURING                                                                                                                                                                                                   | Sets CONF bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |
| status.operation.instrument.lan.CONF                                                                                                                                                                                                          | Sets CONF bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |
| status.operation.instrument.lan.TRIGGER_OVERRUN                                                                                                                                                                                               | Sets TRGOVR bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |
| status.operation.instrument.lan.TRGOVR                                                                                                                                                                                                        | Sets TRGOVR bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |
| Remarks                                                                                                                                                                                                                                       | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status LAN summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• The used bits of the operation status LAN summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B0, CON:</b> Set bit indicates that the LAN cable is connected and a link has been detected.</li> <li>• <b>Bit B1, CONF:</b> Set bit indicates the LAN is performing its configuration sequence.</li> <li>• <b>Bit B10, TRGOVR:</b> Set bit indicates one or more enabled bits for the Operation Status LAN Summary register is set.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |
| Details                                                                                                                                                                                                                                       | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |
| Example                                                                                                                                                                                                                                       | Sets the CONFIGURING bit of the operation status LAN summary enable register:<br><pre>status.operation.instrument.lan.enable = status.operation.instrument.lan.CONF</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                 |                                            |                    |                                     |                    |                                             |                     |                                      |                     |                                                 |                        |                                        |                        |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|-------------------------------------------------------|--------------------|-------------------------------------------------------|--------------------|-------------------------------------------------------|--------------------|-------------------------------------------------------|--------------------|-------------------------------------------------------|--------------------|-------------------------------------------------------|--------------------|-------------------------------------------------------|--------------------|-------------------------------------------------------|--------------------|
| <b>status.operation.instrument.lan.trigger_overnrun.condition</b><br><b>status.operation.instrument.lan.trigger_overnrun.enable</b><br><b>status.operation.instrument.lan.trigger_overnrun.event</b><br><b>status.operation.instrument.lan.trigger_overnrun.ntr</b><br><b>status.operation.instrument.lan.trigger_overnrun.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |
| Attribute                                                                                                                                                                                                                                                                                                                          | Operation status LAN trigger overrun register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |
| Default                                                                                                                                                                                                                                                                                                                            | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |                  |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |
| TSP-Link accessibility                                                                                                                                                                                                                                                                                                             | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |
| Usage                                                                                                                                                                                                                                                                                                                              | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.instrument.lan.trigger_overnrun.condition operreg = status.operation.instrument.lan.trigger_overnrun.enable operreg = status.operation.instrument.lan.trigger_overnrun.event operreg = status.operation.instrument.lan.trigger_overnrun.ntr operreg = status.operation.instrument.lan.trigger_overnrun.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.instrument.lan.trigger_overnrun.enable = operreg status.operation.instrument.lan.trigger_overnrun.ntr = operreg status.operation.instrument.lan.trigger_overnrun.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.instrument.lan.trigger_overnrun.LAN1</td> <td>Sets LAN1 bit (B1)</td> </tr> <tr> <td>status.operation.instrument.lan.trigger_overnrun.LAN2</td> <td>Sets LAN2 bit (B2)</td> </tr> <tr> <td>status.operation.instrument.lan.trigger_overnrun.LAN3</td> <td>Sets LAN3 bit (B3)</td> </tr> <tr> <td>status.operation.instrument.lan.trigger_overnrun.LAN4</td> <td>Sets LAN4 bit (B4)</td> </tr> <tr> <td>status.operation.instrument.lan.trigger_overnrun.LAN5</td> <td>Sets LAN5 bit (B5)</td> </tr> <tr> <td>status.operation.instrument.lan.trigger_overnrun.LAN6</td> <td>Sets LAN6 bit (B6)</td> </tr> <tr> <td>status.operation.instrument.lan.trigger_overnrun.LAN7</td> <td>Sets LAN7 bit (B7)</td> </tr> <tr> <td>status.operation.instrument.lan.trigger_overnrun.LAN8</td> <td>Sets LAN8 bit (B8)</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Examples:<br/> To set bit B1 (LAN1), set operreg to 2 (<math>2^1</math>).<br/> To set bit B5 (LAN5), set operreg to 32 (<math>2^5</math>).<br/> To set two bits, set operreg to the sum of the decimal weights of both bits:<br/> To set bits B1 and B5, set operreg to 34 (2 + 32).</p> | 0 | Clears all bits. | status.operation.instrument.lan.trigger_overnrun.LAN1 | Sets LAN1 bit (B1) | status.operation.instrument.lan.trigger_overnrun.LAN2 | Sets LAN2 bit (B2) | status.operation.instrument.lan.trigger_overnrun.LAN3 | Sets LAN3 bit (B3) | status.operation.instrument.lan.trigger_overnrun.LAN4 | Sets LAN4 bit (B4) | status.operation.instrument.lan.trigger_overnrun.LAN5 | Sets LAN5 bit (B5) | status.operation.instrument.lan.trigger_overnrun.LAN6 | Sets LAN6 bit (B6) | status.operation.instrument.lan.trigger_overnrun.LAN7 | Sets LAN7 bit (B7) | status.operation.instrument.lan.trigger_overnrun.LAN8 | Sets LAN8 bit (B8) |
| 0                                                                                                                                                                                                                                                                                                                                  | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |
| status.operation.instrument.lan.trigger_overnrun.LAN1                                                                                                                                                                                                                                                                              | Sets LAN1 bit (B1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |
| status.operation.instrument.lan.trigger_overnrun.LAN2                                                                                                                                                                                                                                                                              | Sets LAN2 bit (B2)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |
| status.operation.instrument.lan.trigger_overnrun.LAN3                                                                                                                                                                                                                                                                              | Sets LAN3 bit (B3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |
| status.operation.instrument.lan.trigger_overnrun.LAN4                                                                                                                                                                                                                                                                              | Sets LAN4 bit (B4)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |
| status.operation.instrument.lan.trigger_overnrun.LAN5                                                                                                                                                                                                                                                                              | Sets LAN5 bit (B5)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |
| status.operation.instrument.lan.trigger_overnrun.LAN6                                                                                                                                                                                                                                                                              | Sets LAN6 bit (B6)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |
| status.operation.instrument.lan.trigger_overnrun.LAN7                                                                                                                                                                                                                                                                              | Sets LAN7 bit (B7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |
| status.operation.instrument.lan.trigger_overnrun.LAN8                                                                                                                                                                                                                                                                              | Sets LAN8 bit (B8)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |                                                       |                    |

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|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status LAN trigger overrun registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 0000000000000110. This value indicates that bit B1 (LAN1) and bit B2 (LAN2) are set.</li> <li>• The used bits of the operation status LAN trigger overrun registers are described as follows:</li> <li>• <b>Bit B1, LAN1:</b> Set bit indicates LAN trigger 1 generated an action overrun when triggered to generate a trigger packet.</li> <li>• <b>Bit B2, LAN2:</b> Set bit indicates LAN trigger 2 generated an action overrun when triggered to generate a trigger packet.</li> <li>• <b>Bit B3, LAN3:</b> Set bit indicates LAN trigger 3 generated an action overrun when triggered to generate a trigger packet.</li> <li>• <b>Bit B4, LAN4:</b> Set bit indicates LAN trigger 4 generated an action overrun when triggered to generate a trigger packet.</li> <li>• <b>Bit B5, LAN5:</b> Set bit indicates LAN trigger 5 generated an action overrun when triggered to generate a trigger packet.</li> <li>• <b>Bit B6, LAN6:</b> Set bit indicates LAN trigger 6 generated an action overrun when triggered to generate a trigger packet.</li> <li>• <b>Bit B7, LAN7:</b> Set bit indicates LAN trigger 7 generated an action overrun when triggered to generate a trigger packet.</li> <li>• <b>Bit B8, LAN8:</b> Set bit indicates LAN trigger 8 generated an action overrun when triggered to generate a trigger packet.</li> </ul> |
| Details | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Example | Sets the LAN1 bit of the operation status LAN trigger overrun enable register:<br><pre>status.operation.instrument.lan.trigger_overrun.enable = status.operation.instrument.lan.trigger_overrun.LAN1</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---|------------------|----------------------------------------------|--------------------|--------------------------------------|--------------------|-------------------------------------------|--------------------|--------------------------------------|--------------------|--------------------------------------------|---------------------|---------------------------------------|---------------------|--------------------------------------------------|------------------------|-----------------------------------------|------------------------|
| <b>status.operation.instrument.smuX.condition</b><br><b>status.operation.instrument.smuX.enable</b><br><b>status.operation.instrument.smuX.event</b><br><b>status.operation.instrument.smuX.ntr</b><br><b>status.operation.instrument.smuX.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | smuX = smua or smub |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| Attribute                                                                                                                                                                                                                                          | Operation status SMU X summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| Default                                                                                                                                                                                                                                            | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| TSP-Link accessibility                                                                                                                                                                                                                             | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| Usage                                                                                                                                                                                                                                              | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.instrument.smuX.condition operreg = status.operation.instrument.smuX.enable operreg = status.operation.instrument.smuX.event operreg = status.operation.instrument.smuX.ntr operreg = status.operation.instrument.smuX.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.instrument.smuX.enable = operreg status.operation.instrument.smuX.ntr = operreg status.operation.instrument.smuX.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 70%;">0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.instrument.smuX.CALIBRATING</td> <td>Sets CAL bit (B0).</td> </tr> <tr> <td>status.operation.instrument.smuX.CAL</td> <td>Sets CAL bit (B0).</td> </tr> <tr> <td>status.operation.instrument.smuX.SWEEPING</td> <td>Sets SWE bit (B3).</td> </tr> <tr> <td>status.operation.instrument.smuX.SWE</td> <td>Sets SWE bit (B3).</td> </tr> <tr> <td>status.operation.instrument.smuX.MEASURING</td> <td>Sets MEAS bit (B4).</td> </tr> <tr> <td>status.operation.instrument.smuX.MEAS</td> <td>Sets MEAS bit (B4).</td> </tr> <tr> <td>status.operation.instrument.smuX.TRIGGER_OVERRUN</td> <td>Sets TRGOVR bit (B10).</td> </tr> <tr> <td>status.operation.instrument.smuX.TRGOVR</td> <td>Sets TRGOVR bit (B10).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Examples:<br/>           To set bit B0 (CAL), set operreg to 1 (2<sup>0</sup>).<br/>           To set bit B4 (MEAS), set operreg to 16 (2<sup>4</sup>).<br/>           To set more than one bit of the register, set operreg to the sum of their decimal weights. For example, to set bits B0 and B4, set operreg to 17 (1 + 16).</p> |                     | 0 | Clears all bits. | status.operation.instrument.smuX.CALIBRATING | Sets CAL bit (B0). | status.operation.instrument.smuX.CAL | Sets CAL bit (B0). | status.operation.instrument.smuX.SWEEPING | Sets SWE bit (B3). | status.operation.instrument.smuX.SWE | Sets SWE bit (B3). | status.operation.instrument.smuX.MEASURING | Sets MEAS bit (B4). | status.operation.instrument.smuX.MEAS | Sets MEAS bit (B4). | status.operation.instrument.smuX.TRIGGER_OVERRUN | Sets TRGOVR bit (B10). | status.operation.instrument.smuX.TRGOVR | Sets TRGOVR bit (B10). |
| 0                                                                                                                                                                                                                                                  | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| status.operation.instrument.smuX.CALIBRATING                                                                                                                                                                                                       | Sets CAL bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| status.operation.instrument.smuX.CAL                                                                                                                                                                                                               | Sets CAL bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| status.operation.instrument.smuX.SWEEPING                                                                                                                                                                                                          | Sets SWE bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| status.operation.instrument.smuX.SWE                                                                                                                                                                                                               | Sets SWE bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| status.operation.instrument.smuX.MEASURING                                                                                                                                                                                                         | Sets MEAS bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| status.operation.instrument.smuX.MEAS                                                                                                                                                                                                              | Sets MEAS bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| status.operation.instrument.smuX.TRIGGER_OVERRUN                                                                                                                                                                                                   | Sets TRGOVR bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| status.operation.instrument.smuX.TRGOVR                                                                                                                                                                                                            | Sets TRGOVR bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| Remarks                                                                                                                                                                                                                                            | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status SMU X summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 17 is returned for the enable register. The binary equivalent is 0000000000010001. This value indicates that bit B0 (CAL) and bit B4 (MEAS) are set.</li> <li>• The used bits of the operation status SMU X summary registers are described as follows:               <ul style="list-style-type: none"> <li>• <b>Bit B0, CAL:</b> Set bit indicates that SMU X is calibrating.</li> <li>• <b>Bit B3, SWE:</b> Set bit indicates that SMU X is sweeping.</li> <li>• <b>Bit B4, MEAS:</b> Bit will be set when taking an overlapped measurement, but it will not set when taking a normal synchronous measurement.</li> <li>• <b>Bit B10, TRGOVR:</b> Set bit indicates a bit has been set in the operation status SMU X trigger overrun event register.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| Details                                                                                                                                                                                                                                            | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |
| Example                                                                                                                                                                                                                                            | Sets the MEAS bit of the operation status SMU A summary enable register:<br><pre>status.operation.instrument.smua.enable = status.operation.instrument.smua.MEAS</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                     |   |                  |                                              |                    |                                      |                    |                                           |                    |                                      |                    |                                            |                     |                                       |                     |                                                  |                        |                                         |                        |



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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---|------------------|-------------------------------------------------------|--------------------|-------------------------------------------------------|--------------------|--------------------------------------------------------|---------------------|--------------------------------------------------------|---------------------|
| <b>status.operation.instrument.smuX.trigger_overnrun.condition</b><br><b>status.operation.instrument.smuX.trigger_overnrun.enable</b><br><b>status.operation.instrument.smuX.trigger_overnrun.event</b><br><b>status.operation.instrument.smuX.trigger_overnrun.ntr</b><br><b>status.operation.instrument.smuX.trigger_overnrun.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | smuX = smua or smub |   |                  |                                                       |                    |                                                       |                    |                                                        |                     |                                                        |                     |
| Attribute                                                                                                                                                                                                                                                                                                                               | Operation status SMU X trigger overrun register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                     |   |                  |                                                       |                    |                                                       |                    |                                                        |                     |                                                        |                     |
| Default                                                                                                                                                                                                                                                                                                                                 | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                     |   |                  |                                                       |                    |                                                       |                    |                                                        |                     |                                                        |                     |
| TSP-Link accessibility                                                                                                                                                                                                                                                                                                                  | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |   |                  |                                                       |                    |                                                       |                    |                                                        |                     |                                                        |                     |
| Usage                                                                                                                                                                                                                                                                                                                                   | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.instrument.smuX.trigger_overnrun.condition operreg = status.operation.instrument.smuX.trigger_overnrun.enable operreg = status.operation.instrument.smuX.trigger_overnrun.event operreg = status.operation.instrument.smuX.trigger_overnrun.ntr operreg = status.operation.instrument.smuX.trigger_overnrun.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.instrument.smuX.trigger_overnrun.enable = operreg status.operation.instrument.smuX.trigger_overnrun.ntr = operreg status.operation.instrument.smuX.trigger_overnrun.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.instrument.smuX.trigger_overnrun.ARM</td> <td>Sets ARM bit (B1).</td> </tr> <tr> <td>status.operation.instrument.smuX.trigger_overnrun.SRC</td> <td>Sets SRC bit (B2).</td> </tr> <tr> <td>status.operation.instrument.smuX.trigger_overnrun.MEAS</td> <td>Sets MEAS bit (B3).</td> </tr> <tr> <td>status.operation.instrument.smuX.trigger_overnrun.ENDP</td> <td>Sets ENDP bit (B4).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Examples:</p> <p>To set bit B1 (ARM), set operreg to 2 (2<sup>1</sup>).</p> <p>To set bit B3 (MEAS), set operreg to 8 (2<sup>3</sup>).</p> <p>To set bit B4 (ENDP), set operreg to 16 (2<sup>4</sup>).</p> <p>To set more than one bit of the register, set operreg to the sum of their decimal weights. For example, to set bits B1 and B4, set operreg to 18 (2 + 16).</p> |                     | 0 | Clears all bits. | status.operation.instrument.smuX.trigger_overnrun.ARM | Sets ARM bit (B1). | status.operation.instrument.smuX.trigger_overnrun.SRC | Sets SRC bit (B2). | status.operation.instrument.smuX.trigger_overnrun.MEAS | Sets MEAS bit (B3). | status.operation.instrument.smuX.trigger_overnrun.ENDP | Sets ENDP bit (B4). |
| 0                                                                                                                                                                                                                                                                                                                                       | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                     |   |                  |                                                       |                    |                                                       |                    |                                                        |                     |                                                        |                     |
| status.operation.instrument.smuX.trigger_overnrun.ARM                                                                                                                                                                                                                                                                                   | Sets ARM bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                     |   |                  |                                                       |                    |                                                       |                    |                                                        |                     |                                                        |                     |
| status.operation.instrument.smuX.trigger_overnrun.SRC                                                                                                                                                                                                                                                                                   | Sets SRC bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                     |   |                  |                                                       |                    |                                                       |                    |                                                        |                     |                                                        |                     |
| status.operation.instrument.smuX.trigger_overnrun.MEAS                                                                                                                                                                                                                                                                                  | Sets MEAS bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                     |   |                  |                                                       |                    |                                                       |                    |                                                        |                     |                                                        |                     |
| status.operation.instrument.smuX.trigger_overnrun.ENDP                                                                                                                                                                                                                                                                                  | Sets ENDP bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                     |   |                  |                                                       |                    |                                                       |                    |                                                        |                     |                                                        |                     |
| Remarks                                                                                                                                                                                                                                                                                                                                 | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status SMU X trigger overrun registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• The used bits of the operation status SMU X trigger overrun registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, ARM:</b> Set bit indicates that the arm event detector of the SMU was already in the detected state when the trigger was received.</li> <li>• <b>Bit B2, SRC:</b> Set bit indicates that the source event detector of the SMU was already in the detected state when the trigger was received.</li> <li>• <b>Bit B3, MEAS:</b> Set bit indicates that the measure event detector of the SMU was already in the detected state when the trigger was received.</li> <li>• <b>Bit B4, ENDP:</b> Set bit indicates that the end pulse event detector of the SMU was already in the detected state when the trigger was received.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                     |   |                  |                                                       |                    |                                                       |                    |                                                        |                     |                                                        |                     |
| Details                                                                                                                                                                                                                                                                                                                                 | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                     |   |                  |                                                       |                    |                                                       |                    |                                                        |                     |                                                        |                     |

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>status.operation.instrument.trigger_blender.condition</b><br><b>status.operation.instrument.trigger_blender.enable</b><br><b>status.operation.instrument.trigger_blender.event</b><br><b>status.operation.instrument.trigger_blender.ntr</b><br><b>status.operation.instrument.trigger_blender.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Attribute                                                                                                                                                                                                                                                                                                 | Operation status trigger blender summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Default                                                                                                                                                                                                                                                                                                   | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility                                                                                                                                                                                                                                                                                    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Usage                                                                                                                                                                                                                                                                                                     | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.instrument.trigger_blender.condition operreg = status.operation.instrument.trigger_blender.enable operreg = status.operation.instrument.trigger_blender.event operreg = status.operation.instrument.trigger_blender.ntr operreg = status.operation.instrument.trigger_blender.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.instrument.trigger_blender.enable = operreg status.operation.instrument.trigger_blender.ntr = operreg status.operation.instrument.trigger_blender.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <pre>0                Clears all bits. status.operation.instrument.trigger_blender.TRIGGER_OVERRUN                 Sets TRGOVR bit (B10). status.operation.instrument.trigger_blender.TRGOVR                 Sets TRGOVR bit (B10).</pre> <p>operreg can also be set to the decimal weight of the bit to be set. Example:<br/>To set bit B10 (TRGOVR), set operreg to 1024 (2<sup>10</sup>).</p> |
| Remarks                                                                                                                                                                                                                                                                                                   | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status trigger blender summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• The used bits of the operation instrument registers are described as follows:</li> <li>• <b>Bit B10, TRGOVR:</b> Set bit indicates one or more enabled bits for the Trigger Overrun operation register is set.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Details                                                                                                                                                                                                                                                                                                   | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Example                                                                                                                                                                                                                                                                                                   | <p>Sets the Trigger Overrun bit of the operation status trigger blender summary enable register:</p> <pre>status.operation.instrument.trigger_blender.enable = status.operation.instrument.trigger_blender.TRG_OVR</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

|                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                  |                                                                   |                      |                                                                   |                      |                                                                   |                      |                                                                   |                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|-------------------------------------------------------------------|----------------------|-------------------------------------------------------------------|----------------------|-------------------------------------------------------------------|----------------------|-------------------------------------------------------------------|----------------------|
| <b>status.operation.instrument.trigger_blender.trigger_overrun.condition</b><br><b>status.operation.instrument.trigger_blender.trigger_overrun.enable</b><br><b>status.operation.instrument.trigger_blender.trigger_overrun.event</b><br><b>status.operation.instrument.trigger_blender.trigger_overrun.ntr</b><br><b>status.operation.instrument.trigger_blender.trigger_overrun.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                  |                                                                   |                      |                                                                   |                      |                                                                   |                      |                                                                   |                      |
| Attribute                                                                                                                                                                                                                                                                                                                                                                                 | Operation status trigger blender overrun register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                                                   |                      |                                                                   |                      |                                                                   |                      |                                                                   |                      |
| Default                                                                                                                                                                                                                                                                                                                                                                                   | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                                                   |                      |                                                                   |                      |                                                                   |                      |                                                                   |                      |
| TSP-Link accessibility                                                                                                                                                                                                                                                                                                                                                                    | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                                                   |                      |                                                                   |                      |                                                                   |                      |                                                                   |                      |
| Usage                                                                                                                                                                                                                                                                                                                                                                                     | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg =   status.operation.instrument.trigger_blender.trigger_overrun.condition operreg =   status.operation.instrument.trigger_blender.trigger_overrun.enable operreg =   status.operation.instrument.trigger_blender.trigger_overrun.event operreg = status.operation.instrument.trigger_blender.trigger_overrun.ntr operreg = status.operation.instrument.trigger_blender.trigger_overrun.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.instrument.trigger_blender.trigger_overrun.enable =   operreg status.operation.instrument.trigger_blender.trigger_overrun.ntr = operreg status.operation.instrument.trigger_blender.trigger_overrun.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.instrument.trigger_blender.trigger_overrun.BLND1</td> <td>Sets BLND1 bit (B1).</td> </tr> <tr> <td>status.operation.instrument.trigger_blender.trigger_overrun.BLND2</td> <td>Sets BLND2 bit (B2).</td> </tr> <tr> <td>status.operation.instrument.trigger_blender.trigger_overrun.BLND3</td> <td>Sets BLND3 bit (B3).</td> </tr> <tr> <td>status.operation.instrument.trigger_blender.trigger_overrun.BLND4</td> <td>Sets BLND4 bit (B4).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Example:<br/>To set bit B3 (BLND3), set operreg to 8 (2<sup>3</sup>).</p> | 0 | Clears all bits. | status.operation.instrument.trigger_blender.trigger_overrun.BLND1 | Sets BLND1 bit (B1). | status.operation.instrument.trigger_blender.trigger_overrun.BLND2 | Sets BLND2 bit (B2). | status.operation.instrument.trigger_blender.trigger_overrun.BLND3 | Sets BLND3 bit (B3). | status.operation.instrument.trigger_blender.trigger_overrun.BLND4 | Sets BLND4 bit (B4). |
| 0                                                                                                                                                                                                                                                                                                                                                                                         | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                                                   |                      |                                                                   |                      |                                                                   |                      |                                                                   |                      |
| status.operation.instrument.trigger_blender.trigger_overrun.BLND1                                                                                                                                                                                                                                                                                                                         | Sets BLND1 bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                                                   |                      |                                                                   |                      |                                                                   |                      |                                                                   |                      |
| status.operation.instrument.trigger_blender.trigger_overrun.BLND2                                                                                                                                                                                                                                                                                                                         | Sets BLND2 bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                                                   |                      |                                                                   |                      |                                                                   |                      |                                                                   |                      |
| status.operation.instrument.trigger_blender.trigger_overrun.BLND3                                                                                                                                                                                                                                                                                                                         | Sets BLND3 bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                                                   |                      |                                                                   |                      |                                                                   |                      |                                                                   |                      |
| status.operation.instrument.trigger_blender.trigger_overrun.BLND4                                                                                                                                                                                                                                                                                                                         | Sets BLND4 bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                                                   |                      |                                                                   |                      |                                                                   |                      |                                                                   |                      |
| Remarks                                                                                                                                                                                                                                                                                                                                                                                   | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status trigger blender overrun registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 000000000000110. This value indicates that bit B1 (BLND1) and bit B2 (BLND2) are set.</li> <li>• The used bits of the operation status trigger blender overrun registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, BLND1:</b> Set bit indicates Trigger Blender 1 generated an overrun.</li> <li>• <b>Bit B2, BLND2:</b> Set bit indicates Trigger Blender 1 generated an overrun.</li> <li>• <b>Bit B3, BLND3:</b> Set bit indicates Trigger Blender 1 generated an overrun.</li> <li>• <b>Bit B4, BLND4:</b> Set bit indicates Trigger Blender 1 generated an overrun.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                                                   |                      |                                                                   |                      |                                                                   |                      |                                                                   |                      |
| Details                                                                                                                                                                                                                                                                                                                                                                                   | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |                  |                                                                   |                      |                                                                   |                      |                                                                   |                      |                                                                   |                      |
| Example                                                                                                                                                                                                                                                                                                                                                                                   | <p>Sets the bit for blender 1 of the operation status trigger blender overrun enable register:</p> <pre>status.operation.instrument.trigger_blender.trigger_overrun.enable = status.operation.instrument.trigger_blender.trigger_overrun.BLND1</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                                                   |                      |                                                                   |                      |                                                                   |                      |                                                                   |                      |

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| <b>status.operation.instrument.trigger_timer.condition</b><br><b>status.operation.instrument.trigger_timer.enable</b><br><b>status.operation.instrument.trigger_timer.event</b><br><b>status.operation.instrument.trigger_timer.ntr</b><br><b>status.operation.instrument.trigger_timer.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                                           |                        |                                                  |                        |
| Attribute                                                                                                                                                                                                                                                                                       | Operation status trigger timer summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                  |                                                           |                        |                                                  |                        |
| Default                                                                                                                                                                                                                                                                                         | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                                           |                        |                                                  |                        |
| TSP-Link accessibility                                                                                                                                                                                                                                                                          | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                                           |                        |                                                  |                        |
| Usage                                                                                                                                                                                                                                                                                           | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.instrument.trigger_timer.condition operreg = status.operation.instrument.trigger_timer.enable operreg = status.operation.instrument.trigger_timer.event operreg = status.operation.instrument.trigger_timer.ntr operreg = status.operation.instrument.trigger_timer.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.instrument.trigger_timer.enable = operreg status.operation.instrument.trigger_timer.ntr = operreg status.operation.instrument.trigger_timer.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.instrument.trigger_timer.TRIGGER_OVERRUN</td> <td>Sets TRGOVR bit (B10).</td> </tr> <tr> <td>status.operation.instrument.trigger_timer.TRGOVR</td> <td>Sets TRGOVR bit (B10).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Example:<br/>To set bit B10 (TRGOVR), set operreg to 1024 (<math>2^{10}</math>).</p> | 0 | Clears all bits. | status.operation.instrument.trigger_timer.TRIGGER_OVERRUN | Sets TRGOVR bit (B10). | status.operation.instrument.trigger_timer.TRGOVR | Sets TRGOVR bit (B10). |
| 0                                                                                                                                                                                                                                                                                               | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                                           |                        |                                                  |                        |
| status.operation.instrument.trigger_timer.TRIGGER_OVERRUN                                                                                                                                                                                                                                       | Sets TRGOVR bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                                           |                        |                                                  |                        |
| status.operation.instrument.trigger_timer.TRGOVR                                                                                                                                                                                                                                                | Sets TRGOVR bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                                           |                        |                                                  |                        |
| Remarks                                                                                                                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status trigger timer summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• The bits of the operation status trigger timer summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B10, TRGOVR:</b> Set bit indicates one or more enabled bits for the operation status trigger timer overrun register is set.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                                           |                        |                                                  |                        |
| Details                                                                                                                                                                                                                                                                                         | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                                           |                        |                                                  |                        |

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| <b>status.operation.instrument.trigger_timer.trigger_overnrun.condition</b><br><b>status.operation.instrument.trigger_timer.trigger_overnrun.enable</b><br><b>status.operation.instrument.trigger_timer.trigger_overnrun.event</b><br><b>status.operation.instrument.trigger_timer.trigger_overnrun.ntr</b><br><b>status.operation.instrument.trigger_timer.trigger_overnrun.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |
| Attribute                                                                                                                                                                                                                                                                                                                                                                            | Operation status trigger timer overrun register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |
| Default                                                                                                                                                                                                                                                                                                                                                                              | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |
| TSP-Link accessibility                                                                                                                                                                                                                                                                                                                                                               | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |
| Usage                                                                                                                                                                                                                                                                                                                                                                                | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.instrument.trigger_timer.trigger_overnrun.condition operreg = status.operation.instrument.trigger_timer.trigger_overnrun.enable operreg = status.operation.instrument.trigger_timer.trigger_overnrun.event operreg = status.operation.instrument.trigger_timer.trigger_overnrun.ntr operreg = status.operation.instrument.trigger_timer.trigger_overnrun.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.instrument.trigger_timer.trigger_overnrun.enable = operreg status.operation.instrument.trigger_timer.trigger_overnrun.ntr = operreg status.operation.instrument.trigger_timer.trigger_overnrun.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.instrument.trigger_timer.trigger_overnrun.TMR1</td> <td>Sets TMR1 bit (B1).</td> </tr> <tr> <td>status.operation.instrument.trigger_timer.trigger_overnrun.TMR2</td> <td>Sets TMR2 bit (B2).</td> </tr> <tr> <td>status.operation.instrument.trigger_timer.trigger_overnrun.TMR3</td> <td>Sets TMR3 bit (B3).</td> </tr> <tr> <td>status.operation.instrument.trigger_timer.trigger_overnrun.TMR4</td> <td>Sets TMR4 bit (B4).</td> </tr> <tr> <td>status.operation.instrument.trigger_timer.trigger_overnrun.TMR5</td> <td>Sets TMR5 bit (B5).</td> </tr> <tr> <td>status.operation.instrument.trigger_timer.trigger_overnrun.TMR6</td> <td>Sets TMR6 bit (B6).</td> </tr> <tr> <td>status.operation.instrument.trigger_timer.trigger_overnrun.TMR7</td> <td>Sets TMR7 bit (B7).</td> </tr> <tr> <td>status.operation.instrument.trigger_timer.trigger_overnrun.TMR8</td> <td>Sets TMR8 bit (B8).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Example:<br/>To set bit B6 (TMR6), set operreg to 64 (2<sup>6</sup>).</p> | 0 | Clears all bits. | status.operation.instrument.trigger_timer.trigger_overnrun.TMR1 | Sets TMR1 bit (B1). | status.operation.instrument.trigger_timer.trigger_overnrun.TMR2 | Sets TMR2 bit (B2). | status.operation.instrument.trigger_timer.trigger_overnrun.TMR3 | Sets TMR3 bit (B3). | status.operation.instrument.trigger_timer.trigger_overnrun.TMR4 | Sets TMR4 bit (B4). | status.operation.instrument.trigger_timer.trigger_overnrun.TMR5 | Sets TMR5 bit (B5). | status.operation.instrument.trigger_timer.trigger_overnrun.TMR6 | Sets TMR6 bit (B6). | status.operation.instrument.trigger_timer.trigger_overnrun.TMR7 | Sets TMR7 bit (B7). | status.operation.instrument.trigger_timer.trigger_overnrun.TMR8 | Sets TMR8 bit (B8). |
| 0                                                                                                                                                                                                                                                                                                                                                                                    | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |
| status.operation.instrument.trigger_timer.trigger_overnrun.TMR1                                                                                                                                                                                                                                                                                                                      | Sets TMR1 bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |
| status.operation.instrument.trigger_timer.trigger_overnrun.TMR2                                                                                                                                                                                                                                                                                                                      | Sets TMR2 bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |
| status.operation.instrument.trigger_timer.trigger_overnrun.TMR3                                                                                                                                                                                                                                                                                                                      | Sets TMR3 bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |
| status.operation.instrument.trigger_timer.trigger_overnrun.TMR4                                                                                                                                                                                                                                                                                                                      | Sets TMR4 bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |
| status.operation.instrument.trigger_timer.trigger_overnrun.TMR5                                                                                                                                                                                                                                                                                                                      | Sets TMR5 bit (B5).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |
| status.operation.instrument.trigger_timer.trigger_overnrun.TMR6                                                                                                                                                                                                                                                                                                                      | Sets TMR6 bit (B6).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |
| status.operation.instrument.trigger_timer.trigger_overnrun.TMR7                                                                                                                                                                                                                                                                                                                      | Sets TMR7 bit (B7).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |
| status.operation.instrument.trigger_timer.trigger_overnrun.TMR8                                                                                                                                                                                                                                                                                                                      | Sets TMR8 bit (B8).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |                                                                 |                     |

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| Remarks | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status trigger timer overrun registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• The used bits of the operation status trigger timer overrun registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, TMR1:</b> Set bit indicates Timer 1 generated an action overrun because it was still processing a delay from a previous trigger when a new trigger was received.</li> <li>• <b>Bit B2, TMR2:</b> Set bit indicates Timer 2 generated an action overrun because it was still processing a delay from a previous trigger when a new trigger was received.</li> <li>• <b>Bit B3, TMR3:</b> Set bit indicates Timer 3 generated an action overrun because it was still processing a delay from a previous trigger when a new trigger was received.</li> <li>• <b>Bit B4, TMR4:</b> Set bit indicates Timer 4 generated an action overrun because it was still processing a delay from a previous trigger when a new trigger was received.</li> <li>• <b>Bit B5, TMR5:</b> Set bit indicates Timer 5 generated an action overrun because it was still processing a delay from a previous trigger when a new trigger was received.</li> <li>• <b>Bit B6, TMR6:</b> Set bit indicates Timer 6 generated an action overrun because it was still processing a delay from a previous trigger when a new trigger was received.</li> <li>• <b>Bit B7, TMR7:</b> Set bit indicates Timer 7 generated an action overrun because it was still processing a delay from a previous trigger when a new trigger was received.</li> <li>• <b>Bit B8, TMR8:</b> Set bit indicates Timer 8 generated an action overrun because it was still processing a delay from a previous trigger when a new trigger was received.</li> </ul> </li> </ul> |
| Details | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Example | Sets the Timer 3 bit of the operation status trigger timer overrun enable register:<br><pre>status.operation.instrument.trigger_timer.trigger_overrun.enable = status.operation.instrument.trigger_timer.trigger_overrun.TMR3</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

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| <b>status.operation.instrument.tsplink.condition</b><br><b>status.operation.instrument.tsplink.enable</b><br><b>status.operation.instrument.tsplink.event</b><br><b>status.operation.instrument.tsplink.ntr</b><br><b>status.operation.instrument.tsplink.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                                     |                        |                                            |                        |
| Attribute                                                                                                                                                                                                                                                         | Operation status TSP-Link summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                                     |                        |                                            |                        |
| Default                                                                                                                                                                                                                                                           | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |                  |                                                     |                        |                                            |                        |
| TSP-Link accessibility                                                                                                                                                                                                                                            | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                                     |                        |                                            |                        |
| Usage                                                                                                                                                                                                                                                             | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.instrument.tsplink.condition operreg = status.operation.instrument.tsplink.enable operreg = status.operation.instrument.tsplink.event operreg = status.operation.instrument.tsplink.ntr operreg = status.operation.instrument.tsplink.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.instrument.tsplink.enable = operreg status.operation.instrument.tsplink.ntr = operreg status.operation.instrument.tsplink.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table style="width: 100%; border: none;"> <tr> <td style="padding-right: 20px;">0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.instrument.tsplink.TRIGGER_OVERRUN</td> <td>Sets TRGOVR bit (B10).</td> </tr> <tr> <td>status.operation.instrument.tsplink.TRGOVR</td> <td>Sets TRGOVR bit (B10).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Example:<br/>To set bit B10 (TRGOVR), set operreg to 1024 (<math>2^{10}</math>).</p> | 0 | Clears all bits. | status.operation.instrument.tsplink.TRIGGER_OVERRUN | Sets TRGOVR bit (B10). | status.operation.instrument.tsplink.TRGOVR | Sets TRGOVR bit (B10). |
| 0                                                                                                                                                                                                                                                                 | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                                     |                        |                                            |                        |
| status.operation.instrument.tsplink.TRIGGER_OVERRUN                                                                                                                                                                                                               | Sets TRGOVR bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                                     |                        |                                            |                        |
| status.operation.instrument.tsplink.TRGOVR                                                                                                                                                                                                                        | Sets TRGOVR bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                                     |                        |                                            |                        |
| Remarks                                                                                                                                                                                                                                                           | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status TSP-Link summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• The used bits of the operation status TSP-Link summary registers are described as follows:</li> <li>• <b>Bit B10, TRGOVR:</b> Set bit indicates one or more enabled bits for the operation status TSP-Link overrun register is set.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                                     |                        |                                            |                        |
| Details                                                                                                                                                                                                                                                           | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                  |                                                     |                        |                                            |                        |
| Example                                                                                                                                                                                                                                                           | <p>Sets the trigger overrun bit of the operation status TSP-Link summary enable register:</p> <pre>status.operation.instrument.tsplink.enable = status.operation.instrument.tsplink.TRGOVR</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                                     |                        |                                            |                        |

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| <b>status.operation.instrument.tsplink.trigger_overn.run.condition</b><br><b>status.operation.instrument.tsplink.trigger_overn.run.enable</b><br><b>status.operation.instrument.tsplink.trigger_overn.run.event</b><br><b>status.operation.instrument.tsplink.trigger_overn.run.ntr</b><br><b>status.operation.instrument.tsplink.trigger_overn.run.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                  |                                                             |                      |                                                             |                      |                                                             |                      |
| Attribute                                                                                                                                                                                                                                                                                                                                                   | Operation status TSP-Link overrun register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                  |                                                             |                      |                                                             |                      |                                                             |                      |
| Default                                                                                                                                                                                                                                                                                                                                                     | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                                             |                      |                                                             |                      |                                                             |                      |
| TSP-Link accessibility                                                                                                                                                                                                                                                                                                                                      | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                                             |                      |                                                             |                      |                                                             |                      |
| Usage                                                                                                                                                                                                                                                                                                                                                       | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.instrument.tsplink.trigger_overn.run.condition operreg = status.operation.instrument.tsplink.trigger_overn.run.enable operreg = status.operation.instrument.tsplink.trigger_overn.run.event operreg = status.operation.instrument.tsplink.trigger_overn.run.ntr operreg = status.operation.instrument.tsplink.trigger_overn.run.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.instrument.tsplink.trigger_overn.run.enable = operreg status.operation.instrument.tsplink.trigger_overn.run.ntr = operreg status.operation.instrument.tsplink.trigger_overn.run.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table style="width: 100%; border: none;"> <tr> <td style="padding-right: 20px;">0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.instrument.tsplink.trigger_overn.run.LINE1</td> <td>Sets LINE1 bit (B1).</td> </tr> <tr> <td>status.operation.instrument.tsplink.trigger_overn.run.LINE2</td> <td>Sets LINE2 bit (B2).</td> </tr> <tr> <td>status.operation.instrument.tsplink.trigger_overn.run.LINE3</td> <td>Sets LINE3 bit (B3).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Example:<br/> To set bit B2 (LINE2), set operreg to 4 (2<sup>2</sup>).<br/> To set two bits, set operreg to the sum of the decimal weights of both bits.<br/> To set bits B1 and B2, set operreg to 6 (2 + 4).</p> | 0 | Clears all bits. | status.operation.instrument.tsplink.trigger_overn.run.LINE1 | Sets LINE1 bit (B1). | status.operation.instrument.tsplink.trigger_overn.run.LINE2 | Sets LINE2 bit (B2). | status.operation.instrument.tsplink.trigger_overn.run.LINE3 | Sets LINE3 bit (B3). |
| 0                                                                                                                                                                                                                                                                                                                                                           | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                                             |                      |                                                             |                      |                                                             |                      |
| status.operation.instrument.tsplink.trigger_overn.run.LINE1                                                                                                                                                                                                                                                                                                 | Sets LINE1 bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                                             |                      |                                                             |                      |                                                             |                      |
| status.operation.instrument.tsplink.trigger_overn.run.LINE2                                                                                                                                                                                                                                                                                                 | Sets LINE2 bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                                             |                      |                                                             |                      |                                                             |                      |
| status.operation.instrument.tsplink.trigger_overn.run.LINE3                                                                                                                                                                                                                                                                                                 | Sets LINE3 bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                                             |                      |                                                             |                      |                                                             |                      |
| Remarks                                                                                                                                                                                                                                                                                                                                                     | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status TSP-Link overrun registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 000000000000110. This value indicates that bit B1 (LINE1) and bit B2 (LINE2) are set.</li> <li>• The used bits of the operation status TSP-Link overrun registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, LINE1:</b> Set bit indicates that Line 1 generated an action overrun when triggered to generate an output trigger.</li> <li>• <b>Bit B2, LINE2:</b> Set bit indicates that Line 2 generated an action overrun when triggered to generate an output trigger.</li> <li>• <b>Bit B3, LINE3:</b> Set bit indicates that Line 3 generated an action overrun when triggered to generate an output trigger.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                          |   |                  |                                                             |                      |                                                             |                      |                                                             |                      |
| Details                                                                                                                                                                                                                                                                                                                                                     | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |                  |                                                             |                      |                                                             |                      |                                                             |                      |
| Example                                                                                                                                                                                                                                                                                                                                                     | Sets the Line 1 bit of the operation status TSP-Link overrun enable register:<br><pre>status.operation.instrument.tsplink.trigger_overn.run.enable = status.operation.instrument.tsplink.trigger_overn.run.LINE1</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                                             |                      |                                                             |                      |                                                             |                      |



| <b>status.operation.measuring.condition</b><br><b>status.operation.measuring.enable</b><br><b>status.operation.measuring.event</b><br><b>status.operation.measuring.ntr</b><br><b>status.operation.measuring.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                 |                     |                                 |                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|---------------------------------|---------------------|---------------------------------|---------------------|
| Attribute                                                                                                                                                                                                            | Operation status measuring summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                 |                     |                                 |                     |
| Default                                                                                                                                                                                                              | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                 |                     |                                 |                     |
| TSP-Link accessibility                                                                                                                                                                                               | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                 |                     |                                 |                     |
| Usage                                                                                                                                                                                                                | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.measuring.condition operreg = status.operation.measuring.enable operreg = status.operation.measuring.event operreg = status.operation.measuring.ntr operreg = status.operation.measuring.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.measuring.enable = operreg status.operation.measuring.ntr = operreg status.operation.measuring.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.measuring.SMUA</td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td>status.operation.measuring.SMUB</td> <td>Sets SMUB bit (B2).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B1 (SMUA), set operreg to 2 (<math>2^1</math>).</li> <li>To set bit B2 (SMUB), set operreg to 4 (<math>2^2</math>).</li> <li>To set both bits, set operreg to the sum of the decimal weights of both bits.</li> <li>To set bits B1 and B2, set operreg to 6 (<math>2 + 4</math>).</li> </ul> | 0 | Clears all bits. | status.operation.measuring.SMUA | Sets SMUA bit (B1). | status.operation.measuring.SMUB | Sets SMUB bit (B2). |
| 0                                                                                                                                                                                                                    | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                 |                     |                                 |                     |
| status.operation.measuring.SMUA                                                                                                                                                                                      | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                 |                     |                                 |                     |
| status.operation.measuring.SMUB                                                                                                                                                                                      | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                 |                     |                                 |                     |
| Remarks                                                                                                                                                                                                              | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status measuring summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 0000000000000110. This value indicates that bit B1(SMUA) and bit B2 (SMUB) are set.</li> <li>• The used bits of the operation measurement registers are described as follows:</li> <li>• <b>Bit B1, SMUA:</b> Set bit indicates the enabled MEAS bit for the SMU A operation register is set.</li> <li>• <b>Bit B2, SMUB:</b> Set bit indicates the enabled MEAS bit for the SMU B operation register is set.</li> </ul>                                                                                                                                                                                                                                                                                                      |   |                  |                                 |                     |                                 |                     |
| Details                                                                                                                                                                                                              | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                 |                     |                                 |                     |
| Example                                                                                                                                                                                                              | <p>Sets the SMUA bit of the operation status measuring summary enable register:</p> <pre>status.operation.measuring.enable = status.operation.measuring.SMUA</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                 |                     |                                 |                     |

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| <b>status.operation.remote.condition</b><br><b>status.operation.remote.enable</b><br><b>status.operation.remote.event</b><br><b>status.operation.remote.ntr</b><br><b>status.operation.remote.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |                  |                                           |                    |                             |                    |                                         |                       |                               |                       |
| Attribute                                                                                                                                                                                             | Operation status remote summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                           |                    |                             |                    |                                         |                       |                               |                       |
| Default                                                                                                                                                                                               | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                           |                    |                             |                    |                                         |                       |                               |                       |
| TSP-Link accessibility                                                                                                                                                                                | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                  |                                           |                    |                             |                    |                                         |                       |                               |                       |
| Usage                                                                                                                                                                                                 | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.remote.condition operreg = status.operation.remote.enable operreg = status.operation.remote.event operreg = status.operation.remote.ntr operreg = status.operation.remote.ptr</pre> <p>Writes to condition, enable, NTR, and PTR registers:</p> <pre>status.operation.remote.enable = operreg status.operation.remote.ntr = operreg status.operation.remote.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.remote.COMMAND_AVAILABLE</td> <td>Sets CAV bit (B1).</td> </tr> <tr> <td>status.operation.remote.CAV</td> <td>Sets CAV bit (B1).</td> </tr> <tr> <td>status.operation.remote.PROMPTS_ENABLED</td> <td>Sets PRMPT bit (B11).</td> </tr> <tr> <td>status.operation.remote.PRMPT</td> <td>Sets PRMPT bit (B11).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Examples:</p> <p>To set bit B1, set operreg to 2 (<math>2^1</math>).</p> <p>To set bit B11, set operreg to 2048 (<math>2^{11}</math>).</p> <p>To set more than one bit of the register, set operreg to the sum of their decimal weights. For example, to set bit B1 and bit B11, set operreg to 2050 (<math>2 + 2048</math>).</p> | 0 | Clears all bits. | status.operation.remote.COMMAND_AVAILABLE | Sets CAV bit (B1). | status.operation.remote.CAV | Sets CAV bit (B1). | status.operation.remote.PROMPTS_ENABLED | Sets PRMPT bit (B11). | status.operation.remote.PRMPT | Sets PRMPT bit (B11). |
| 0                                                                                                                                                                                                     | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                           |                    |                             |                    |                                         |                       |                               |                       |
| status.operation.remote.COMMAND_AVAILABLE                                                                                                                                                             | Sets CAV bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                           |                    |                             |                    |                                         |                       |                               |                       |
| status.operation.remote.CAV                                                                                                                                                                           | Sets CAV bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                           |                    |                             |                    |                                         |                       |                               |                       |
| status.operation.remote.PROMPTS_ENABLED                                                                                                                                                               | Sets PRMPT bit (B11).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                           |                    |                             |                    |                                         |                       |                               |                       |
| status.operation.remote.PRMPT                                                                                                                                                                         | Sets PRMPT bit (B11).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                           |                    |                             |                    |                                         |                       |                               |                       |
| Remarks                                                                                                                                                                                               | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status remote summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• <b>Bit B1, CAV:</b> Set bit indicates there is a command available in the execution queue.</li> <li>• <b>Bit B2, PRMPT:</b> Set bit indicates command prompts are enabled.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                           |                    |                             |                    |                                         |                       |                               |                       |
| Details                                                                                                                                                                                               | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                           |                    |                             |                    |                                         |                       |                               |                       |
| Example                                                                                                                                                                                               | <p>Sets the CAV bit of the operation status remote summary enable register:</p> <pre>status.operation.remote.enable = status.operation.remote.CAV</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                           |                    |                             |                    |                                         |                       |                               |                       |

|                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                |                     |                                |                     |
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| <b>status.operation.sweeping.condition</b><br><b>status.operation.sweeping.enable</b><br><b>status.operation.sweeping.event</b><br><b>status.operation.sweeping.ntr</b><br><b>status.operation.sweeping.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                |                     |                                |                     |
| Attribute                                                                                                                                                                                                       | Operation status sweeping summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                |                     |                                |                     |
| Default                                                                                                                                                                                                         | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                |                     |                                |                     |
| TSP-Link accessibility                                                                                                                                                                                          | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                |                     |                                |                     |
| Usage                                                                                                                                                                                                           | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.sweeping.condition operreg = status.operation.sweeping.enable operreg = status.operation.sweeping.event operreg = status.operation.sweeping.ntr operreg = status.operation.sweeping.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.sweeping.enable = operreg status.operation.sweeping.ntr = operreg status.operation.sweeping.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.sweeping.SMUA</td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td>status.operation.sweeping.SMUB</td> <td>Sets SMUB bit (B2).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Examples:<br/> To set bit B1 (SMUA), set operreg to 2 (<math>2^1</math>).<br/> To set bit B2 (SMUB), set operreg to 4 (<math>2^2</math>).<br/> To set both bits, set operreg to the sum of the decimal weights of both bits:<br/> To set bits B1 and B2, set operreg to 6 (<math>2 + 4</math>).</p> | 0 | Clears all bits. | status.operation.sweeping.SMUA | Sets SMUA bit (B1). | status.operation.sweeping.SMUB | Sets SMUB bit (B2). |
| 0                                                                                                                                                                                                               | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                |                     |                                |                     |
| status.operation.sweeping.SMUA                                                                                                                                                                                  | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                |                     |                                |                     |
| status.operation.sweeping.SMUB                                                                                                                                                                                  | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                |                     |                                |                     |
| Remarks                                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status sweeping summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 0000000000000110. This value indicates that bit B1(SMUA) and bit B2 (SMUB) are set.</li> <li>• The used bits of the operation status sweeping summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, SMUA:</b> Set bit indicates the enabled SWE bit for the SMU A operation register is set.</li> <li>• <b>Bit B2, SMUB:</b> Set bit indicates the enabled SWE bit for the SMU B operation register is set.</li> </ul> </li> </ul>                                                                                                                                                                                |   |                  |                                |                     |                                |                     |
| Details                                                                                                                                                                                                         | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                |                     |                                |                     |
| Example                                                                                                                                                                                                         | Sets the SMUA bit of the operation status sweeping summary enable register:<br><pre>status.operation.sweeping.enable = status.operation.sweeping.SMUA</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                |                     |                                |                     |

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| <b>status.operation.trigger_overnrun.condition</b><br><b>status.operation.trigger_overnrun.enable</b><br><b>status.operation.trigger_overnrun.event</b><br><b>status.operation.trigger_overnrun.ntr</b><br><b>status.operation.trigger_overnrun.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| Attribute                                                                                                                                                                                                                                               | Operation status trigger overrun register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| Default                                                                                                                                                                                                                                                 | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| TSP-Link accessibility                                                                                                                                                                                                                                  | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| Usage                                                                                                                                                                                                                                                   | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.trigger_overnrun.condition operreg = status.operation.trigger_overnrun.enable operreg = status.operation.trigger_overnrun.event operreg = status.operation.trigger_overnrun.ntr operreg = status.operation.trigger_overnrun.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.operation.trigger_overnrun.enable = operreg status.operation.trigger_overnrun.ntr = operreg status.operation.trigger_overnrun.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.trigger_overnrun.SMUA</td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td>status.operation.trigger_overnrun.SMUB</td> <td>Sets SMUB bit (B2).</td> </tr> <tr> <td>status.operation.trigger_overnrun.TRIGGER_BLENDER</td> <td>Sets TRGBLND bit (B10).</td> </tr> <tr> <td>status.operation.trigger_overnrun.TRGBLND</td> <td>Sets TRGBLND bit (B10).</td> </tr> <tr> <td>status.operation.trigger_overnrun.TRIGGER_TIMER</td> <td>Sets TRGTMR bit (B11).</td> </tr> <tr> <td>status.operation.trigger_overnrun.TRGTMR</td> <td>Sets TRGTMR bit (B11).</td> </tr> <tr> <td>status.operation.trigger_overnrun.DIGITAL_IO</td> <td>Sets DIGIO bit (B12).</td> </tr> <tr> <td>status.operation.trigger_overnrun.DIGIO</td> <td>Sets DIGIO bit (B12).</td> </tr> <tr> <td>status.operation.trigger_overnrun.TSPLINK</td> <td>Sets TSPLINK bit (B13).</td> </tr> <tr> <td>status.operation.trigger_overnrun.LAN</td> <td>Sets LAN bit (B14).</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B1 (SMUA), set operreg to 2 (<math>2^1</math>).</li> <li>To set bit B2 (SMUB), set operreg to 4 (<math>2^2</math>).</li> <li>To set bit B13 (TSPLINK), set operreg to 8192 (<math>2^{13}</math>).</li> <li>To set two bits, set operreg to the sum of the decimal weights of both bits:</li> <li>To set bits B1 and B2, set operreg to 6 (<math>2 + 4</math>).</li> </ul> | 0 | Clears all bits. | status.operation.trigger_overnrun.SMUA | Sets SMUA bit (B1). | status.operation.trigger_overnrun.SMUB | Sets SMUB bit (B2). | status.operation.trigger_overnrun.TRIGGER_BLENDER | Sets TRGBLND bit (B10). | status.operation.trigger_overnrun.TRGBLND | Sets TRGBLND bit (B10). | status.operation.trigger_overnrun.TRIGGER_TIMER | Sets TRGTMR bit (B11). | status.operation.trigger_overnrun.TRGTMR | Sets TRGTMR bit (B11). | status.operation.trigger_overnrun.DIGITAL_IO | Sets DIGIO bit (B12). | status.operation.trigger_overnrun.DIGIO | Sets DIGIO bit (B12). | status.operation.trigger_overnrun.TSPLINK | Sets TSPLINK bit (B13). | status.operation.trigger_overnrun.LAN | Sets LAN bit (B14). |
| 0                                                                                                                                                                                                                                                       | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| status.operation.trigger_overnrun.SMUA                                                                                                                                                                                                                  | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| status.operation.trigger_overnrun.SMUB                                                                                                                                                                                                                  | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| status.operation.trigger_overnrun.TRIGGER_BLENDER                                                                                                                                                                                                       | Sets TRGBLND bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| status.operation.trigger_overnrun.TRGBLND                                                                                                                                                                                                               | Sets TRGBLND bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| status.operation.trigger_overnrun.TRIGGER_TIMER                                                                                                                                                                                                         | Sets TRGTMR bit (B11).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| status.operation.trigger_overnrun.TRGTMR                                                                                                                                                                                                                | Sets TRGTMR bit (B11).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| status.operation.trigger_overnrun.DIGITAL_IO                                                                                                                                                                                                            | Sets DIGIO bit (B12).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| status.operation.trigger_overnrun.DIGIO                                                                                                                                                                                                                 | Sets DIGIO bit (B12).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| status.operation.trigger_overnrun.TSPLINK                                                                                                                                                                                                               | Sets TSPLINK bit (B13).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |
| status.operation.trigger_overnrun.LAN                                                                                                                                                                                                                   | Sets LAN bit (B14).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                        |                     |                                        |                     |                                                   |                         |                                           |                         |                                                 |                        |                                          |                        |                                              |                       |                                         |                       |                                           |                         |                                       |                     |

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| Remarks | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status trigger overrun registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 0000000000000110. This value indicates that bit B1(SMUA) and bit B2 (SMUB) are set.</li> <li>• The used bits of the operation status trigger overrun registers are described as follows:</li> <li>• <b>Bit B1, SMUA:</b> Set bit indicates one of the enabled bits in the operation status SMU A trigger overrun event register is set.</li> <li>• <b>Bit B2, SMUB:</b> Set bit indicates one of the enabled bits in the operation status SMU B trigger overrun event register is set.</li> <li>• <b>Bit B10, TRGBLND:</b> Set bit indicates one of the enabled bits in the operation status trigger blender overrun event register is set.</li> <li>• <b>Bit B11, TRGTMR:</b> Set bit indicates one of the enabled bits in the operation status trigger timer overrun event register is set.</li> <li>• <b>Bit B12, DIGIO:</b> Set bit indicates one of the enabled bits in the operation status digital I/O overrun event register is set.</li> <li>• <b>Bit B13, TSPLINK:</b> Set bit indicates one of the enabled bits in the operation status TSP-Link overrun event register is set.</li> <li>• <b>Bit B14, LAN:</b> Set bit indicates one of the enabled bits in the operation status LAN trigger overrun event register is set.</li> </ul> |
| Details | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Example | Sets the SMUA bit of the operation status trigger overrun enable register:<br><pre>status.operation.trigger_overrun.enable = status.operation.trigger_overrun.SMUA</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

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| <b>status.operation.user.condition</b><br><b>status.operation.user.enable</b><br><b>status.operation.user.event</b><br><b>status.operation.user.ntr</b><br><b>status.operation.user.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| Attribute                                                                                                                                                                                   | Operation status user register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| Default                                                                                                                                                                                     | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| TSP-Link accessibility                                                                                                                                                                      | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| Usage                                                                                                                                                                                       | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>operreg = status.operation.user.condition operreg = status.operation.user.enable operreg = status.operation.user.event operreg = status.operation.user.ntr operreg = status.operation.user.ptr</pre> <p>Writes to condition, enable, NTR, and PTR registers:</p> <pre>status.operation.user.condition = operreg status.operation.user.enable = operreg status.operation.user.ntr = operreg status.operation.user.ptr = operreg</pre> <p>Set operreg to one of the following values:</p> <table> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.operation.user.BIT0</td> <td>Sets user BIT0.</td> </tr> <tr> <td>status.operation.user.BIT1</td> <td>Sets user BIT1.</td> </tr> <tr> <td>status.operation.user.BIT2</td> <td>Sets user BIT2.</td> </tr> <tr> <td>status.operation.user.BIT3</td> <td>Sets user BIT3.</td> </tr> <tr> <td>status.operation.user.BIT4</td> <td>Sets user BIT4.</td> </tr> <tr> <td>status.operation.user.BIT5</td> <td>Sets user BIT5.</td> </tr> <tr> <td>status.operation.user.BIT6</td> <td>Sets user BIT6.</td> </tr> <tr> <td>status.operation.user.BIT7</td> <td>Sets user BIT7.</td> </tr> <tr> <td>status.operation.user.BIT8</td> <td>Sets user BIT8.</td> </tr> <tr> <td>status.operation.user.BIT9</td> <td>Sets user BIT9.</td> </tr> <tr> <td>status.operation.user.BIT10</td> <td>Sets user BIT10.</td> </tr> <tr> <td>status.operation.user.BIT11</td> <td>Sets user BIT11.</td> </tr> <tr> <td>status.operation.user.BIT12</td> <td>Sets user BIT12.</td> </tr> <tr> <td>status.operation.user.BIT13</td> <td>Sets user BIT13.</td> </tr> <tr> <td>status.operation.user.BIT14</td> <td>Sets user BIT14.</td> </tr> </table> <p>operreg can also be set to the decimal weight of the bit to be set. Examples:<br/> To set user BIT0, set operreg to 1 (<math>2^0</math>).<br/> To set user BIT11, set operreg to 2048 (<math>2^{11}</math>).<br/> To set more than one bit of the register, set operreg to the sum of their decimal weights. For example, to set BIT0 and BIT4, set operreg to 17 (1 + 16).</p> | 0 | Clears all bits. | status.operation.user.BIT0 | Sets user BIT0. | status.operation.user.BIT1 | Sets user BIT1. | status.operation.user.BIT2 | Sets user BIT2. | status.operation.user.BIT3 | Sets user BIT3. | status.operation.user.BIT4 | Sets user BIT4. | status.operation.user.BIT5 | Sets user BIT5. | status.operation.user.BIT6 | Sets user BIT6. | status.operation.user.BIT7 | Sets user BIT7. | status.operation.user.BIT8 | Sets user BIT8. | status.operation.user.BIT9 | Sets user BIT9. | status.operation.user.BIT10 | Sets user BIT10. | status.operation.user.BIT11 | Sets user BIT11. | status.operation.user.BIT12 | Sets user BIT12. | status.operation.user.BIT13 | Sets user BIT13. | status.operation.user.BIT14 | Sets user BIT14. |
| 0                                                                                                                                                                                           | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT0                                                                                                                                                                  | Sets user BIT0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT1                                                                                                                                                                  | Sets user BIT1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT2                                                                                                                                                                  | Sets user BIT2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT3                                                                                                                                                                  | Sets user BIT3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT4                                                                                                                                                                  | Sets user BIT4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT5                                                                                                                                                                  | Sets user BIT5.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT6                                                                                                                                                                  | Sets user BIT6.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT7                                                                                                                                                                  | Sets user BIT7.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT8                                                                                                                                                                  | Sets user BIT8.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT9                                                                                                                                                                  | Sets user BIT9.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT10                                                                                                                                                                 | Sets user BIT10.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT11                                                                                                                                                                 | Sets user BIT11.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT12                                                                                                                                                                 | Sets user BIT12.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT13                                                                                                                                                                 | Sets user BIT13.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| status.operation.user.BIT14                                                                                                                                                                 | Sets user BIT14.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| Remarks                                                                                                                                                                                     | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the operation status user registers.</li> <li>• Bits of the operation status user event register are set by setting the corresponding bits of the operation status user enable register and the operation status user condition register. For example, the following code will set B1 (Bit 1) of the operation status user event register: <ul style="list-style-type: none"> <li>• status.operation.user.enable = 2</li> <li>• status.operation.user.condition = 2</li> </ul> </li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 17 is returned for the enable register. The binary equivalent is 0000000000010001. This value indicates that BIT0 and BIT4 are set.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| Details                                                                                                                                                                                     | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |
| Example                                                                                                                                                                                     | Sets user BIT0 of the operation status user enable register:<br><pre>status.operation.user.enable = status.operation.user.BIT0</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                  |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                            |                 |                             |                  |                             |                  |                             |                  |                             |                  |                             |                  |

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|---------------------------------|--------------------|-------------------------|--------------------|-------------------------------------|-------------------|------------------------|-------------------|--------------------------------------|-----------------------|---------------------------|-----------------------|----------------------------------------|----------------------|--------------------------|----------------------|
| <b>status.questionable.condition</b><br><b>status.questionable.enable</b><br><b>status.questionable.event</b><br><b>status.questionable.ntr</b><br><b>status.questionable.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| Attribute                                                                                                                                                                         | Questionable status register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| Default                                                                                                                                                                           | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| TSP-Link accessibility                                                                                                                                                            | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| Usage                                                                                                                                                                             | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>quesreg = status.questionable.condition quesreg = status.questionable.enable quesreg = status.questionable.event quesreg = status.questionable.ntr quesreg = status.questionable.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.questionable.enable = quesreg status.questionable.ntr = quesreg status.questionable.ptr = quesreg</pre> <p>Set quesreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.questionable.CALIBRATION</td> <td>Sets CAL bit (B8).</td> </tr> <tr> <td>status.questionable.CAL</td> <td>Sets CAL bit (B8).</td> </tr> <tr> <td>status.questionable.UNSTABLE_OUTPUT</td> <td>Sets UO bit (B9).</td> </tr> <tr> <td>status.questionable.UO</td> <td>Sets UO bit (B9).</td> </tr> <tr> <td>status.questionable.OVER_TEMPERATURE</td> <td>Sets OTEMP bit (B12).</td> </tr> <tr> <td>status.questionable.OTEMP</td> <td>Sets OTEMP bit (B12).</td> </tr> <tr> <td>status.questionable.INSTRUMENT_SUMMARY</td> <td>Sets INST bit (B13).</td> </tr> <tr> <td>status.questionable.INST</td> <td>Sets INST bit (B13).</td> </tr> </table> <p>quesreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B8 (CAL), set quesreg to 256 (<math>2^8</math>).</li> <li>To set bit B9 (UO), set quesreg to 512 (<math>2^9</math>).</li> <li>To set bit B12 (OTEMP), set quesreg to 4096 (<math>2^{12}</math>).</li> <li>To set bit B13 (INST), set quesreg to 8192 (<math>2^{13}</math>).</li> </ul> <p>To set more than one bit of the register, set quesreg to the sum of their decimal weights. For example, to set bits B8 and B12, set quesreg to 4352 (256 + 4096).</p> | 0 | Clears all bits. | status.questionable.CALIBRATION | Sets CAL bit (B8). | status.questionable.CAL | Sets CAL bit (B8). | status.questionable.UNSTABLE_OUTPUT | Sets UO bit (B9). | status.questionable.UO | Sets UO bit (B9). | status.questionable.OVER_TEMPERATURE | Sets OTEMP bit (B12). | status.questionable.OTEMP | Sets OTEMP bit (B12). | status.questionable.INSTRUMENT_SUMMARY | Sets INST bit (B13). | status.questionable.INST | Sets INST bit (B13). |
| 0                                                                                                                                                                                 | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| status.questionable.CALIBRATION                                                                                                                                                   | Sets CAL bit (B8).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| status.questionable.CAL                                                                                                                                                           | Sets CAL bit (B8).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| status.questionable.UNSTABLE_OUTPUT                                                                                                                                               | Sets UO bit (B9).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| status.questionable.UO                                                                                                                                                            | Sets UO bit (B9).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| status.questionable.OVER_TEMPERATURE                                                                                                                                              | Sets OTEMP bit (B12).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| status.questionable.OTEMP                                                                                                                                                         | Sets OTEMP bit (B12).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| status.questionable.INSTRUMENT_SUMMARY                                                                                                                                            | Sets INST bit (B13).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| status.questionable.INST                                                                                                                                                          | Sets INST bit (B13).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| Remarks                                                                                                                                                                           | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the questionable status registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 4352 is returned for the enable register. The binary equivalent is 0001000100000000. This value indicates that bit B8 (CAL) and bit B12 (OTEMP) are set.</li> <li>• The used bits of the questionable status registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B8, CAL:</b> Set bit indicates that calibration is questionable.</li> <li>• <b>Bit B9, UO:</b> Set bit indicates that an unstable output condition was detected.</li> <li>• <b>Bit B12, OTEMP:</b> Set bit indicates that an over temperature condition was detected.</li> <li>• <b>Bit B13, INST:</b> Set bit indicates that a bit in the questionable status instrument summary register is set.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| Details                                                                                                                                                                           | See <a href="#">Questionable Status Register</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |
| Example                                                                                                                                                                           | Sets the OTEMP bit of the questionable status enable register:<br><pre>status.questionable.enable = status.questionable.OTEMP</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                  |                                 |                    |                         |                    |                                     |                   |                        |                   |                                      |                       |                           |                       |                                        |                      |                          |                      |

|                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                      |                     |                                      |                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|--------------------------------------|---------------------|--------------------------------------|---------------------|
| <b>status.questionable.calibration.condition</b><br><b>status.questionable.calibration.enable</b><br><b>status.questionable.calibration.event</b><br><b>status.questionable.calibration.ntr</b><br><b>status.questionable.calibration.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                      |                     |                                      |                     |
| Attribute                                                                                                                                                                                                                                     | Questionable status calibration summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                      |                     |                                      |                     |
| Default                                                                                                                                                                                                                                       | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                      |                     |                                      |                     |
| TSP-Link accessibility                                                                                                                                                                                                                        | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                      |                     |                                      |                     |
| Usage                                                                                                                                                                                                                                         | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>quesreg = status.questionable.calibration.condition quesreg = status.questionable.calibration.enable quesreg = status.questionable.calibration.event quesreg = status.questionable.calibration.ntr quesreg = status.questionable.calibration.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.questionable.calibration.enable = quesreg status.questionable.calibration.ntr = quesreg status.questionable.calibration.ptr = quesreg</pre> <p>Set quesreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.questionable.calibration.SMUA</td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td>status.questionable.calibration.SMUB</td> <td>Sets SMUB bit (B2).</td> </tr> </table> <p>quesreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B1 (SMUA), set quesreg to 2 (2<sup>1</sup>).</li> <li>To set bit B2 (SMUB), set quesreg to 4 (2<sup>2</sup>).</li> <li>To set both bits, set quesreg to the sum of the decimal weights of both bits. To set bits B1 and B2, set quesreg to 6 (2 + 4).</li> </ul> | 0 | Clears all bits. | status.questionable.calibration.SMUA | Sets SMUA bit (B1). | status.questionable.calibration.SMUB | Sets SMUB bit (B2). |
| 0                                                                                                                                                                                                                                             | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                      |                     |                                      |                     |
| status.questionable.calibration.SMUA                                                                                                                                                                                                          | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                      |                     |                                      |                     |
| status.questionable.calibration.SMUB                                                                                                                                                                                                          | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                      |                     |                                      |                     |
| Remarks                                                                                                                                                                                                                                       | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the questionable status calibration registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 000000000000110. This value indicates that bit B1(SMUA) and bit B2 (SMUB) are set.</li> <li>• The used bits of the questionable status calibration registers are described as follows:</li> <li>• <b>Bit B1, SMUA:</b> Set bit indicates the enabled CAL bit for the SMU A questionable register is set.</li> <li>• <b>Bit B2, SMUB:</b> Set bit indicates the enabled CAL bit for the SMU B questionable register is set.</li> </ul>                                                                                                                                                                                                                                                                                                                             |   |                  |                                      |                     |                                      |                     |
| Details                                                                                                                                                                                                                                       | See <a href="#">Questionable Status Register</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                      |                     |                                      |                     |
| Example                                                                                                                                                                                                                                       | <p>Sets the SMUA bit of the questionable status calibration enable register:</p> <pre>status.questionable.calibration.enable = status.questionable.calibration.SMUA</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                  |                                      |                     |                                      |                     |



|                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |                  |                                     |                     |                                     |                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|-------------------------------------|---------------------|-------------------------------------|---------------------|
| <b>status.questionable.instrument.condition</b><br><b>status.questionable.instrument.enable</b><br><b>status.questionable.instrument.event</b><br><b>status.questionable.instrument.ntr</b><br><b>status.questionable.instrument.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |                  |                                     |                     |                                     |                     |
| Attribute                                                                                                                                                                                                                                | Questionable status instrument summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |                  |                                     |                     |                                     |                     |
| Default                                                                                                                                                                                                                                  | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                  |                                     |                     |                                     |                     |
| TSP-Link accessibility                                                                                                                                                                                                                   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                     |                     |                                     |                     |
| Usage                                                                                                                                                                                                                                    | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>quesreg = status.questionable.instrument.condition quesreg = status.questionable.instrument.enable quesreg = status.questionable.instrument.event quesreg = status.questionable.instrument.ntr quesreg = status.questionable.instrument.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.questionable.instrument.enable = quesreg status.questionable.instrument.ntr = quesreg status.questionable.instrument.ptr = quesreg</pre> <p>Set operreg to one of the following values:</p> <table> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.questionable.instrument.SMUA</td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td>status.questionable.instrument.SMUB</td> <td>Sets SMUB bit (B2).</td> </tr> </table> <p>quesreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B1 (SMUA), set quesreg to 2 (<math>2^1</math>).</li> <li>To set bit B2 (SMUB), set quesreg to 4 (<math>2^2</math>).</li> <li>To set both bits, set quesreg to the sum of the decimal weights of both bits.</li> <li>To set bits B1 and B2, set quesreg to 6 (<math>2 + 4</math>).</li> </ul> | 0 | Clears all bits. | status.questionable.instrument.SMUA | Sets SMUA bit (B1). | status.questionable.instrument.SMUB | Sets SMUB bit (B2). |
| 0                                                                                                                                                                                                                                        | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                  |                                     |                     |                                     |                     |
| status.questionable.instrument.SMUA                                                                                                                                                                                                      | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                     |                     |                                     |                     |
| status.questionable.instrument.SMUB                                                                                                                                                                                                      | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                     |                     |                                     |                     |
| Remarks                                                                                                                                                                                                                                  | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the questionable status instrument summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 0000000000000110. This value indicates that bit B1 (SMUA) and bit B2 (SMUB) are set.</li> <li>• The used bits of the questionable status instrument summary registers are described as follows:</li> <li>• <b>Bit B1, SMUA:</b> Set bit indicates one or more enabled bits for the SMU A questionable register is set.</li> <li>• <b>Bit B2, SMUB:</b> Set bit indicates one or more enabled bits for the SMU B questionable register is set.</li> </ul>                                                                                                                                                                                                                                                                                                          |   |                  |                                     |                     |                                     |                     |
| Details                                                                                                                                                                                                                                  | See <a href="#">Questionable Status Register</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                  |                                     |                     |                                     |                     |
| Example                                                                                                                                                                                                                                  | <p>Sets the SMUA bit of the questionable status instrument summary enable register:</p> <pre>status.questionable.instrument.enable = status.questionable.instrument.SMUA</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                     |                     |                                     |                     |

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---|------------------|-------------------------------------------------|--------------------|-----------------------------------------|--------------------|-----------------------------------------------------|-------------------|----------------------------------------|-------------------|------------------------------------------------------|-----------------------|-------------------------------------------|-----------------------|
| <b>status.questionable.instrument.smuX.condition</b><br><b>status.questionable.instrument.smuX.enable</b><br><b>status.questionable.instrument.smuX.event</b><br><b>status.questionable.instrument.smuX.ntr</b><br><b>status.questionable.instrument.smuX.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | smuX = smua or smub |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |
| Attribute                                                                                                                                                                                                                                                         | Questionable status SMU X summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                     |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |
| Default                                                                                                                                                                                                                                                           | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                     |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |
| TSP-Link accessibility                                                                                                                                                                                                                                            | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                     |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |
| Usage                                                                                                                                                                                                                                                             | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>quesreg = status.questionable.instrument.smuX.condition quesreg = status.questionable.instrument.smuX.enable quesreg = status.questionable.instrument.smuX.event quesreg = status.questionable.instrument.smuX.ntr quesreg = status.questionable.instrument.smuX.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.questionable.instrument.smuX.enable = quesreg status.questionable.instrument.smuX.ntr = quesreg status.questionable.instrument.smuX.ptr = quesreg</pre> <p>Set quesreg to one of the following values:</p> <table style="width: 100%; border: none;"> <tr> <td style="padding-left: 20px;">0</td> <td style="padding-left: 20px;">Clears all bits.</td> </tr> <tr> <td style="padding-left: 20px;">status.questionable.instrument.smuX.CALIBRATING</td> <td style="padding-left: 20px;">Sets CAL bit (B8).</td> </tr> <tr> <td style="padding-left: 20px;">status.questionable.instrument.smuX.CAL</td> <td style="padding-left: 20px;">Sets CAL bit (B8).</td> </tr> <tr> <td style="padding-left: 20px;">status.questionable.instrument.smuX.UNSTABLE_OUTPUT</td> <td style="padding-left: 20px;">Sets UO bit (B9).</td> </tr> <tr> <td style="padding-left: 20px;">status.questionable.instrument.smuX.UO</td> <td style="padding-left: 20px;">Sets UO bit (B9).</td> </tr> <tr> <td style="padding-left: 20px;">status.questionable.instrument.smuX.OVER_TEMPERATURE</td> <td style="padding-left: 20px;">Sets OTEMP bit (B12).</td> </tr> <tr> <td style="padding-left: 20px;">status.questionable.instrument.smuX.OTEMP</td> <td style="padding-left: 20px;">Sets OTEMP bit (B12).</td> </tr> </table> <p>quesreg can also be set to the decimal weight of the bit to be set. Examples:<br/> To set bit B8 (CAL), set quesreg to 256 (<math>2^8</math>).<br/> To set bit B9 (UO), set quesreg to 512 (<math>2^9</math>).<br/> To set bit B12 (OTEMP), set quesreg to 4096 (<math>2^{12}</math>).<br/> To set more than one bit of the register, set quesreg to the sum of the decimal weights.<br/> To set bits B8 and B12, set quesreg to 4362 (256 + 4096).</p> |                     | 0 | Clears all bits. | status.questionable.instrument.smuX.CALIBRATING | Sets CAL bit (B8). | status.questionable.instrument.smuX.CAL | Sets CAL bit (B8). | status.questionable.instrument.smuX.UNSTABLE_OUTPUT | Sets UO bit (B9). | status.questionable.instrument.smuX.UO | Sets UO bit (B9). | status.questionable.instrument.smuX.OVER_TEMPERATURE | Sets OTEMP bit (B12). | status.questionable.instrument.smuX.OTEMP | Sets OTEMP bit (B12). |
| 0                                                                                                                                                                                                                                                                 | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                     |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |
| status.questionable.instrument.smuX.CALIBRATING                                                                                                                                                                                                                   | Sets CAL bit (B8).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                     |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |
| status.questionable.instrument.smuX.CAL                                                                                                                                                                                                                           | Sets CAL bit (B8).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                     |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |
| status.questionable.instrument.smuX.UNSTABLE_OUTPUT                                                                                                                                                                                                               | Sets UO bit (B9).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                     |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |
| status.questionable.instrument.smuX.UO                                                                                                                                                                                                                            | Sets UO bit (B9).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                     |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |
| status.questionable.instrument.smuX.OVER_TEMPERATURE                                                                                                                                                                                                              | Sets OTEMP bit (B12).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                     |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |
| status.questionable.instrument.smuX.OTEMP                                                                                                                                                                                                                         | Sets OTEMP bit (B12).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                     |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |
| Remarks                                                                                                                                                                                                                                                           | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the questionable status SMU X summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 4362 is returned for the enable register. The binary equivalent is 0001000100000000. This value indicates that bit B8 (CAL bit) and bit B12 (OTEMP bit) are set.</li> <li>• The used bits of the questionable status SMU X summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B8, CAL:</b> Set bit indicates that calibration is questionable.</li> <li>• <b>Bit B9, UO:</b> Set bit indicates that an unstable output condition was detected.</li> <li>• <b>Bit B12, OTEMP:</b> Set bit indicates that an over temperature condition was detected.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                     |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |
| Details                                                                                                                                                                                                                                                           | See <a href="#">Operation Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |
| Example                                                                                                                                                                                                                                                           | Sets the OTEMP bit of the questionable status SMU A summary enable register:<br><pre>status.questionable.instrument.smua.enable = status.questionable.instrument.smua.OTEMP</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                     |   |                  |                                                 |                    |                                         |                    |                                                     |                   |                                        |                   |                                                      |                       |                                           |                       |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|-------------------------------------------|---------------------|-------------------------------------------|---------------------|
| <b>status.questionable.over_temperature.condition</b><br><b>status.questionable.over_temperature.enable</b><br><b>status.questionable.over_temperature.event</b><br><b>status.questionable.over_temperature.ntr</b><br><b>status.questionable.over_temperature.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                  |                                           |                     |                                           |                     |
| Attribute                                                                                                                                                                                                                                                              | Questionable status over temperature summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                           |                     |                                           |                     |
| Default                                                                                                                                                                                                                                                                | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                           |                     |                                           |                     |
| TSP-Link accessibility                                                                                                                                                                                                                                                 | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |                  |                                           |                     |                                           |                     |
| Usage                                                                                                                                                                                                                                                                  | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>quesreg = status.questionable.over_temperature.condition quesreg = status.questionable.over_temperature.enable quesreg = status.questionable.over_temperature.event quesreg = status.questionable.over_temperature.ntr quesreg = status.questionable.over_temperature.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.questionable.over_temperature.enable = quesreg status.questionable.over_temperature.ntr = quesreg status.questionable.over_temperature.ptr = quesreg</pre> <p>Set operreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.questionable.over_temperature.SMUA</td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td>status.questionable.over_temperature.SMUB</td> <td>Sets SMUB bit (B2).</td> </tr> </table> <p>quesreg can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B1 (SMUA), set quesreg to 2 (<math>2^1</math>).</li> <li>To set bit B2 (SMUB), set quesreg to 4 (<math>2^2</math>).</li> <li>To set both bits, set quesreg to the sum of the decimal weights of both bits.</li> <li>To set bits B1 and B2, set quesreg to 6 (<math>2 + 4</math>).</li> </ul> | 0 | Clears all bits. | status.questionable.over_temperature.SMUA | Sets SMUA bit (B1). | status.questionable.over_temperature.SMUB | Sets SMUB bit (B2). |
| 0                                                                                                                                                                                                                                                                      | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                           |                     |                                           |                     |
| status.questionable.over_temperature.SMUA                                                                                                                                                                                                                              | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                           |                     |                                           |                     |
| status.questionable.over_temperature.SMUB                                                                                                                                                                                                                              | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                           |                     |                                           |                     |
| Remarks                                                                                                                                                                                                                                                                | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the questionable status over temperature summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 000000000000110. This value indicates that bit B1 (SMUA) and bit B2 (SMUB) are set.</li> <li>• The used bits of the questionable status over temperature summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, SMUA:</b> Set bit indicates the enabled OTEMP bit for the SMU A questionable register is set.</li> <li>• <b>Bit B2, SMUB:</b> Set bit indicates the enabled OTEMP bit for the SMU B questionable register is set.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                  |   |                  |                                           |                     |                                           |                     |
| Details                                                                                                                                                                                                                                                                | See <a href="#">Questionable Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                  |                                           |                     |                                           |                     |
| Example                                                                                                                                                                                                                                                                | Sets the SMUA bit of the questionable status over temperature summary enable register:<br><pre>status.questionable.over_temperature.enable = status.questionable.over_temperature.SMUA</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                           |                     |                                           |                     |

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| <b>status.questionable.unstable_output.condition</b><br><b>status.questionable.unstable_output.enable</b><br><b>status.questionable.unstable_output.event</b><br><b>status.questionable.unstable_output.ntr</b><br><b>status.questionable.unstable_output.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |                  |                                                       |                     |                                                       |                     |
| Attribute                                                                                                                                                                                                                                                         | Questionable status unstable output summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |                  |                                                       |                     |                                                       |                     |
| Default                                                                                                                                                                                                                                                           | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                  |                                                       |                     |                                                       |                     |
| TSP-Link accessibility                                                                                                                                                                                                                                            | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                                       |                     |                                                       |                     |
| Usage                                                                                                                                                                                                                                                             | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>quesreg = status.questionable.unstable_output.condition quesreg = status.questionable.unstable_output.enable quesreg = status.questionable.unstable_output.event quesreg = status.questionable.unstable_output.ntr quesreg = status.questionable.unstable_output.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.questionable.unstable_output.enable = quesreg status.questionable.unstable_output.ntr = quesreg status.questionable.unstable_output.ptr = quesreg</pre> <p>Set <code>operreg</code> to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td><code>status.questionable.unstable_output.SMUA</code></td> <td>Sets SMUA bit (B1).</td> </tr> <tr> <td><code>status.questionable.unstable_output.SMUB</code></td> <td>Sets SMUB bit (B2).</td> </tr> </table> <p><code>quesreg</code> can also be set to the decimal weight of the bit to be set. Examples:</p> <ul style="list-style-type: none"> <li>To set bit B1 (SMUA), set <code>quesreg</code> to 2 (<math>2^1</math>).</li> <li>To set bit B2 (SMUB), set <code>quesreg</code> to 4 (<math>2^2</math>).</li> <li>To set both bits, set <code>quesreg</code> to the sum of the decimal weights of both bits.</li> <li>To set bits B1 and B2, set <code>quesreg</code> to 6 (<math>2 + 4</math>).</li> </ul> | 0 | Clears all bits. | <code>status.questionable.unstable_output.SMUA</code> | Sets SMUA bit (B1). | <code>status.questionable.unstable_output.SMUB</code> | Sets SMUB bit (B2). |
| 0                                                                                                                                                                                                                                                                 | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                                       |                     |                                                       |                     |
| <code>status.questionable.unstable_output.SMUA</code>                                                                                                                                                                                                             | Sets SMUA bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                                       |                     |                                                       |                     |
| <code>status.questionable.unstable_output.SMUB</code>                                                                                                                                                                                                             | Sets SMUB bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                                       |                     |                                                       |                     |
| Remarks                                                                                                                                                                                                                                                           | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the questionable status unstable output summary registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 6 is returned for the enable register. The binary equivalent is 0000000000000110. This value indicates that bit B1 (SMUA) and bit B2 (SMUB) are set.</li> <li>• The used bits of the questionable status unstable output summary registers are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B1, SMUA:</b> Set bit indicates the enabled UO bit for the SMU A questionable register is set.</li> <li>• <b>Bit B2, SMUB:</b> Set bit indicates the enabled UO bit for the SMU B questionable register is set.</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |                  |                                                       |                     |                                                       |                     |
| Details                                                                                                                                                                                                                                                           | See <a href="#">Questionable Status Register</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                  |                                                       |                     |                                                       |                     |
| Example                                                                                                                                                                                                                                                           | Sets the SMUA bit of the questionable status unstable output summary enable register:<br><pre>status.questionable.unstable_output.enable = status.questionable.unstable_output.SMUA</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |                  |                                                       |                     |                                                       |                     |

| <b>status.request_enable</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------------------|---------------------------------------------|------------------------------|-------------------------|------------------------------|----------------------------------------|------------------------------|-------------------------|------------------------------|-------------------------------------|------------------------------|-------------------------|------------------------------|----------------------------------------------|------------------------------|-------------------------|------------------------------|---------------------------------------|------------------------------|-------------------------|------------------------------|---------------------------------------|------------------------------|-------------------------|------------------------------|-------------------------------------------|------------------------------|-------------------------|------------------------------|
| Attribute                                    | Service request enable register.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| TSP-Link accessibility                       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| Usage                                        | <p>Reads service request enable register:<br/> <code>servenabreg = status.request_enable</code></p> <p>Writes to service request enable register:<br/> <code>status.request_enable = servenabreg</code></p> <p>Set <code>servenabreg</code> to one of the following values:</p> <table border="0"> <tr> <td><code>0</code></td> <td>Clears all bits.</td> </tr> <tr> <td><code>status.MEASUREMENT_SUMMARY_BIT</code></td> <td>Sets (enables) MSB bit (B0).</td> </tr> <tr> <td><code>status.MSB</code></td> <td>Sets (enables) MSB bit (B0).</td> </tr> <tr> <td><code>status.SYSTEM_SUMMARY_BIT</code></td> <td>Sets (enables) SSB bit (B1).</td> </tr> <tr> <td><code>status.SSB</code></td> <td>Sets (enables) SSB bit (B1).</td> </tr> <tr> <td><code>status.ERROR_AVAILABLE</code></td> <td>Sets (enables) EAV bit (B2).</td> </tr> <tr> <td><code>status.EAV</code></td> <td>Sets (enables) EAV bit (B2).</td> </tr> <tr> <td><code>status.QUESTIONABLE_SUMMARY_BIT</code></td> <td>Sets (enables) QSB bit (B3).</td> </tr> <tr> <td><code>status.QSB</code></td> <td>Sets (enables) QSB bit (B3).</td> </tr> <tr> <td><code>status.MESSAGE_AVAILABLE</code></td> <td>Sets (enables) MAV bit (B4).</td> </tr> <tr> <td><code>status.MAV</code></td> <td>Sets (enables) MAV bit (B4).</td> </tr> <tr> <td><code>status.EVENT_SUMMARY_BIT</code></td> <td>Sets (enables) ESB bit (B5).</td> </tr> <tr> <td><code>status.ESB</code></td> <td>Sets (enables) ESB bit (B5).</td> </tr> <tr> <td><code>status.OPERATION_SUMMARY_BIT</code></td> <td>Sets (enables) OSB bit (B7).</td> </tr> <tr> <td><code>status.OSB</code></td> <td>Sets (enables) OSB bit (B7).</td> </tr> </table> <p><code>servenabreg</code> can also be set to the decimal weight of the bit to be set. Examples:<br/> To set bit B0 (MSB), set <code>servenabreg</code> to 1 (<math>2^0</math>).<br/> To set bit B2 (EAV), set <code>servenabreg</code> to 4 (<math>2^2</math>).<br/> To set bit B7 (OSB), set <code>servenabreg</code> to 128 (<math>2^7</math>).<br/> To set more than one bit of the register, set <code>servenabreg</code> to the sum of their decimal weights.<br/> For example, to set bits B0 and B7, set <code>servenabreg</code> to 129 (1 + 128).</p> | <code>0</code> | Clears all bits. | <code>status.MEASUREMENT_SUMMARY_BIT</code> | Sets (enables) MSB bit (B0). | <code>status.MSB</code> | Sets (enables) MSB bit (B0). | <code>status.SYSTEM_SUMMARY_BIT</code> | Sets (enables) SSB bit (B1). | <code>status.SSB</code> | Sets (enables) SSB bit (B1). | <code>status.ERROR_AVAILABLE</code> | Sets (enables) EAV bit (B2). | <code>status.EAV</code> | Sets (enables) EAV bit (B2). | <code>status.QUESTIONABLE_SUMMARY_BIT</code> | Sets (enables) QSB bit (B3). | <code>status.QSB</code> | Sets (enables) QSB bit (B3). | <code>status.MESSAGE_AVAILABLE</code> | Sets (enables) MAV bit (B4). | <code>status.MAV</code> | Sets (enables) MAV bit (B4). | <code>status.EVENT_SUMMARY_BIT</code> | Sets (enables) ESB bit (B5). | <code>status.ESB</code> | Sets (enables) ESB bit (B5). | <code>status.OPERATION_SUMMARY_BIT</code> | Sets (enables) OSB bit (B7). | <code>status.OSB</code> | Sets (enables) OSB bit (B7). |
| <code>0</code>                               | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.MEASUREMENT_SUMMARY_BIT</code>  | Sets (enables) MSB bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.MSB</code>                      | Sets (enables) MSB bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.SYSTEM_SUMMARY_BIT</code>       | Sets (enables) SSB bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.SSB</code>                      | Sets (enables) SSB bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.ERROR_AVAILABLE</code>          | Sets (enables) EAV bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.EAV</code>                      | Sets (enables) EAV bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.QUESTIONABLE_SUMMARY_BIT</code> | Sets (enables) QSB bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.QSB</code>                      | Sets (enables) QSB bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.MESSAGE_AVAILABLE</code>        | Sets (enables) MAV bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.MAV</code>                      | Sets (enables) MAV bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.EVENT_SUMMARY_BIT</code>        | Sets (enables) ESB bit (B5).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.ESB</code>                      | Sets (enables) ESB bit (B5).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.OPERATION_SUMMARY_BIT</code>    | Sets (enables) OSB bit (B7).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| <code>status.OSB</code>                      | Sets (enables) OSB bit (B7).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| Remarks                                      | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the service request enable register.</li> <li>• Reading the service request enable register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 7.</li> <li>• For example, assume value 129 is returned for the service request enable register. The binary equivalent is 10000001. This value indicates that bit B0 (MSB) and bit B7 (OSB) are set.</li> <li>• Assigning a value to this attribute enables one or more status events for service request. When an enabled status event occurs, bit B6 of the status byte sets to generate an SRQ (service request).</li> <li>• The service request enable register uses most of the same summary events as the status byte. Bit B6 (MSS) is not used by the enable register. For details, see <a href="#">status.condition</a> register.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| Details                                      | See <a href="#">Status byte and service request (SRQ)</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |
| Example                                      | Sets the MSB bit of the service request enable register:<br><code>status.request_enable = status.MSB</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                |                  |                                             |                              |                         |                              |                                        |                              |                         |                              |                                     |                              |                         |                              |                                              |                              |                         |                              |                                       |                              |                         |                              |                                       |                              |                         |                              |                                           |                              |                         |                              |

| <b>status.request_event</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                   | Service request event register.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility      | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Usage                       | Reads the service request event register:<br><code>serveventreg = status.request_event</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Remarks                     | <ul style="list-style-type: none"> <li>• These attributes are used to read the service request event register, which is returned as a numeric value. Reading this register returns a value. The binary equivalent of the returned value. The least significant bit of the binary number is bit 0, and the most significant bit is bit 7.</li> <li>• For example, assume value 129 is returned for the event register. The binary equivalent is 10000001. This value indicates that bit B0 (MSB) and bit B7 (OSB) are set.</li> <li>• The service request event register uses most of the same summary events as the status byte. Bit B6 (MSS) is not used by the event register. For details, see <a href="#">status.condition</a>.</li> </ul> |
| Details                     | See <a href="#">Status byte and service request (SRQ)</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Example                     | Reads the service request event register:<br><pre>serveventreg = status.request_event print(serveventreg)</pre> Output: 1.29000e+02<br>The above output indicates that bits B0 (MSS) and B7 (OSB) are set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

| <b>status.reset</b> |                                                                                                                  |
|---------------------|------------------------------------------------------------------------------------------------------------------|
| Function            | Resets all bits set in the status model.                                                                         |
| Usage               | <code>status.reset()</code>                                                                                      |
| Remarks             | This function clears all status data structure registers (enable, event, NTR, and PTR) to their power up states. |
| Details             | See <a href="#">Appendix C</a> .                                                                                 |

|                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|------------------------------------|--------------------|---------------------|--------------------|-----------------------------|--------------------|---------------------|--------------------|----------------------------------------|--------------------|---------------------|--------------------|---------------------------------|--------------------|---------------------|--------------------|-------------------------------|--------------------|---------------------|--------------------|------------------------------|--------------------|---------------------|--------------------|--------------------------|--------------------|---------------------|--------------------|
| <b>status.standard.condition</b><br><b>status.standard.enable</b><br><b>status.standard.event</b><br><b>status.standard.ntr</b><br><b>status.standard.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| Attribute                                                                                                                                                     | Standard event status register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| Default                                                                                                                                                       | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| TSP-Link accessibility                                                                                                                                        | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| Usage                                                                                                                                                         | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>standardreg = status.standard.condition standardreg = status.standard.enable standardreg = status.standard.event standardreg = status.standard.ntr standardreg = status.standard.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.standard.enable = standardreg status.standard.ntr = standardreg status.standard.ptr = standardreg</pre> <p>Set standardreg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.standard.OPERATION_COMPLETE</td> <td>Sets OPC bit (B0).</td> </tr> <tr> <td>status.standard.OPC</td> <td>Sets OPC bit (B0).</td> </tr> <tr> <td>status.standard.QUERY_ERROR</td> <td>Sets QYE bit (B2).</td> </tr> <tr> <td>status.standard.QYE</td> <td>Sets QYE bit (B2).</td> </tr> <tr> <td>status.standard.DEVICE_DEPENDENT_ERROR</td> <td>Sets DDE bit (B3).</td> </tr> <tr> <td>status.standard.DDE</td> <td>Sets DDE bit (B3).</td> </tr> <tr> <td>status.standard.EXECUTION_ERROR</td> <td>Sets EXE bit (B4).</td> </tr> <tr> <td>status.standard.EXE</td> <td>Sets EXE bit (B4).</td> </tr> <tr> <td>status.standard.COMMAND_ERROR</td> <td>Sets CME bit (B5).</td> </tr> <tr> <td>status.standard.CME</td> <td>Sets CME bit (B5).</td> </tr> <tr> <td>status.standard.USER_REQUEST</td> <td>Sets URQ bit (B6).</td> </tr> <tr> <td>status.standard.URQ</td> <td>Sets URQ bit (B6).</td> </tr> <tr> <td>status.standard.POWER_ON</td> <td>Sets PON bit (B7).</td> </tr> <tr> <td>status.standard.PON</td> <td>Sets PON bit (B7).</td> </tr> </table> <p>standardreg can also be set to the decimal weight of the bit to be set. Examples:<br/> To set bit B0 (OPC), set standardreg to 1 (<math>2^0</math>).<br/> To set bit B2 (QYE), set standardreg to 4 (<math>2^2</math>).<br/> To set bit B5 (CME), set standardreg to 32 (<math>2^5</math>).<br/> To set more than one bit of the register, set standardreg to the sum of their decimal weights.<br/> For example, to set bits B0 and B2, set standardreg to 5 (1 + 4).</p> | 0 | Clears all bits. | status.standard.OPERATION_COMPLETE | Sets OPC bit (B0). | status.standard.OPC | Sets OPC bit (B0). | status.standard.QUERY_ERROR | Sets QYE bit (B2). | status.standard.QYE | Sets QYE bit (B2). | status.standard.DEVICE_DEPENDENT_ERROR | Sets DDE bit (B3). | status.standard.DDE | Sets DDE bit (B3). | status.standard.EXECUTION_ERROR | Sets EXE bit (B4). | status.standard.EXE | Sets EXE bit (B4). | status.standard.COMMAND_ERROR | Sets CME bit (B5). | status.standard.CME | Sets CME bit (B5). | status.standard.USER_REQUEST | Sets URQ bit (B6). | status.standard.URQ | Sets URQ bit (B6). | status.standard.POWER_ON | Sets PON bit (B7). | status.standard.PON | Sets PON bit (B7). |
| 0                                                                                                                                                             | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.OPERATION_COMPLETE                                                                                                                            | Sets OPC bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.OPC                                                                                                                                           | Sets OPC bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.QUERY_ERROR                                                                                                                                   | Sets QYE bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.QYE                                                                                                                                           | Sets QYE bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.DEVICE_DEPENDENT_ERROR                                                                                                                        | Sets DDE bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.DDE                                                                                                                                           | Sets DDE bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.EXECUTION_ERROR                                                                                                                               | Sets EXE bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.EXE                                                                                                                                           | Sets EXE bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.COMMAND_ERROR                                                                                                                                 | Sets CME bit (B5).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.CME                                                                                                                                           | Sets CME bit (B5).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.USER_REQUEST                                                                                                                                  | Sets URQ bit (B6).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.URQ                                                                                                                                           | Sets URQ bit (B6).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.POWER_ON                                                                                                                                      | Sets PON bit (B7).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |
| status.standard.PON                                                                                                                                           | Sets PON bit (B7).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                  |                                    |                    |                     |                    |                             |                    |                     |                    |                                        |                    |                     |                    |                                 |                    |                     |                    |                               |                    |                     |                    |                              |                    |                     |                    |                          |                    |                     |                    |

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| Remarks | <ul style="list-style-type: none"> <li>• These attributes are used to read or write to the standard event status registers.</li> <li>• Reading a status register returns a value. The binary equivalent of the returned value indicates which register bits are set. The least significant bit of the binary number is bit 0, and the most significant bit is bit 15.</li> <li>• For example, assume value 9 is returned for the enable register. The binary equivalent is 0000000000001001. This value indicates that bit 0 (OPC) and bit 3 (DDE) are set.</li> <li>• The used bits of the standard event status register are described as follows: <ul style="list-style-type: none"> <li>• <b>Bit B0, Operation Complete (OPC):</b> Set bit indicates that all pending selected instrument operations are completed and the SourceMeter instrument is ready to accept new commands. The bit is set in response to an *OPC command. The ICL function <code>opc ( )</code> can be used in place of the *OPC command. See Appendix C for details on *OPC</li> <li>• <b>Bit B2, Query Error (QYE):</b> Set bit indicates that you attempted to read data from an empty Output Queue.</li> <li>• <b>Bit B3, Device-Dependent Error (DDE):</b> Set bit indicates that an instrument operation did not execute properly due to some internal condition.</li> <li>• <b>Bit B4, Execution Error (EXE):</b> Set bit indicates that the SourceMeter instrument detected an error while trying to execute a command.</li> <li>• <b>Bit B5, Command Error (CME):</b> Set bit indicates that a command error has occurred. Command errors include:<br/>IEEE-488.2 syntax error: SourceMeter instrument received a message that does not follow the defined syntax of the IEEE-488.2 standard.<br/>Semantic error: SourceMeter instrument received a command that was misspelled or received an optional IEEE-488.2 command that is not implemented.<br/>The instrument received a Group Execute Trigger (GET) inside a program message.</li> <li>• <b>Bit B6, User Request (URQ):</b> Set bit indicates that the LOCAL key on the SourceMeter instrument front panel was pressed.</li> <li>• <b>Bit B7, Power ON (PON):</b> Set bit indicates that the SourceMeter instrument has been turned off and turned back on since the last time this register has been read.</li> </ul> </li> </ul> |
| Details | See <a href="#">Standard Event Register</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Example | Sets the PON bit of the standard event status enable register:<br><code>status.standard.enable = status.standard.PON</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |



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| <b>status.system.condition</b><br><b>status.system.enable</b><br><b>status.system.event</b><br><b>status.system.ntr</b><br><b>status.system.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| Attribute                                                                                                                                           | TSP-Link system summary register set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| Default                                                                                                                                             | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| TSP-Link accessibility                                                                                                                              | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| Usage                                                                                                                                               | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>enablereg = status.system.condition enablereg = status.system.enable enablereg = status.system.event enablereg = status.system.ntr enablereg = status.system.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.system.enable = enablereg status.system.ntr = enablereg status.system.ptr = enablereg</pre> <p>Set enablereg to one of the following values:</p> <table> <tr> <td>0</td> <td>Clears all bits</td> </tr> <tr> <td>status.system.EXTENSION_BIT</td> <td>Sets EXT Bit (B0)</td> </tr> <tr> <td>status.system.EXT</td> <td>Sets EXT Bit (B0)</td> </tr> <tr> <td>status.system.NODE1</td> <td>Sets node bit 1 (B1)</td> </tr> <tr> <td>status.system.NODE2</td> <td>Sets node bit 2 (B2)</td> </tr> <tr> <td>status.system.NODE3</td> <td>Sets node bit 3 (B3)</td> </tr> <tr> <td>status.system.NODE4</td> <td>Sets node bit 4 (B4)</td> </tr> <tr> <td>status.system.NODE5</td> <td>Sets node bit 5 (B5)</td> </tr> <tr> <td>status.system.NODE6</td> <td>Sets node bit 6 (B6)</td> </tr> <tr> <td>status.system.NODE7</td> <td>Sets node bit 7 (B7)</td> </tr> <tr> <td>status.system.NODE8</td> <td>Sets node bit 8 (B8)</td> </tr> <tr> <td>status.system.NODE9</td> <td>Sets node bit 9 (B9)</td> </tr> <tr> <td>status.system.NODE10</td> <td>Sets node bit 10 (B10)</td> </tr> <tr> <td>status.system.NODE11</td> <td>Sets node bit 11 (B11)</td> </tr> <tr> <td>status.system.NODE12</td> <td>Sets node bit 12 (B12)</td> </tr> <tr> <td>status.system.NODE13</td> <td>Sets node bit 13 (B13)</td> </tr> <tr> <td>status.system.NODE14</td> <td>Sets node bit 14 (B14)</td> </tr> </table> | 0                 | Clears all bits    | status.system.EXTENSION_BIT | Sets EXT Bit (B0) | status.system.EXT | Sets EXT Bit (B0) | status.system.NODE1 | Sets node bit 1 (B1) | status.system.NODE2 | Sets node bit 2 (B2) | status.system.NODE3 | Sets node bit 3 (B3) | status.system.NODE4 | Sets node bit 4 (B4) | status.system.NODE5 | Sets node bit 5 (B5) | status.system.NODE6 | Sets node bit 6 (B6) | status.system.NODE7 | Sets node bit 7 (B7) | status.system.NODE8 | Sets node bit 8 (B8) | status.system.NODE9 | Sets node bit 9 (B9) | status.system.NODE10 | Sets node bit 10 (B10) | status.system.NODE11 | Sets node bit 11 (B11) | status.system.NODE12 | Sets node bit 12 (B12) | status.system.NODE13 | Sets node bit 13 (B13) | status.system.NODE14 | Sets node bit 14 (B14) |
| 0                                                                                                                                                   | Clears all bits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.EXTENSION_BIT                                                                                                                         | Sets EXT Bit (B0)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.EXT                                                                                                                                   | Sets EXT Bit (B0)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE1                                                                                                                                 | Sets node bit 1 (B1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE2                                                                                                                                 | Sets node bit 2 (B2)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE3                                                                                                                                 | Sets node bit 3 (B3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE4                                                                                                                                 | Sets node bit 4 (B4)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE5                                                                                                                                 | Sets node bit 5 (B5)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE6                                                                                                                                 | Sets node bit 6 (B6)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE7                                                                                                                                 | Sets node bit 7 (B7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE8                                                                                                                                 | Sets node bit 8 (B8)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE9                                                                                                                                 | Sets node bit 9 (B9)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE10                                                                                                                                | Sets node bit 10 (B10)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE11                                                                                                                                | Sets node bit 11 (B11)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE12                                                                                                                                | Sets node bit 12 (B12)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE13                                                                                                                                | Sets node bit 13 (B13)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| status.system.NODE14                                                                                                                                | Sets node bit 14 (B14)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| Remarks                                                                                                                                             | <ul style="list-style-type: none"> <li>In an expanded system (TSP-Link), These attributes are used to read or write to the system summary registers.</li> <li>Reading a system summary register returns a numeric value whose binary equivalent indicates which register bits are set. The bits of the system summary register are identified as follows: <table> <tr> <td>Bit B0 - EXT bit</td> <td>Bit B4 - Node 4</td> <td>Bit B8 - Node 8</td> <td>Bit B12 - Node 12</td> </tr> <tr> <td>Bit B1 - Node 1</td> <td>Bit B5 - Node 5</td> <td>Bit B9 - Node 9</td> <td>Bit B13 - Node 13</td> </tr> <tr> <td>Bit B2 - Node 2</td> <td>Bit B6 - Node 6</td> <td>Bit B10 - Node 10</td> <td>Bit B14 - Node 14</td> </tr> <tr> <td>Bit B3 - Node 3</td> <td>Bit B7 - Node 7</td> <td>Bit B11 - Node 11</td> <td>Bit B15 - Not used</td> </tr> </table> </li> <li>For example, assume the value 9 is returned for the enable register. The binary equivalent is 0000000000001001. This value indicates that bit 0 (EXT) and bit 3 (Node 3) are set.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Bit B0 - EXT bit  | Bit B4 - Node 4    | Bit B8 - Node 8             | Bit B12 - Node 12 | Bit B1 - Node 1   | Bit B5 - Node 5   | Bit B9 - Node 9     | Bit B13 - Node 13    | Bit B2 - Node 2     | Bit B6 - Node 6      | Bit B10 - Node 10   | Bit B14 - Node 14    | Bit B3 - Node 3     | Bit B7 - Node 7      | Bit B11 - Node 11   | Bit B15 - Not used   |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| Bit B0 - EXT bit                                                                                                                                    | Bit B4 - Node 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Bit B8 - Node 8   | Bit B12 - Node 12  |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| Bit B1 - Node 1                                                                                                                                     | Bit B5 - Node 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Bit B9 - Node 9   | Bit B13 - Node 13  |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| Bit B2 - Node 2                                                                                                                                     | Bit B6 - Node 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Bit B10 - Node 10 | Bit B14 - Node 14  |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| Bit B3 - Node 3                                                                                                                                     | Bit B7 - Node 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Bit B11 - Node 11 | Bit B15 - Not used |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| Details                                                                                                                                             | See <a href="#">System Summary Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| Also see                                                                                                                                            | <a href="#">status.system2</a> , <a href="#">status.system3</a> , <a href="#">status.system4</a> , <a href="#">status.system5</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |
| Example                                                                                                                                             | <p>Sets the extension bit of the system summary enable register:</p> <pre>status.system.enable = status.system.EXT</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                    |                             |                   |                   |                   |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                     |                      |                      |                        |                      |                        |                      |                        |                      |                        |                      |                        |

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| <b>status.system2.condition</b><br><b>status.system2.enable</b><br><b>status.system2.event</b><br><b>status.system2.ntr</b><br><b>status.system2.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Attribute                                                                                                                                                | TSP-Link system summary register 2 set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Default                                                                                                                                                  | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| TSP-Link accessibility                                                                                                                                   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Usage                                                                                                                                                    | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>enablereg = status.system2.condition enablereg = status.system2.enable enablereg = status.system2.event enablereg = status.system2.ntr enablereg = status.system2.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.system2.enable = enablereg status.system2.ntr = enablereg status.system2.ptr = enablereg</pre> <p>Set enablereg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.system2.EXTENSION_BIT</td> <td>Sets EXT bit (B0).</td> </tr> <tr> <td>status.system2.EXT</td> <td>Sets EXT bit (B0).</td> </tr> <tr> <td>status.system2.NODE15</td> <td>Sets node bit (B1)</td> </tr> <tr> <td>status.system2.NODE16</td> <td>Sets node bit (B2)</td> </tr> <tr> <td>status.system2.NODE17</td> <td>Sets node bit (B3)</td> </tr> <tr> <td>status.system2.NODE18</td> <td>Sets node bit (B4)</td> </tr> <tr> <td>status.system2.NODE19</td> <td>Sets node bit (B5)</td> </tr> <tr> <td>status.system2.NODE20</td> <td>Sets node bit (B6)</td> </tr> <tr> <td>status.system2.NODE21</td> <td>Sets node bit (B7)</td> </tr> <tr> <td>status.system2.NODE22</td> <td>Sets node bit (B8)</td> </tr> <tr> <td>status.system2.NODE23</td> <td>Sets node bit (B9)</td> </tr> <tr> <td>status.system2.NODE24</td> <td>Sets node bit (B10)</td> </tr> <tr> <td>status.system2.NODE25</td> <td>Sets node bit (B11)</td> </tr> <tr> <td>status.system2.NODE26</td> <td>Sets node bit (B12)</td> </tr> <tr> <td>status.system2.NODE27</td> <td>Sets node bit (B13)</td> </tr> <tr> <td>status.system2.NODE28</td> <td>Sets node bit (B14)</td> </tr> </table> | 0                 | Clears all bits.   | status.system2.EXTENSION_BIT | Sets EXT bit (B0). | status.system2.EXT | Sets EXT bit (B0). | status.system2.NODE15 | Sets node bit (B1) | status.system2.NODE16 | Sets node bit (B2) | status.system2.NODE17 | Sets node bit (B3) | status.system2.NODE18 | Sets node bit (B4) | status.system2.NODE19 | Sets node bit (B5) | status.system2.NODE20 | Sets node bit (B6) | status.system2.NODE21 | Sets node bit (B7) | status.system2.NODE22 | Sets node bit (B8) | status.system2.NODE23 | Sets node bit (B9) | status.system2.NODE24 | Sets node bit (B10) | status.system2.NODE25 | Sets node bit (B11) | status.system2.NODE26 | Sets node bit (B12) | status.system2.NODE27 | Sets node bit (B13) | status.system2.NODE28 | Sets node bit (B14) |
| 0                                                                                                                                                        | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.EXTENSION_BIT                                                                                                                             | Sets EXT bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.EXT                                                                                                                                       | Sets EXT bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE15                                                                                                                                    | Sets node bit (B1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE16                                                                                                                                    | Sets node bit (B2)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE17                                                                                                                                    | Sets node bit (B3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE18                                                                                                                                    | Sets node bit (B4)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE19                                                                                                                                    | Sets node bit (B5)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE20                                                                                                                                    | Sets node bit (B6)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE21                                                                                                                                    | Sets node bit (B7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE22                                                                                                                                    | Sets node bit (B8)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE23                                                                                                                                    | Sets node bit (B9)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE24                                                                                                                                    | Sets node bit (B10)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE25                                                                                                                                    | Sets node bit (B11)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE26                                                                                                                                    | Sets node bit (B12)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE27                                                                                                                                    | Sets node bit (B13)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system2.NODE28                                                                                                                                    | Sets node bit (B14)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Remarks                                                                                                                                                  | <ul style="list-style-type: none"> <li>In an expanded system (TSP-Link), These attributes are used to read or write to the system summary register 2 registers.</li> <li>Reading system summary register 2 returns a numeric value whose binary equivalent indicates which register bits are set. The bits of system summary register 2 are identified as follows: <table border="0"> <tr> <td>Bit B0 - EXT bit</td> <td>Bit B4 - Node 18</td> <td>Bit B8 - Node 22</td> <td>Bit B12 - Node 26</td> </tr> <tr> <td>Bit B1 - Node 15</td> <td>Bit B5 - Node 19</td> <td>Bit B9 - Node 23</td> <td>Bit B13 - Node 27</td> </tr> <tr> <td>Bit B2 - Node 16</td> <td>Bit B6 - Node 20</td> <td>Bit B10 - Node 24</td> <td>Bit B14 - Node 28</td> </tr> <tr> <td>Bit B3 - Node 17</td> <td>Bit B7 - Node 21</td> <td>Bit B11 - Node 25</td> <td>Bit B15 - Not used</td> </tr> </table> </li> <li>For example, assume value 9 is returned for the enable register. The binary equivalent is 000000000001001. This value indicates that bit 0 (EXT) and bit 3 (Node 17) are set.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Bit B0 - EXT bit  | Bit B4 - Node 18   | Bit B8 - Node 22             | Bit B12 - Node 26  | Bit B1 - Node 15   | Bit B5 - Node 19   | Bit B9 - Node 23      | Bit B13 - Node 27  | Bit B2 - Node 16      | Bit B6 - Node 20   | Bit B10 - Node 24     | Bit B14 - Node 28  | Bit B3 - Node 17      | Bit B7 - Node 21   | Bit B11 - Node 25     | Bit B15 - Not used |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Bit B0 - EXT bit                                                                                                                                         | Bit B4 - Node 18                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Bit B8 - Node 22  | Bit B12 - Node 26  |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Bit B1 - Node 15                                                                                                                                         | Bit B5 - Node 19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Bit B9 - Node 23  | Bit B13 - Node 27  |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Bit B2 - Node 16                                                                                                                                         | Bit B6 - Node 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Bit B10 - Node 24 | Bit B14 - Node 28  |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Bit B3 - Node 17                                                                                                                                         | Bit B7 - Node 21                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Bit B11 - Node 25 | Bit B15 - Not used |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Details                                                                                                                                                  | See <a href="#">System Summary Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Also see                                                                                                                                                 | <a href="#">status.system</a> , <a href="#">status.system3</a> , <a href="#">status.system4</a> , <a href="#">status.system5</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Example                                                                                                                                                  | Sets the extension bit of the system summary register 2 enable register:<br><pre>status.system2.enable = status.system2.EXT</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |

| <b>status.system3.condition</b><br><b>status.system3.enable</b><br><b>status.system3.event</b><br><b>status.system3.ntr</b><br><b>status.system3.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
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| Attribute                                                                                                                                                | TSP-Link system summary register 3 set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Default                                                                                                                                                  | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| TSP-Link accessibility                                                                                                                                   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Usage                                                                                                                                                    | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>enablereg = status.system3.condition enablereg = status.system3.enable enablereg = status.system3.event enablereg = status.system3.ntr enablereg = status.system3.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.system3.enable = enablereg status.system3.ntr = enablereg status.system3.ptr = enablereg</pre> <p>Set enablereg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.system3.EXTENSION_BIT</td> <td>Sets EXT bit (B0).</td> </tr> <tr> <td>status.system3.EXT</td> <td>Sets EXT bit (B0).</td> </tr> <tr> <td>status.system3.NODE29</td> <td>Sets node bit (B1)</td> </tr> <tr> <td>status.system3.NODE30</td> <td>Sets node bit (B2)</td> </tr> <tr> <td>status.system3.NODE31</td> <td>Sets node bit (B3)</td> </tr> <tr> <td>status.system3.NODE32</td> <td>Sets node bit (B4)</td> </tr> <tr> <td>status.system3.NODE33</td> <td>Sets node bit (B5)</td> </tr> <tr> <td>status.system3.NODE34</td> <td>Sets node bit (B6)</td> </tr> <tr> <td>status.system3.NODE35</td> <td>Sets node bit (B7)</td> </tr> <tr> <td>status.system3.NODE36</td> <td>Sets node bit (B8)</td> </tr> <tr> <td>status.system3.NODE37</td> <td>Sets node bit (B9)</td> </tr> <tr> <td>status.system3.NODE38</td> <td>Sets node bit (B10)</td> </tr> <tr> <td>status.system3.NODE39</td> <td>Sets node bit (B11)</td> </tr> <tr> <td>status.system3.NODE40</td> <td>Sets node bit (B12)</td> </tr> <tr> <td>status.system3.NODE41</td> <td>Sets node bit (B13)</td> </tr> <tr> <td>status.system3.NODE42</td> <td>Sets node bit (B14)</td> </tr> </table> | 0                 | Clears all bits.   | status.system3.EXTENSION_BIT | Sets EXT bit (B0). | status.system3.EXT | Sets EXT bit (B0). | status.system3.NODE29 | Sets node bit (B1) | status.system3.NODE30 | Sets node bit (B2) | status.system3.NODE31 | Sets node bit (B3) | status.system3.NODE32 | Sets node bit (B4) | status.system3.NODE33 | Sets node bit (B5) | status.system3.NODE34 | Sets node bit (B6) | status.system3.NODE35 | Sets node bit (B7) | status.system3.NODE36 | Sets node bit (B8) | status.system3.NODE37 | Sets node bit (B9) | status.system3.NODE38 | Sets node bit (B10) | status.system3.NODE39 | Sets node bit (B11) | status.system3.NODE40 | Sets node bit (B12) | status.system3.NODE41 | Sets node bit (B13) | status.system3.NODE42 | Sets node bit (B14) |
| 0                                                                                                                                                        | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.EXTENSION_BIT                                                                                                                             | Sets EXT bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.EXT                                                                                                                                       | Sets EXT bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE29                                                                                                                                    | Sets node bit (B1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE30                                                                                                                                    | Sets node bit (B2)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE31                                                                                                                                    | Sets node bit (B3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE32                                                                                                                                    | Sets node bit (B4)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE33                                                                                                                                    | Sets node bit (B5)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE34                                                                                                                                    | Sets node bit (B6)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE35                                                                                                                                    | Sets node bit (B7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE36                                                                                                                                    | Sets node bit (B8)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE37                                                                                                                                    | Sets node bit (B9)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE38                                                                                                                                    | Sets node bit (B10)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE39                                                                                                                                    | Sets node bit (B11)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE40                                                                                                                                    | Sets node bit (B12)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE41                                                                                                                                    | Sets node bit (B13)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| status.system3.NODE42                                                                                                                                    | Sets node bit (B14)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Remarks                                                                                                                                                  | <ul style="list-style-type: none"> <li>In an expanded system (TSP-Link), These attributes are used to read or write to the system summary register 3 registers.</li> <li>Reading a system summary register 3 register returns a numeric value whose binary equivalent indicates which register bits are set. The bits of the system summary register 3 register are identified as follows: <table border="0"> <tr> <td>Bit B0 - EXT bit</td> <td>Bit B4 - Node 32</td> <td>Bit B8 - Node 36</td> <td>Bit B12 - Node 40</td> </tr> <tr> <td>Bit B1 - Node 29</td> <td>Bit B5 - Node 33</td> <td>Bit B9 - Node 37</td> <td>Bit B13 - Node 41</td> </tr> <tr> <td>Bit B2 - Node 30</td> <td>Bit B6 - Node 34</td> <td>Bit B10 - Node 38</td> <td>Bit B14 - Node 42</td> </tr> <tr> <td>Bit B3 - Node 31</td> <td>Bit B7 - Node 35</td> <td>Bit B11 - Node 39</td> <td>Bit B15 - Not used</td> </tr> </table> </li> <li>For example, assume value 9 is returned for the enable register. The binary equivalent is 0000000000001001. This value indicates that bit 0 (EXT) and bit 3 (Node 31) are set.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Bit B0 - EXT bit  | Bit B4 - Node 32   | Bit B8 - Node 36             | Bit B12 - Node 40  | Bit B1 - Node 29   | Bit B5 - Node 33   | Bit B9 - Node 37      | Bit B13 - Node 41  | Bit B2 - Node 30      | Bit B6 - Node 34   | Bit B10 - Node 38     | Bit B14 - Node 42  | Bit B3 - Node 31      | Bit B7 - Node 35   | Bit B11 - Node 39     | Bit B15 - Not used |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Bit B0 - EXT bit                                                                                                                                         | Bit B4 - Node 32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Bit B8 - Node 36  | Bit B12 - Node 40  |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Bit B1 - Node 29                                                                                                                                         | Bit B5 - Node 33                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Bit B9 - Node 37  | Bit B13 - Node 41  |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Bit B2 - Node 30                                                                                                                                         | Bit B6 - Node 34                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Bit B10 - Node 38 | Bit B14 - Node 42  |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Bit B3 - Node 31                                                                                                                                         | Bit B7 - Node 35                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Bit B11 - Node 39 | Bit B15 - Not used |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Details                                                                                                                                                  | See <a href="#">System Summary Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Also see                                                                                                                                                 | <a href="#">status.system</a> , <a href="#">status.system2</a> , <a href="#">status.system4</a> , <a href="#">status.system5</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |
| Example                                                                                                                                                  | Sets the extension bit of the system summary register 3 enable register:<br><pre>status.system3.enable = status.system3.EXT</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |                    |                              |                    |                    |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |

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| <b>status.system4.condition</b><br><b>status.system4.enable</b><br><b>status.system4.event</b><br><b>status.system4.ntr</b><br><b>status.system4.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| Attribute                                                                                                                                                | TSP-Link system summary register 4 set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| Default                                                                                                                                                  | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| TSP-Link accessibility                                                                                                                                   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| Usage                                                                                                                                                    | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>enablereg = status.system4.condition enablereg = status.system4.enable enablereg = status.system4.event enablereg = status.system4.ntr enablereg = status.system4.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.system4.enable = enablereg status.system4.ntr = enablereg status.system4.ptr = enablereg</pre> <p>Set enablereg to one of the following values:</p> <table border="0"> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.system4.EXTENSION_BIT</td> <td>Sets EXT bit (B0).</td> </tr> <tr> <td>status.system4.EXT</td> <td>Sets EXT bit (B0).</td> </tr> <tr> <td>status.system4.NODE43</td> <td>Sets node bit (B1).</td> </tr> <tr> <td>status.system4.NODE44</td> <td>Sets node bit (B2).</td> </tr> <tr> <td>status.system4.NODE45</td> <td>Sets node bit (B3).</td> </tr> <tr> <td>status.system4.NODE46</td> <td>Sets node bit (B4).</td> </tr> <tr> <td>status.system4.NODE47</td> <td>Sets node bit (B5).</td> </tr> <tr> <td>status.system4.NODE48</td> <td>Sets node bit (B6).</td> </tr> <tr> <td>status.system4.NODE49</td> <td>Sets node bit (B7).</td> </tr> <tr> <td>status.system4.NODE50</td> <td>Sets node bit (B8).</td> </tr> <tr> <td>status.system4.NODE51</td> <td>Sets node bit (B9).</td> </tr> <tr> <td>status.system4.NODE52</td> <td>Sets node bit (B10).</td> </tr> <tr> <td>status.system4.NODE53</td> <td>Sets node bit (B11).</td> </tr> <tr> <td>status.system4.NODE54</td> <td>Sets node bit (B12).</td> </tr> <tr> <td>status.system4.NODE55</td> <td>Sets node bit (B13).</td> </tr> <tr> <td>status.system4.NODE56</td> <td>Sets node bit (B14).</td> </tr> </table> | 0                 | Clears all bits.   | status.system4.EXTENSION_BIT | Sets EXT bit (B0). | status.system4.EXT | Sets EXT bit (B0). | status.system4.NODE43 | Sets node bit (B1). | status.system4.NODE44 | Sets node bit (B2). | status.system4.NODE45 | Sets node bit (B3). | status.system4.NODE46 | Sets node bit (B4). | status.system4.NODE47 | Sets node bit (B5). | status.system4.NODE48 | Sets node bit (B6). | status.system4.NODE49 | Sets node bit (B7). | status.system4.NODE50 | Sets node bit (B8). | status.system4.NODE51 | Sets node bit (B9). | status.system4.NODE52 | Sets node bit (B10). | status.system4.NODE53 | Sets node bit (B11). | status.system4.NODE54 | Sets node bit (B12). | status.system4.NODE55 | Sets node bit (B13). | status.system4.NODE56 | Sets node bit (B14). |
| 0                                                                                                                                                        | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.EXTENSION_BIT                                                                                                                             | Sets EXT bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.EXT                                                                                                                                       | Sets EXT bit (B0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE43                                                                                                                                    | Sets node bit (B1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE44                                                                                                                                    | Sets node bit (B2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE45                                                                                                                                    | Sets node bit (B3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE46                                                                                                                                    | Sets node bit (B4).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE47                                                                                                                                    | Sets node bit (B5).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE48                                                                                                                                    | Sets node bit (B6).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE49                                                                                                                                    | Sets node bit (B7).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE50                                                                                                                                    | Sets node bit (B8).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE51                                                                                                                                    | Sets node bit (B9).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE52                                                                                                                                    | Sets node bit (B10).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE53                                                                                                                                    | Sets node bit (B11).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE54                                                                                                                                    | Sets node bit (B12).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE55                                                                                                                                    | Sets node bit (B13).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| status.system4.NODE56                                                                                                                                    | Sets node bit (B14).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| Remarks                                                                                                                                                  | <ul style="list-style-type: none"> <li>In an expanded system (TSP-Link), These attributes are used to read or write to the system summary register 4 registers.</li> <li>Reading a system summary register 4 register returns a numeric value whose binary equivalent indicates which register bits are set. The bits of the system summary register 4 register are identified as follows: <table border="0"> <tr> <td>Bit B0 - EXT bit</td> <td>Bit B4 - Node 46</td> <td>Bit B8 - Node 50</td> <td>Bit B12 - Node 54</td> </tr> <tr> <td>Bit B1 - Node 43</td> <td>Bit B5 - Node 47</td> <td>Bit B9 - Node 51</td> <td>Bit B13 - Node 55</td> </tr> <tr> <td>Bit B2 - Node 44</td> <td>Bit B6 - Node 48</td> <td>Bit B10 - Node 52</td> <td>Bit B14 - Node 56</td> </tr> <tr> <td>Bit B3 - Node 45</td> <td>Bit B7 - Node 49</td> <td>Bit B11 - Node 53</td> <td>Bit B15 - Not used</td> </tr> </table> </li> <li>For example, assume value 9 is returned for the enable register. The binary equivalent is 000000000001001. This value indicates that bit 0 (EXT) and bit 3 (Node 45) are set.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Bit B0 - EXT bit  | Bit B4 - Node 46   | Bit B8 - Node 50             | Bit B12 - Node 54  | Bit B1 - Node 43   | Bit B5 - Node 47   | Bit B9 - Node 51      | Bit B13 - Node 55   | Bit B2 - Node 44      | Bit B6 - Node 48    | Bit B10 - Node 52     | Bit B14 - Node 56   | Bit B3 - Node 45      | Bit B7 - Node 49    | Bit B11 - Node 53     | Bit B15 - Not used  |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| Bit B0 - EXT bit                                                                                                                                         | Bit B4 - Node 46                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Bit B8 - Node 50  | Bit B12 - Node 54  |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| Bit B1 - Node 43                                                                                                                                         | Bit B5 - Node 47                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Bit B9 - Node 51  | Bit B13 - Node 55  |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| Bit B2 - Node 44                                                                                                                                         | Bit B6 - Node 48                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Bit B10 - Node 52 | Bit B14 - Node 56  |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| Bit B3 - Node 45                                                                                                                                         | Bit B7 - Node 49                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Bit B11 - Node 53 | Bit B15 - Not used |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| Details                                                                                                                                                  | See <a href="#">System Summary Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| Also see                                                                                                                                                 | <a href="#">status.system</a> , <a href="#">status.system2</a> , <a href="#">status.system3</a> , <a href="#">status.system5</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |
| Example                                                                                                                                                  | Sets the extension bit of the system summary register 4 enable register:<br><pre>status.system4.enable = status.system4.EXT</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                    |                              |                    |                    |                    |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                     |                       |                      |                       |                      |                       |                      |                       |                      |                       |                      |

| <b>status.system5.condition</b><br><b>status.system5.enable</b><br><b>status.system5.event</b><br><b>status.system5.ntr</b><br><b>status.system5.ptr</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|------------------|-----------------------|--------------------|-----------------------|-----------------------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|
| Attribute                                                                                                                                                | TSP-Link system summary register 5 set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| Default                                                                                                                                                  | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| TSP-Link accessibility                                                                                                                                   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| Usage                                                                                                                                                    | <p>Reads condition, enable, event, NTR, and PTR registers:</p> <pre>enablereg = status.system5.condition enablereg = status.system5.enable enablereg = status.system5.event enablereg = status.system5.ntr enablereg = status.system5.ptr</pre> <p>Writes to enable, NTR, and PTR registers:</p> <pre>status.system5.enable = enablereg status.system5.ntr = enablereg status.system5.ptr = enablereg</pre> <p>Set enablereg to one of the following values:</p> <table> <tr> <td>0</td> <td>Clears all bits.</td> </tr> <tr> <td>status.system5.NODE57</td> <td>Sets node bit (B1)</td> </tr> <tr> <td>status.system5.NODE58</td> <td>Sets node bit (B2)</td> </tr> <tr> <td>status.system5.NODE59</td> <td>Sets node bit (B3)</td> </tr> <tr> <td>status.system5.NODE60</td> <td>Sets node bit (B4)</td> </tr> <tr> <td>status.system5.NODE61</td> <td>Sets node bit (B5)</td> </tr> <tr> <td>status.system5.NODE62</td> <td>Sets node bit (B6)</td> </tr> <tr> <td>status.system5.NODE63</td> <td>Sets node bit (B7)</td> </tr> <tr> <td>status.system5.NODE64</td> <td>Sets node bit (B8)</td> </tr> </table> | 0                                 | Clears all bits. | status.system5.NODE57 | Sets node bit (B1) | status.system5.NODE58 | Sets node bit (B2)                | status.system5.NODE59 | Sets node bit (B3) | status.system5.NODE60 | Sets node bit (B4) | status.system5.NODE61 | Sets node bit (B5) | status.system5.NODE62 | Sets node bit (B6) | status.system5.NODE63 | Sets node bit (B7) | status.system5.NODE64 | Sets node bit (B8) |
| 0                                                                                                                                                        | Clears all bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| status.system5.NODE57                                                                                                                                    | Sets node bit (B1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| status.system5.NODE58                                                                                                                                    | Sets node bit (B2)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| status.system5.NODE59                                                                                                                                    | Sets node bit (B3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| status.system5.NODE60                                                                                                                                    | Sets node bit (B4)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| status.system5.NODE61                                                                                                                                    | Sets node bit (B5)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| status.system5.NODE62                                                                                                                                    | Sets node bit (B6)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| status.system5.NODE63                                                                                                                                    | Sets node bit (B7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| status.system5.NODE64                                                                                                                                    | Sets node bit (B8)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| Remarks                                                                                                                                                  | <ul style="list-style-type: none"> <li>In an expanded system (TSP-Link), These attributes are used to read or write to the system summary register 5 registers.</li> <li>Reading a system summary register returns a numeric value whose binary equivalent indicates which register bits are set. The bits of the system summary register 5 register are identified as follows: <table> <tr> <td>Bit B0 - Not used</td> <td>Bit B4 - Node 60</td> <td>Bit B8 - Node 64</td> </tr> <tr> <td>Bit B1 - Node 57</td> <td>Bit B5 - Node 61</td> <td>Bit B9 through Bit B15 - Not used</td> </tr> <tr> <td>Bit B2 - Node 58</td> <td>Bit B6 - Node 62</td> <td></td> </tr> <tr> <td>Bit B3 - Node 59</td> <td>Bit B7 - Node 63</td> <td></td> </tr> </table> </li> <li>For example, assume value 9 is returned for the enable register. The binary equivalent is 0000000000001010. This value indicates that bit 1 (Node 57) and bit 3 (Node 59) are set.</li> </ul>                                                                                                                                                    | Bit B0 - Not used                 | Bit B4 - Node 60 | Bit B8 - Node 64      | Bit B1 - Node 57   | Bit B5 - Node 61      | Bit B9 through Bit B15 - Not used | Bit B2 - Node 58      | Bit B6 - Node 62   |                       | Bit B3 - Node 59   | Bit B7 - Node 63      |                    |                       |                    |                       |                    |                       |                    |
| Bit B0 - Not used                                                                                                                                        | Bit B4 - Node 60                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Bit B8 - Node 64                  |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| Bit B1 - Node 57                                                                                                                                         | Bit B5 - Node 61                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Bit B9 through Bit B15 - Not used |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| Bit B2 - Node 58                                                                                                                                         | Bit B6 - Node 62                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| Bit B3 - Node 59                                                                                                                                         | Bit B7 - Node 63                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| Details                                                                                                                                                  | See <a href="#">System Summary Event Registers</a> in <a href="#">Appendix C</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| Also see                                                                                                                                                 | <a href="#">status.system</a> , <a href="#">status.system2</a> , <a href="#">status.system3</a> , <a href="#">status.system4</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |
| Example                                                                                                                                                  | Sets the NODE57 bit of the system summary register 5 enable register:<br><pre>status.system5.enable = status.system5.NODE57</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                   |                  |                       |                    |                       |                                   |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |                       |                    |

## timer

The functions in this group are used for the timer. The timer can be used to measure the time it takes to perform various operations. Use the `timer.reset` function at the beginning of an

operation to reset the timer to zero, and then use the `timer.measure.t` at the end of the operation to measure the elapsed time.

| <b>timer.measure.t</b> |                                                                                                                                                                                                                                                                                          |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Measures the elapsed time since the timer was last reset.                                                                                                                                                                                                                                |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                               |
| Usage                  | <code>time = timer.measure.t()</code><br><code>time</code> Returns the elapsed time in seconds (1µs resolution).                                                                                                                                                                         |
| Remarks                | <ul style="list-style-type: none"> <li>This function returns the elapsed time in seconds since the timer was reset.</li> </ul>                                                                                                                                                           |
| Also see               | <a href="#">timer.reset</a>                                                                                                                                                                                                                                                              |
| Example                | Resets the timer and then measures the time since the reset:<br><pre>timer.reset() ... time = timer.measure.t() print(time) Output: 1.469077e+01</pre> <p>The above output indicates that <code>timer.measure.t</code> was executed 14.69077 seconds after <code>timer.reset</code>.</p> |

| <b>timer.reset</b>     |                                                                                                                                                                                                                                                                                          |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Resets the timer to 0 seconds.                                                                                                                                                                                                                                                           |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                               |
| Usage                  | <code>timer.reset()</code>                                                                                                                                                                                                                                                               |
| Remarks                | This function will restart the timer at zero.                                                                                                                                                                                                                                            |
| Also see               | <a href="#">timer.measure.t</a>                                                                                                                                                                                                                                                          |
| Example                | Resets the timer and then measures the time since the reset:<br><pre>timer.reset() ... time = timer.measure.t() print(time) Output: 1.469077e+01</pre> <p>The above output indicates that <code>timer.measure.t</code> was executed 14.69077 seconds after <code>timer.reset</code>.</p> |

## trigger

Use the functions and attributes to control specific trigger objects.

| <b>trigger.blender[N].clear</b> <span style="float: right;">Replace N with the values 1-4</span> |                                                                                                                                                                                    |
|--------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                                                                                         | Clears the blender event detector and overrun indicator.                                                                                                                           |
| TSP-Link accessibility                                                                           | This function can be accessed from a remote TSP-Link node.                                                                                                                         |
| Usage                                                                                            | <code>trigger.blender[n].clear()</code><br><br>n <span style="float: right;">Blender number.</span>                                                                                |
| Remarks                                                                                          | <ul style="list-style-type: none"> <li>This function will set the blender event detector to the undetected state and will reset the event detector's overrun indicator.</li> </ul> |

| <b>trigger.blender[N].EVENT_ID</b> <span style="float: right;">Replace N with the values 1-4</span> |                                                                                                                                                                                                |
|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                           | The trigger blender event number.                                                                                                                                                              |
| TSP-Link accessibility                                                                              | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                    |
| Usage                                                                                               | <code>event_id = trigger.blender[n].EVENT_ID</code><br><br>event_id <span style="float: right;">Trigger event number.</span><br>n <span style="float: right;">Blender number.</span>           |
| Remarks                                                                                             | <ul style="list-style-type: none"> <li>Set the stimulus of any trigger event detector to the value of this constant to have it respond to trigger events from this trigger blender.</li> </ul> |

| <b>trigger.blender[N].orenable</b> <span style="float: right;">Replace N with the values 1-4</span> |                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                           | Selects whether the blender operates in OR-mode or AND-mode.                                                                                                                                                                                                                                                                              |
| Default                                                                                             | false                                                                                                                                                                                                                                                                                                                                     |
| TSP-Link accessibility                                                                              | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                               |
| Usage                                                                                               | <code>orenable = trigger.blender[n].orenable -- Reads blender mode.</code><br><code>trigger.blender[n].orenable = orenable -- Writes blender mode.</code><br><br>n <span style="float: right;">Blender number.</span><br>orenable <span style="float: right;">OR enable selection.</span>                                                 |
| Remarks                                                                                             | <ul style="list-style-type: none"> <li>This attribute selects whether the blender will wait for any one event (the "OR" mode) or will wait for all selected events (the "AND" mode) before signaling an output event.</li> <li>Set this attribute to <code>true</code> for OR-mode. Set it to <code>false</code> for AND-mode.</li> </ul> |

| <b>trigger.blender[N].overrun</b> <span style="float: right;">Replace N with the values 1-4</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                          | Indicates whether an event was ignored because of the event detector state.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| TSP-Link accessibility                                                                             | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Usage                                                                                              | <pre>overrun = trigger.blender[n].overrun</pre> <p>n                                      Event blender number.<br/>overrun                                Trigger overrun state.</p>                                                                                                                                                                                                                                                                                                                                         |
| Remarks                                                                                            | <ul style="list-style-type: none"> <li>• A read-only attribute that indicates if an event was ignored because the event detector was already in the detected state when the event occurred.</li> <li>• This is an indication of the state of the event detector built into the event blender itself.</li> <li>• It does not indicate if an overrun occurred in any other part of the trigger model or in any other trigger object that is monitoring the event. It also is not an indication of an action overrun.</li> </ul> |

| <b>trigger.blender[N].stimulus[M]</b> <span style="float: right;">Replace N with the values 1-4<br/>Replace M with the values 1-4</span> |                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                                                                | Selects which events will trigger the blender.                                                                                                                                                                                                                                                                                                                                          |
| Default                                                                                                                                  | 0                                                                                                                                                                                                                                                                                                                                                                                       |
| TSP-Link accessibility                                                                                                                   | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                             |
| Usage                                                                                                                                    | <pre>eventid = trigger.blender[n].stimulus[m] -- Reads blender trigger.</pre> <pre>trigger.blender[n].stimulus[m] = eventid -- Writes blender trigger.</pre> <p>n                                      Event blender number.<br/>m                                      Trigger stimulus number.<br/>eventid                                Event that triggers the blender action.</p> |
| Remarks                                                                                                                                  | <ul style="list-style-type: none"> <li>• There are 4 acceptors that can each select a different event. eventid can be the event ID of any trigger event.</li> <li>• Use zero to disable the blender input.</li> </ul>                                                                                                                                                                   |

| <b>trigger.blender[N].wait</b> <span style="float: right;">Replace N with the values 1-4</span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                                                                                       | Waits for an event blender trigger.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| TSP-Link accessibility                                                                          | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Usage                                                                                           | <pre>triggered = trigger.blender[n].wait(timeout)</pre> <p>n                                      Event blender number on which to wait.<br/>timeout                                Maximum amount of time in seconds to wait for the trigger.<br/>triggered                                Trigger detection indicator.</p>                                                                                                                                                                   |
| Remarks                                                                                         | <ul style="list-style-type: none"> <li>• This function will wait for a an event blender trigger.</li> <li>• If one or more trigger events were generated by the blender since the last time trigger.blender[n].wait or trigger.blender[n].clear was called, this function will return immediately.</li> <li>• After waiting for a trigger with this function, the event detector will be automatically reset and rearmed. This is true regardless of the number of events detected.</li> </ul> |





| <b>trigger.timer[N].count</b> |                                                                                                                                                                                                                                                                                                                                                                             | Replace N with the values 1-8 |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| Attribute                     | Sets the number of times the timer will trigger an event.                                                                                                                                                                                                                                                                                                                   |                               |
| Default                       | 1                                                                                                                                                                                                                                                                                                                                                                           |                               |
| TSP-Link accessibility        | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                 |                               |
| Usage                         | <pre>count = trigger.timer[n].count    -- Reads trigger count. trigger.timer[n].count = count    -- Writes trigger count.</pre> <p>n                                    Trigger timer number.<br/>count                                Repeat trigger count.</p>                                                                                                            |                               |
| Remarks                       | <ul style="list-style-type: none"> <li>This attribute sets the number of times the timer will generate a trigger event.</li> <li>If this attribute is set greater than 1, the timer will automatically start the next delay at expiration of a previous delay.</li> <li>This attribute will generate the set number of trigger events each time it is triggered.</li> </ul> |                               |

| <b>trigger.timer[N].delay</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                | Replace N with the values 1-8 |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| Attribute                     | Sets and reads the timer delay.                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
| Default                       | 10e-6                                                                                                                                                                                                                                                                                                                                                                                                                                          |                               |
| TSP-Link accessibility        | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                    |                               |
| Usage                         | <pre>interval = trigger.timer[n].delay  -- Reads timer delay. trigger.timer[n].delay = interval  -- Writes timer delay.</pre> <p>n                                    Trigger timer number.<br/>interval                            Delay interval (in seconds).</p>                                                                                                                                                                           |                               |
| Remarks                       | <ul style="list-style-type: none"> <li>This attribute sets a fixed timer delay. Each time the timer is triggered it will use this delay period.</li> <li>Assigning a value to this attribute is equivalent to: <pre>trigger.timer[n].delaylist = {interval}</pre> <p>This creates a delay list of one value.</p></li> <li>Reading this attribute returns the delay interval that will be used the next time the timer is triggered.</li> </ul> |                               |

| <b>trigger.timer[N].delaylist</b> |                                                                                                                                                                                                                                                   | Replace N with the values 1-8 |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| Attribute                         | Stores the timer delays in an array.                                                                                                                                                                                                              |                               |
| Default                           | {10e-6}                                                                                                                                                                                                                                           |                               |
| TSP-Link accessibility            | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                       |                               |
| Usage                             | <pre>intervals = trigger.timer[n].delaylist trigger.timer[n].delaylist = intervals</pre> <p>n                                    Trigger timer number.<br/>intervals                            Table of delay intervals (in seconds).</p>        |                               |
| Remarks                           | <ul style="list-style-type: none"> <li>Each time the timer is triggered it will use the next delay period in the array.</li> <li>After all elements in the array have been used, the delays will restart at the beginning of the list.</li> </ul> |                               |



| <b>trigger.timer[N].stimulus</b> |                                                                                                                                                                                                                                                                                                             | Replace N with the values 1-8 |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| Attribute                        | Selects which event will start the timer.                                                                                                                                                                                                                                                                   |                               |
| Default                          | 0                                                                                                                                                                                                                                                                                                           |                               |
| TSP-Link accessibility           | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                 |                               |
| Usage                            | <pre>eventid = trigger.timer[n].stimulus -- Reads timer delay trigger event. trigger.timer[n].stimulus = eventid -- Writes timer delay trigger event.</pre><br><pre>  n                                Trigger timer number.   event_id                          Event that triggers the timer delay.</pre> |                               |
| Remarks                          | <ul style="list-style-type: none"> <li>• This attribute selects which event starts the timer.</li> <li>• Set this attribute to the event id of any trigger event to wait for that event.</li> <li>• Use zero to disable event processing.</li> </ul>                                                        |                               |

| <b>trigger.timer[N].wait</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Replace N with the values 1-8 |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| Attribute                    | Wait for a timer trigger.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                               |
| TSP-Link accessibility       | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |
| Usage                        | <pre>triggered = trigger.timer[n].wait(timeout)</pre><br><pre>  n                                Trigger timer number on which to wait.   timeout                          Maximum time (in seconds) to wait for the trigger.   triggered                          Trigger detection indicator.</pre>                                                                                                                                                                                          |                               |
| Remarks                      | <ul style="list-style-type: none"> <li>• This function will wait for a timer trigger.</li> <li>• If the timer generated one or more trigger event since the last time <code>trigger.timer[n].wait</code> or <code>trigger.timer[n].clear</code> was called, this function will return immediately.</li> <li>• After waiting for a trigger with this function, the event detector will be automatically reset and rearmed. This is true regardless of the number of events detected.</li> </ul> |                               |

| <b>trigger.wait</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Wait for a command interface trigger event.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Usage                  | <pre>triggered = trigger.wait(timeout)</pre> <p> <code>timeout</code>                                   Maximum amount of time in seconds to wait for the trigger.<br/> <code>triggered</code>                                   Returns <code>true</code> if a trigger was detected. Returns <code>false</code> if no triggers were detected during the timeout period. </p>                                                                                                                                                                                                                                                                                                                                                                    |
| Remarks                | <ul style="list-style-type: none"> <li>• This function will wait up to <code>timeout</code> seconds for a trigger on the active command interface. A command interface trigger occurs when: <ul style="list-style-type: none"> <li>• A GPIB GET command is detected (GPIB only).</li> <li>• A VXI-11 <code>device_trigger</code> method is invoked (VXI-11 only).</li> <li>• A <code>*trg</code> message is received.</li> </ul> </li> <li>• If one or more of these trigger events were previously detected, this function will return immediately.</li> <li>• After waiting for a trigger with this function, the event detector will be automatically reset and rearmed. This is true regardless of the number of events detected.</li> </ul> |
| Details                | See <a href="#">Section 8</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Also see               | <a href="#">trigger.clear</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Example                | <p>Waits up to 10 seconds for a trigger:</p> <pre>triggered = trigger.wait(10) print(triggered)</pre> <p>Output: <code>false</code></p> <p>The above output indicates that no trigger was detected during the 10 second timeout.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

## tsplink

| <b>tsplink.group</b>   |                                                                                                                                                                                                                                                                                                        |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | Stores the group number assigned to the node.                                                                                                                                                                                                                                                          |
| Default                | 0                                                                                                                                                                                                                                                                                                      |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                            |
| Usage                  | <pre>groupnumber = tsplink.group tsplink.group = groupnumber</pre> <p>groupnumber                      The TSP-Link group number.</p>                                                                                                                                                                  |
| Remarks                | <ul style="list-style-type: none"> <li>• The default group number is 0.</li> <li>• Set the attribute value to 0 to remove the node from all groups.</li> <li>• Each time the node powers off, the group number for that node changes to 0.</li> <li>• Group numbers can range from 0 to 64.</li> </ul> |

| <b>tsplink.master</b>  |                                                                                                                                     |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | Reads the node number assigned to the master node.                                                                                  |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                         |
| Usage                  | <pre>master = tsplink.master</pre> <p>master                              A custom variable that stores the master node number.</p> |
| Remarks                | This is a read-only attribute.                                                                                                      |

| <b>tsplink.node</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | Use this attribute to set the node number.                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Default                | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Usage                  | <pre>mynode = tsplink.node              Reads the node number. tsplink.node = mynode              Writes the node number.</pre> <p>mynode                              Sets the node number. Choose from 1 to 64.</p>                                                                                                                                                                                                                                                                                         |
| Remarks                | <ul style="list-style-type: none"> <li>• This attribute sets the TSP-Link node number and saves the value in nonvolatile memory.</li> <li>• Changes to the node number do not take effect until the next time <code>tsplink.reset</code> is executed on any node in the system.</li> <li>• Each node connected to the TSP-Link must be assigned a different node number.</li> <li>• 32 nodes is the maximum number of nodes allowed.</li> <li>• This attribute may be any number between 1 and 64.</li> </ul> |
| Details                | See <a href="#">Section 14</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Also see               | <a href="#">tsplink.reset</a> , <a href="#">tsplink.state</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Example                | Sets the TSP-Link node to number 2:<br><code>tsplink.node = 2</code>                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| <b>tsplink.readbit</b> |                                                                                                                                                                                                                                                    |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Reads the state of a TSP-Link synchronization line.                                                                                                                                                                                                |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                         |
| Usage                  | <pre>data = tsplink.readbit(n)</pre> <p>data                                    A custom variable that stores the state of the synchronization line.</p> <p>n                                         Synchronization line to be read (1 - 3).</p> |
| Remarks                | <ul style="list-style-type: none"> <li>Returns a value of 0 if the line is low and a 1 if the line is high.</li> </ul>                                                                                                                             |
| Details                | See <a href="#">TSP-Link synchronization lines</a> in <a href="#">Section 8</a> .                                                                                                                                                                  |
| Also see               | <a href="#">tsplink.readbit</a> , <a href="#">tsplink.readport</a> , <a href="#">tsplink.writebit</a> .                                                                                                                                            |
| Example                | <p>Assume line 3 is set high, and it is then read:</p> <pre>data = tsplink.readbit(3) print(data) Output: 1.000000e+00</pre>                                                                                                                       |

| <b>tsplink.readport</b> |                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                | Reads the TSP-Link synchronization lines as a digital I/O port.                                                                                                                                                                                                                                                                                                            |
| TSP-Link accessibility  | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                 |
| Usage                   | <pre>data = tsplink.readport()</pre>                                                                                                                                                                                                                                                                                                                                       |
| Remarks                 | <ul style="list-style-type: none"> <li>The binary equivalent of the returned value indicates the input pattern on the I/O port. The least significant bit of the binary number corresponds to line 1 and bit 3 corresponds to line 3. For example, a returned value of 2 has a binary equivalent of 010. Line 2 is high (1), and the other 2 lines are low (0).</li> </ul> |
| Details                 | See <a href="#">TSP-Link synchronization lines</a> in <a href="#">Section 8</a> .                                                                                                                                                                                                                                                                                          |
| Also see                | <a href="#">tsplink.readbit</a> , <a href="#">tsplink.writebit</a> , <a href="#">tsplink.writeport</a>                                                                                                                                                                                                                                                                     |
| Example                 | <p>Assume line 2 is set high, and the digio I/O port reads:</p> <pre>data = tsplink.readport() print(data) Output: 2.000000e+00 (binary 010)</pre>                                                                                                                                                                                                                         |

| <b>tsplink.reset</b>   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Initializes (resets) all nodes (instruments) in the TSP-Link system. Also returns the number of nodes found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| TSP-Link accessibility | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Usage                  | <pre>nodes_found = tsplink.reset() nodes_found = tsplink.reset(expected_nodes)</pre> <p>                     expected_nodes                      The number of nodes expected on the system.<br/>                     nodes_found                              The number of nodes actually on the system.                 </p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Remarks                | <ul style="list-style-type: none"> <li>• This function will erase all knowledge of other nodes connected on the TSP-Link and will regenerate the system configuration. This function must be called at least once before any remote nodes can be accessed. If the node number for any instrument is changed, the TSP-Link must again be initialized.</li> <li>• The value of <code>expected_nodes</code> must be a number between 1 and 64. If the <code>expected_nodes</code> parameter is not given, this function will generate an error if no other nodes are found on the TSP-Link network.</li> <li>• If the actual number of nodes is less than the expected number, an error is generated. Note that the node on which the command is running is counted as a node. For example, giving an expected node count of 1 will not generate any errors, even if there are no other nodes on the TSP-Link network.</li> </ul> |
| Details                | See <a href="#">Section 14</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Also see               | <a href="#">tsplink.node</a> , <a href="#">tsplink.state</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| <b>tsplink.state</b>   |                                                                                                                                                                                                                                                                                                                                                         |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | TSP-Link on-line state.                                                                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                             |
| Usage                  | <pre>state = tsplink.state</pre> <p>                     state                                      Indicates the TSP-Link status.                 </p>                                                                                                                                                                                                 |
| Remarks                | <ul style="list-style-type: none"> <li>• This attribute stores the TSP-Link status, either "online" or "offline." The state will be "offline" after the unit is powered on. After <code>tsplink.reset</code> is successful, the state will be "online."</li> <li>• This attribute is read-only.</li> <li>• State is shown as a return value.</li> </ul> |
| Details                | See <a href="#">Section 14</a> .                                                                                                                                                                                                                                                                                                                        |
| Also see               | <a href="#">tsplink.node</a> , <a href="#">tsplink.reset</a>                                                                                                                                                                                                                                                                                            |
| Example                | Reads the on-line state of the TSP-Link:<br><pre>state = tsplink.state print(state)</pre> Output: online                                                                                                                                                                                                                                                |











| <b>tsplink.writebit</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                | Sets a TSP-Link synchronization line high or low.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| TSP-Link accessibility  | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Usage                   | <code>tsplink.writebit(bit, data)</code><br><br><div style="display: flex; justify-content: space-between;"> <span><code>bit</code></span> <span>The synchronization line number (1 to 3).</span> </div> <div style="display: flex; justify-content: space-between;"> <span><code>data</code></span> <span>Value to write to the bit; 0 (low) or 1 (high).</span> </div>                                                                                                                                  |
| Remarks                 | <ul style="list-style-type: none"> <li>• If the output line is write protected by the <code>tsplink.writeprotect</code> attribute, the command will be ignored.</li> <li>• The <code>reset</code> function does not affect the present states of the digital I/O lines.</li> <li>• Use the <code>tsplink.writebit</code> and <code>tsplink.writeport</code> commands to control the output state of the synchronization line when the trigger mode is set to <code>tsplink.TRIG_BYPASS</code>.</li> </ul> |
| Details                 | See <a href="#">TSP-Link synchronization lines</a> in <a href="#">Section 8</a> .                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Also see                | <a href="#">tsplink.readbit</a> , <a href="#">tsplink.readport</a> , <a href="#">tsplink.writebit</a> .                                                                                                                                                                                                                                                                                                                                                                                                   |
| Example                 | Sets synchronization line 3 low (0):<br><code>tsplink.writebit(3, 0)</code>                                                                                                                                                                                                                                                                                                                                                                                                                               |

| <b>tsplink.writeport</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                 | Writes to all TSP-Link synchronization lines.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility   | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Usage                    | <code>tsplink.writeport(data)</code><br><br><div style="display: flex; justify-content: space-between;"> <span><code>data</code></span> <span>Value to write to the port; 0 to 7.</span> </div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Remarks                  | <ul style="list-style-type: none"> <li>• The binary representation of data indicates the output pattern to be written to the I/O port. For example, a data value of 2 has a binary equivalent of 010. Line 2 is set high (1), and the other 2 lines are set low (0).</li> <li>• Write protected lines will not be changed (see <code>tsplink.writeprotect</code>).</li> <li>• The <code>reset</code> function does not affect the present states of the digital I/O lines.</li> <li>• Use the <code>tsplink.writebit</code> and <code>tsplink.writeport</code> commands to control the output state of the synchronization line while the trigger mode is set to <code>tsplink.TRIG_BYPASS</code>.</li> </ul> |
| Details                  | See <a href="#">Controlling digital I/O lines</a> in <a href="#">Section 8</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Also see                 | <a href="#">tsplink.readbit</a> , <a href="#">tsplink.readport</a> , <a href="#">tsplink.writebit</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Example                  | Sets the synchronization lines 1 and 2 high (binary 011):<br><code>tsplink.writeport(3)</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

| <b>tsplink.writeprotect</b> |                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                   | Write protect mask that disables bits from being changed with the <code>tsplink.writebit</code> and <code>tsplink.writeport</code> functions.                                                                                                                                                                                               |
| Default                     | 0                                                                                                                                                                                                                                                                                                                                           |
| TSP-Link accessibility      | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                 |
| Usage                       | <pre>mask = tsplink.writeprotect    -- Reads write protect mask. tsplink.writeprotect = mask    -- Writes write protect mask.</pre> <p>mask                            Set to the value that specifies the bit pattern for write protect.</p>                                                                                               |
| Remarks                     | <ul style="list-style-type: none"> <li>• Bits set to 1 cause the corresponding line to be write protected.</li> <li>• The binary equivalent of <code>mask</code> indicates the mask to be set for the I/O port. For example, a <code>mask</code> value of 5 has a binary equivalent 101. This mask write protects lines 1 and 3.</li> </ul> |
| Details                     | See <a href="#">Controlling digital I/O lines</a> in <a href="#">Section 8</a> .                                                                                                                                                                                                                                                            |
| Also see                    | <a href="#">tsplink.readbit</a> , <a href="#">tsplink.readport</a> <a href="#">tsplink.writebit</a>                                                                                                                                                                                                                                         |
| Example                     | Write protects lines 1 and 3:<br><code>tsplink.writeprotect = 5</code>                                                                                                                                                                                                                                                                      |

**tspnet**

| <b>tspnet.clear</b>    |                                                                                                                                                                                                                                                                                               |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Clear the read buffer.                                                                                                                                                                                                                                                                        |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                    |
| Usage                  | <pre>tspnet.clear(connection_id)</pre> <p>connection_id                      Integer value used as a handle for other <code>tspnet</code> commands.</p>                                                                                                                                       |
| Remarks                | <ul style="list-style-type: none"> <li>This command clears any pending output data available from the remote instrument. No data is returned to the caller. No data is processed.</li> <li>Errors: <ul style="list-style-type: none"> <li>Invalid Specified Connection</li> </ul> </li> </ul> |
| Example                | <pre>tspnet.write(myconnection, 'print([[hello]])\n') print(tspnet.readavailable(myconnection))</pre> <p>Output:<br/>6.00000000e+000</p> <pre>tspnet.clear(myconnection) print(tspnet.readavailable(myconnection))</pre> <p>Output:<br/>0.00000000e+000</p>                                   |

| <b>tspnet.connect</b>          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |                                                                        |                         |                                             |                          |                                   |                                |                                    |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|------------------------------------------------------------------------|-------------------------|---------------------------------------------|--------------------------|-----------------------------------|--------------------------------|------------------------------------|
| Function                       | Establish a connection to a remote instrument.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                            |                                                                        |                         |                                             |                          |                                   |                                |                                    |
| TSP-Link accessibility         | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                            |                                                                        |                         |                                             |                          |                                   |                                |                                    |
| Usage                          | <p>To connect to any remote instrument on the LAN:<br/> <code>connection_id = tspnet.connect(ip_address, port_number, initialize_string)</code></p> <p>To connect to a TSP-enabled remote instrument on the LAN:<br/> <code>connection_id = tspnet.connect(ip_address)</code></p> <table> <tr> <td><code>connection_id</code></td> <td>Integer value used as a handle for other <code>tspnet</code> commands.</td> </tr> <tr> <td><code>ip_address</code></td> <td>String variable for passing the IP address.</td> </tr> <tr> <td><code>port_number</code></td> <td>Integer value of the port number.</td> </tr> <tr> <td><code>initialize_string</code></td> <td>The initialization string to send.</td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <code>connection_id</code> | Integer value used as a handle for other <code>tspnet</code> commands. | <code>ip_address</code> | String variable for passing the IP address. | <code>port_number</code> | Integer value of the port number. | <code>initialize_string</code> | The initialization string to send. |
| <code>connection_id</code>     | Integer value used as a handle for other <code>tspnet</code> commands.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                            |                                                                        |                         |                                             |                          |                                   |                                |                                    |
| <code>ip_address</code>        | String variable for passing the IP address.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                            |                                                                        |                         |                                             |                          |                                   |                                |                                    |
| <code>port_number</code>       | Integer value of the port number.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                            |                                                                        |                         |                                             |                          |                                   |                                |                                    |
| <code>initialize_string</code> | The initialization string to send.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                            |                                                                        |                         |                                             |                          |                                   |                                |                                    |
| Remarks                        | <ul style="list-style-type: none"> <li>• This command connects to another instrument by way of the LAN interface (using the optionally-specified port number). The default port number is 5025. If the port number is 23, the interface will use the Telnet protocol (and set appropriate termination characters) to communicate with the instrument.</li> <li>• If a port number and initialization string are provided, the remote instrument is assumed to be non-TSP-enabled. The Series 2600A does not perform any extra processing, prompt handling, error handling, or sending of commands. Additionally, the <code>tspnet.tsp</code> commands do not apply for use on this remote instrument.</li> <li>• If no port number and initialization string is provided, the remote instrument is assumed to be a Keithley Instruments TSP-enabled instrument. Depending on the state of <code>tspnet.tsp.abortonconnect</code>, the Series 2600A sends an <code>abort</code> to the remote instrument upon connection. The Series 2600A also enables TSP prompts on the remote instrument and error management. The Series 2600A places remote errors from the TSP-enabled instrument in its own error queue and prefaces these errors with "Remote Error," followed by an error description. Do not manually change either the prompt functionality (<code>localnode.prompts</code>) or show errors functionality (<code>localnode.showerrors</code>) on the remote TSP-enabled instrument, or subsequent <code>tspnet.tsp.*</code> commands using the connection may fail.</li> <li>• You can simultaneously connect to a maximum of 32 remote instruments.</li> <li>• Errors:<br/> <code>Connection Failed</code><br/> <code>Connection Failed, Timeout</code><br/> <code>Invalid IP Address or Port Number</code></li> </ul> |                            |                                                                        |                         |                                             |                          |                                   |                                |                                    |
| Example                        | <p>To connect to a TSP-enabled instrument:<br/> <code>mytspconnection = tspnet.connect("10.80.64.216")</code></p> <p>To connect to a non-TSP-enabled instrument:<br/> <code>myconnection = tspnet.connect("192.168.1.51", 1394, "*rst\r\n")</code></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                            |                                                                        |                         |                                             |                          |                                   |                                |                                    |



| <b>tspnet.disconnect</b> |                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                 | Close a connection to a remote instrument.                                                                                                                                                                                                                                                                                                                        |
| TSP-Link accessibility   | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                        |
| Usage                    | <pre>tspnet.disconnect(connection_id)</pre> <p>connection_id                      Integer value used as a handle for other <code>tspnet</code> commands.</p>                                                                                                                                                                                                      |
| Remarks                  | <ul style="list-style-type: none"> <li>This command disconnects the remote instrument by closing the connection.</li> <li>For Keithley Instruments TSP™ devices, this results in any remotely running commands or scripts being aborted (terminated).</li> <li>Errors: <ul style="list-style-type: none"> <li>Invalid Specified Connection</li> </ul> </li> </ul> |
| Example                  | <code>tspnet.disconnect(myconnection)</code>                                                                                                                                                                                                                                                                                                                      |

| <b>tspnet.execute</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Executes a command string on the remote instrument.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Usage                  | <pre>tspnet.execute(connection_id, command_string) value1 = tspnet.execute(connection_id, command_string, format_string) value1, value2 = tspnet.execute(connection_id, command_string, format_string) value1, ..., valuen = tspnet.execute(connection_id, command_string, format_string)</pre> <p>connection_id                      The connection ID returned from a <code>tspnet.connect</code> call.</p> <p>command_string                      Command to send to the instrument.</p> <p>format_string                      Format string for decoding response messages.</p> <p>value1                              The first value decoded from the response message.</p> <p>value2                              The second value decoded from the response message.</p> <p>valuen                              The nth value decoded from the response message. There is one return value per format specifier in the format string.</p> |

|         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Remarks | <ul style="list-style-type: none"> <li>• This command sends the command string to the remote instrument. A termination is added to the command string when it is sent to the remote instrument (see <a href="#">tspnet.termination</a>). Optionally, when a format string is specified, the command waits for a response from the remote instrument. The Series 2600A decodes the response message according to the format specified in the format string and returns this as return values from the function (see <a href="#">tspnet.read</a> for format specifiers).</li> <li>• When this command is sent to a TSP-enabled instrument, the Series 2600A suspends operation until a timeout error is generated or until the instrument responds, even if no format string is specified. The TSP prompt from the remote instrument is read and thrown away. The Series 2600A places any remotely-generated errors into its error queue. When the optional format string is not specified, this command is equivalent to <a href="#">tspnet.write</a>, except that a termination is automatically added to the end of the command.</li> <li>• Errors:<br/> Invalid Specified Connection<br/> Write Failed, Timeout<br/> Write Failed<br/> Read Failed, Timeout<br/> Read Failed<br/> Read Failed, Aborted<br/> Remote Error, &lt;remote error generated by command&gt;</li> </ul> |
| Example | <p>Command remote instrument to run script named 'myscript':</p> <pre>tspnet.execute(myconnection, 'myscript()')</pre> <p>Command remote instrument to execute a *idn?:</p> <pre>tspnet.execute(myconnection, '*idn?') print("instrument write/read returns:: " , tspnet.read(myconnection))</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

| <b>tspnet.idn</b>      |                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Retrieves response of remote instrument to '*idn?'.                                                                                                                                                                                                                                                                                                                    |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                             |
| Usage                  | <pre>idn_string = tspnet.idn(connection_id)</pre> <p>idn_string                      Response as a string type.<br/> connection_id                    Integer value used as a handle for other <code>tspnet</code> commands.</p>                                                                                                                                       |
| Remarks                | <ul style="list-style-type: none"> <li>• Sends the '*idn?' string to the remote instrument and retrieves its response.</li> <li>• Errors:<br/> Invalid Specified Connection<br/> Connection Not Available<br/> Connection Failed, Aborted<br/> Write Failed, Timeout<br/> Write Failed<br/> Read Failed, Timeout<br/> Read Failed<br/> Read Failed, Aborted</li> </ul> |
| Example                | <p>Retrieve and print response of '*idn?*' from the remote instrument:</p> <pre>print(tspnet.idn(myconnection))<br/>Keithley Instruments Inc., Model 2602A, 1234567, 02.0.1</pre>                                                                                                                                                                                      |



| <b>tspnet.readavailable</b> |                                                                                                                                                                                                                                                                                                                             |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                    | Read the number of bytes waiting to be read.                                                                                                                                                                                                                                                                                |
| TSP-Link accessibility      | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                  |
| Usage                       | <pre>num_bytes = tspnet.readavailable(connection_id)</pre> <p> <code>connection_id</code>                      Integer value used as a handle for other <code>tspnet</code> commands.<br/> <code>num_bytes</code>                              The number of bytes available. </p>                                          |
| Remarks                     | <ul style="list-style-type: none"> <li>This command checks to see if any data is available from the remote instrument. No data is read. It is intended to allow TSP™ scripts to continue to run without waiting on a remote command to finish.</li> <li>Errors:<br/>Invalid Specified Connection<br/>Read Failed</li> </ul> |
| Example                     | <pre>x = tspnet.readavailable(myconnection)</pre>                                                                                                                                                                                                                                                                           |

| <b>tspnet.reset</b>    |                                                                                                                                                                                                                                                                                                   |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Reset all remote instrument connections.                                                                                                                                                                                                                                                          |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                        |
| Usage                  | <code>tspnet.reset()</code>                                                                                                                                                                                                                                                                       |
| Remarks                | <ul style="list-style-type: none"> <li>This command disconnects all remote instruments currently connected.</li> <li>For Keithley Instruments TSP™ instruments, this results in any remotely running commands or scripts being aborted (terminated).</li> <li>Errors:<br/>&lt;none&gt;</li> </ul> |
| Example                | <code>tspnet.reset()</code>                                                                                                                                                                                                                                                                       |

| <b>tspnet.termination</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                  | Set line termination.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| TSP-Link accessibility    | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Usage                     | <pre> termination_type = tspnet.termination(connection_id) termination_type = tspnet.termination(connection_id, termination_type)  connection_id          Integer value used as a handle for other tspnet                         commands. termination_type       tspnet.TERM_LF, tspnet.TERM_CR,                         TERM_CRLF, or tspnet.TERM_LFCR. </pre>                                                                                                                                                                                                                                                                            |
| Remarks                   | <ul style="list-style-type: none"> <li>This function sets and gets the termination characters used to determine the end of a line for lines being received by a connection. It also is used to terminate lines being sent to a connection. Pass the optional set value to set the termination. The current value is always returned. There are four possible values: LF, CR, CRLF, or LFCR. For TSP™ devices, the default is LF. For non-TSP devices, the default is CRLF. The termination character resets to default when a connection is terminated.</li> <li>Errors:<br/>Invalid Specified Connection<br/>Invalid Termination</li> </ul> |
| Example                   | <p>Set termination character:</p> <pre>tspnet.termination(myconnection, tspnet.TERM_LF)</pre> <p>Gets termination character and evaluates if set to <code>tspnet.TERM_LF</code>. Response of "1" means true, set to <code>termination_type</code>. Response of "0" means false, not set to <code>tspnet.TERM_LF</code>:</p> <pre>print(tspnet.termination(myconnection) == tspnet.TERM_LF)</pre> <p>Output:<br/>1.0000000e+000</p>                                                                                                                                                                                                           |

| <b>tspnet.timeout</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute              | Sets timeout value for <code>tspnet.connect()</code> , <code>tspnet.execute()</code> , and <code>tspnet.read()</code> commands.                                                                                                                                                                                                                                                                                                                             |
| Default                | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| TSP-Link accessibility | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                 |
| Usage                  | <pre>tspnet.timeout = seconds_value seconds_value = tspnet.timeout</pre> <p style="text-align: center;"><code>seconds_value</code>                      Timeout value in seconds.</p>                                                                                                                                                                                                                                                                       |
| Remarks                | <ul style="list-style-type: none"> <li>This setting sets the duration the <code>tspnet.connect</code>, <code>tspnet.read</code>, and <code>tspnet.execute</code> commands will wait for a response. The time is specified in seconds. The default value is 5.0 seconds. The timeout may contain fractional seconds but is only accurate to the nearest 10mS. The timeout may be between 0.0 and 30 seconds.</li> <li>Errors:<br/>Invalid Timeout</li> </ul> |
| Example                | <code>tspnet.timeout = 10.0</code>                                                                                                                                                                                                                                                                                                                                                                                                                          |

| <b>tspnet.tsp.abort</b> |                                                                                                                                                                                                                                     |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                | Aborts remote instrument execution.                                                                                                                                                                                                 |
| TSP-Link accessibility  | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                          |
| Usage                   | <pre>tspnet.tsp.abort(connection_id)</pre> <p style="text-align: center;"><code>connection_id</code>                      Integer value used as a handle for other <code>tspnet</code> commands.</p>                                |
| Remarks                 | <ul style="list-style-type: none"> <li>This convenience command simply sends an "abort" string to the remote instrument.</li> <li>Errors:<br/>Invalid Specified Connection<br/>Connection Not Available<br/>Write Failed</li> </ul> |
| Example                 | <code>tspnet.tsp.abort(myconnection)</code>                                                                                                                                                                                         |

| <b>tspnet.tsp.abortonconnect</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Attribute                        | Abort on connect.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Default                          | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| TSP-Link accessibility           | This attribute can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Usage                            | <pre>tspnet.tsp.abortonconnect = value value = tspnet.tsp.abortonconnect</pre> <p>value                                    1 or 0</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Remarks                          | <ul style="list-style-type: none"> <li>• This setting determines if the Series 2600A sends an abort message when it attempts to connect using <a href="#">tspnet.connect</a> to a TSP™-enabled instrument.</li> <li>• Sending the <code>abort</code> command on a connection causes any other active interfaces being used on that instrument to close to ensure you have obtained access to the remote instrument.</li> <li>• Connecting to a TSP instrument without issuing an <code>abort</code> command, or when <code>tspnet.tsp.abortonconnect</code> is set to 0, can result in the Series 2600A suspending operation until it receives a response back from the instrument or until a timeout error is generated.</li> </ul> |
| Example                          | <code>tspnet.tsp.abortonconnect = 0</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |



| <b>tspnet.tsp.rhtablecopy</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                      | Copies a reading buffer synchronous table from a remote instrument.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| TSP-Link accessibility        | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Usage                         | <pre>array = tspnet.tsp.rhtablecopy(connection_id, name) array = tspnet.tsp.rhtablecopy(connection_id, name, start_index, end_index)</pre> <p> connection_id                    Integer value used as a handle for other <code>tspnet</code> commands.<br/> name                                The full name of the reading buffer synchronous table.<br/> start_index                        Integer start value.<br/> end_index                          Integer end value.<br/> array                                A copy of the synchronous table. </p>                                                                                                                                                                                                                                                                      |
| Remarks                       | <ul style="list-style-type: none"> <li>This convenience command reads the data from a reading buffer on a remote instrument and returns an array of numbers or a string representing the data. The name argument identifies the reading buffer name and synchronous table to copy. The optional <code>start_index</code> and <code>end_index</code> specify the portion of the reading buffer to read. If no index is specified, the entire buffer will be copied.</li> <li>This command is limited to transferring 50,000 readings at a time.</li> <li>Errors: <pre>Invalid Specified Connection Read Failed, Timeout Read Failed, Aborted Read Failed Write Failed, Timeout Write Failed Invalid Reading Buffer Table Invalid Index Range Out of Memory Remote Error, &lt;remote error generated by command&gt;</pre> </li> </ul> |
| Example                       | <pre>t = tspnet.tsp.rhtablecopy(myconnection, 'myremotebuffername.readings', 1, 3)  print(t[1], t[2], t[3])</pre> <p>Output:</p> <pre>4.5653423423e-1 4.5267523423e-1 4.5753543423e-1</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| <b>tspnet.tsp.runscript</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                    | Load and run a script on a remote instrument.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| TSP-Link accessibility      | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Usage                       | <pre>tspnet.tsp.runscript(connection_id, script) tspnet.tsp.runscript(connection_id, name, script)</pre> <p> code&gt;connection_id Integer value used as a handle for other <code>tspnet</code> commands.<br/> code&gt;name The name the script will be assigned.<br/> code&gt;script The body of the script as a string. </p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Remarks                     | <ul style="list-style-type: none"> <li>• This convenience command downloads a script to a remote instrument and runs it. It automatically adds the appropriate <code>loadscript</code> and <code>endscript</code> around the script, captures any errors, and reads back any prompts. No additional substitutions are done on the text.</li> <li>• The script is automatically loaded, compiled, and run.</li> <li>• Any output from previous commands will be discarded.</li> <li>• This command will not wait for the script to complete.</li> <li>• To load only and run at a later time, simply make sure the script contains only functions. Use <a href="#">tspnet.execute</a> to execute those functions at a later time.</li> <li>• This command is appropriate only for TSP™-enabled instruments.</li> <li>• If no name is specified, the script will be unnamed.</li> <li>• Errors: <pre>Invalid Specified Connection Write Failed, Timeout Write Failed Read Failed, Timeout Read Failed, Aborted Remote Error, &lt;remote error generated by command&gt;</pre> </li> </ul> |
| Example                     | <pre>tspnet.tsp.runscript(myconnection, 'mytest', 'print([[start]]) for d = 1, 10 do print([[work]]) end print([[end]])')</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| <b>tspnet.write</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Write a string to a remote instrument.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Usage                  | <pre>tspnet.write(connection_id, input_string)</pre> <p> <code>connection_id</code>                      Integer value used as a handle for other <code>tspnet</code> commands.<br/> <code>input_string</code>                         String type used for writing to the remote instrument. </p>                                                                                                                                                                                       |
| Remarks                | <ul style="list-style-type: none"> <li>• The <code>tspnet.write()</code> command sends the command string to the remote instrument. It does not wait for command completion on the remote instrument.</li> <li>• The Series 2600A sends the input string to the remote instrument exactly as given. The input string must contain any necessary new lines or terminations.</li> <li>• Errors:<br/> Invalid Specified Connection<br/> Write Failed, Timeout<br/> Write Failed </li> </ul> |
| Example                | <p>Command remote instrument to run script named 'myscript':</p> <pre>tspnet.write(myconnection, 'myscript()\n')</pre> <p>Send a *idn? to a remote instrument:</p> <pre>tspnet.write(myconnection, "*idn?\r\n")</pre>                                                                                                                                                                                                                                                                    |

## userstring

The functions in this group are used to store/retrieve user-defined strings in nonvolatile memory.

| <b>userstring.add</b>  |                                                                                                                                                                                                                                                 |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Adds a user-defined string to nonvolatile memory.                                                                                                                                                                                               |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                                                                                                      |
| Usage                  | <pre>userstring.add(name, value)</pre> <p>name                                   The name for the string.<br/>value                                   The string to associate with the name.</p>                                                |
| Remarks                | This function will associate the string <code>value</code> with the string <code>name</code> and store the pair in nonvolatile memory. The value associated with the given name can be retrieved with the <code>userstring.get</code> function. |
| Also see               | <a href="#">userstring.catalog</a> , <a href="#">userstring.delete</a> , <a href="#">userstring.get</a>                                                                                                                                         |
| Example                | Stores user-defined strings in nonvolatile memory:<br><pre>userstring.add("assetnumber", "236") userstring.add("department", "Widgets") userstring.add("contact", "John Doe")</pre>                                                             |

| <b>userstring.catalog</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                  | Creates an iterator for the user string catalog.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| TSP-Link accessibility    | This function cannot be accessed from a remote TSP-Link node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Usage                     | <pre>for name in userstring.catalog() do ... end</pre> <p>name                                   The variable that assumes the name of each string.</p>                                                                                                                                                                                                                                                                                                                                                                                                        |
| Remarks                   | <ul style="list-style-type: none"> <li>Accessing the catalog for user string names allows the user to print or delete all string name values in nonvolatile memory. The entries will be enumerated in no particular order.</li> <li>Each time the body of the function executes, <code>name</code> takes on the value of one string in the catalog. The <code>for</code> loop repeats until all values have been retrieved.</li> </ul>                                                                                                                         |
| Also see                  | <a href="#">userstring.add</a> , <a href="#">userstring.delete</a> , <a href="#">userstring.get</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Example                   | Deletes all user strings in nonvolatile memory:<br><pre>for name in userstring.catalog() do   userstring.delete(name) end</pre> Prints all user string name value pairs in nonvolatile memory:<br><pre>for name in userstring.catalog() do   print(name .. " = " .. userstring.get(name)) end</pre> Output: department = Widgets<br>assetnumber = 236<br>contact = John Doe<br>The above output lists the user strings added in the “Example” for the <code>userstring.add</code> function. Notice that they are not listed in the order that they were added. |

| <b>userstring.delete</b> |                                                                                                                                                                                                     |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                 | Deletes a user-defined string from nonvolatile memory.                                                                                                                                              |
| TSP-Link accessibility   | This function can be accessed from a remote TSP-Link node.                                                                                                                                          |
| Usage                    | <code>userstring.delete(name)</code><br><br>name<br>Name of the user string.                                                                                                                        |
| Remarks                  | This function will delete from nonvolatile memory the string that is associated with the string <code>name</code> .                                                                                 |
| Also see                 | <a href="#">userstring.add</a> , <a href="#">userstring.catalog</a> , <a href="#">userstring.get</a>                                                                                                |
| Example                  | Deletes user-defined strings from nonvolatile memory:<br><code>userstring.delete("assetnumber")</code><br><code>userstring.delete("department")</code><br><code>userstring.delete("contact")</code> |

| <b>userstring.get</b>  |                                                                                                                                                                  |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function               | Retrieves a user-defined string from nonvolatile memory.                                                                                                         |
| TSP-Link accessibility | This function can be accessed from a remote TSP-Link node.                                                                                                       |
| Usage                  | <code>value = userstring.get(name)</code><br><br>name<br>Name of the user string.<br>value<br>Returns the string value associated with name.                     |
| Remarks                | This function will retrieve from nonvolatile memory the string that is associated with the string <code>name</code> .                                            |
| Also see               | <a href="#">userstring.add</a> , <a href="#">userstring.catalog</a> , <a href="#">userstring.delete</a>                                                          |
| Example                | Retrieves the value for a user string from nonvolatile memory:<br><code>value = userstring.get("assetnumber")</code><br><code>print(value)</code><br>Output: 236 |



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>tonumber(x [,base])</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Returns <code>x</code> converted to a number. If <code>x</code> is already a number, or a convertible string, then the number is returned; otherwise, it returns <code>nil</code> .<br>An optional argument specifies the base to interpret the numeral. The base may be any integer between 2 and 36, inclusive. In bases above 10, the letter 'A' (in either upper or lower case) represents 10, 'B' represents 11, and so forth, with 'Z' representing 35. In base 10, the default, the number may have a decimal part, as well as an optional exponent. In other bases, only unsigned integers are accepted. |
| <code>tostring(x)</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Receives an argument of any type and converts it to a string in a reasonable format.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <code>type(v)</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Returns the type of its only argument, coded as a string. The possible results of this function are: <code>nil</code> , <code>number</code> , <code>Boolean</code> , <code>table</code> , or <code>function</code> .                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>NOTE:</b> TSL does automatic memory management. That means that you do not have to worry about allocating memory for new objects and freeing it when the objects are no longer needed. TSL manages memory automatically by running a garbage collector from time to time to collect all dead objects (that is, those objects that are no longer accessible from TSL). All objects in TSL are subject to automatic management: tables, variables, functions, threads, and strings. TSL uses two numbers to control its garbage-collection cycles. One number counts how many bytes of dynamic memory TSL is using; the other is a threshold. When the number of bytes crosses the threshold, TSL runs the garbage collector, which reclaims the memory of all dead objects. The byte counter is adjusted, and then the threshold is reset to twice the new value of the byte counter. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

## String library functions

This library provides generic functions for string manipulation, such as finding and extracting substrings. When indexing a string in TSL, the first character is at position 1 (not 0 as in ANSI C). Indices may be negative and are interpreted as indexing backwards, from the end of the string. Thus, the last character is at position 1, and so on.

|                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>string.byte(s [,i])</code>            | Returns the internal numerical code of the <code>i</code> -th character of string <code>s</code> , or <code>nil</code> if the index is out of range.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <code>string.char(i1, i1, ...)</code>       | Receives 0 or more integers. Returns a string with length equal to the number of arguments, in which each character has the internal numerical code equal to its corresponding argument.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <code>string.format(fs, e1, e2, ...)</code> | Returns a formatted version of its variable number of arguments following the description given in its first argument, which must be a string. The format string follows the same rules as the print family of ANSI C functions. The only differences are that the options/modifiers <code>*</code> , <code>l</code> , <code>L</code> , <code>n</code> , <code>p</code> , and <code>h</code> are not supported. The options <code>c</code> , <code>d</code> , <code>E</code> , <code>e</code> , <code>f</code> , <code>g</code> , <code>G</code> , <code>l</code> , <code>o</code> , <code>u</code> , <code>X</code> , and <code>x</code> all expect a numeric argument, where <code>s</code> expects a string argument. String values to be formatted with <code>%s</code> cannot contain embedded zeros. |
| <code>string.len(s)</code>                  | Returns the length of the strings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <code>string.lower(s)</code>                | Returns a copy of the string <code>s</code> with all uppercase letters changed to lowercase.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <code>string.rep(s, n)</code>               | Returns a string that is the concatenation of <code>n</code> copies of the string <code>s</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <code>string.sub(s, i [,j])</code>          | Returns the substring of <code>s</code> that starts at <code>i</code> and continues until <code>j</code> . <code>i</code> and <code>j</code> may be negative. If <code>j</code> is absent, then it is assumed to be equal to <code>-1</code> , which is the same as the string length. In particular, the call <code>string.sub(s, 1, j)</code> returns a prefix <code>s</code> with length <code>j</code> , and <code>string.sub(s, -i)</code> returns a suffix <code>s</code> with length <code>i</code> .                                                                                                                                                                                                                                                                                               |
| <code>string.upper(s)</code>                | Returns a copy of the string <code>s</code> with all lowercase letters changed to uppercase.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## Math library functions

This library is an interface to most of the functions of the ANSI C math library. All trigonometric functions work in radians. The functions `math.deg()` and `math.rad()` convert between radians and degrees.

|                                   |                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>math.abs(x)</code>          | Returns the absolute value of the argument <code>x</code> .                                                                                                                                                                                                                                                                     |
| <code>math.acos(x)</code>         | Returns the principal value of the trigonometric arc cosine function of <code>x</code> .                                                                                                                                                                                                                                        |
| <code>math.asin(x)</code>         | Returns the principal value of the trigonometric arc sine function of <code>x</code> .                                                                                                                                                                                                                                          |
| <code>math.atan(x)</code>         | Returns the principal value of the trigonometric arc tangent function of <code>x</code> .                                                                                                                                                                                                                                       |
| <code>math.atan2(y,x)</code>      | Returns the principal value of the trigonometric arc tangent function of <code>y/x</code> .                                                                                                                                                                                                                                     |
| <code>math.ceil(x)</code>         | Returns the smallest floating-point number not less than <code>x</code> whose value is an exact mathematical integer.                                                                                                                                                                                                           |
| <code>math.cos(x)</code>          | Returns the trigonometric cosine function of <code>x</code> .                                                                                                                                                                                                                                                                   |
| <code>math.deg(x)</code>          | Returns the value of <code>x</code> in degrees, where <code>x</code> is in radians.                                                                                                                                                                                                                                             |
| <code>math.exp(x)</code>          | Returns the exponential function of <code>x</code> ; that is, $e^x$ , where $e$ is the base of the natural logarithms.                                                                                                                                                                                                          |
| <code>math.floor(x)</code>        | Returns the largest floating-point number not greater than <code>x</code> whose value is an exact mathematical integer.                                                                                                                                                                                                         |
| <code>math.log(x)</code>          | Returns the natural logarithm function of <code>x</code> .                                                                                                                                                                                                                                                                      |
| <code>math.log10(x)</code>        | Returns the base-10 logarithm function of <code>x</code> .                                                                                                                                                                                                                                                                      |
| <code>math.max(x, y, ...)</code>  | Returns the maximum value of its numeric argument(s).                                                                                                                                                                                                                                                                           |
| <code>math.min(x, y, ...)</code>  | Returns the minimum value of its argument(s).                                                                                                                                                                                                                                                                                   |
| <code>math.mod(x, y)</code>       | Returns an approximation to the mathematical value $f$ such that $f$ has the same sign as <code>x</code> , the absolute value of $f$ is less than the absolute value of <code>y</code> , and there exists an integer $k$ such that $k*y+f = x$ .                                                                                |
| <code>math.pi</code>              | Variable containing the value of $\pi$ (3.141592654).                                                                                                                                                                                                                                                                           |
| <code>math.pow(x, y)</code>       | Returns $x^y$ .                                                                                                                                                                                                                                                                                                                 |
| <code>math.rad(x)</code>          | Returns the value of <code>x</code> in radians, where <code>x</code> is in degrees.                                                                                                                                                                                                                                             |
| <code>math.sin(x)</code>          | Returns the trigonometric sine function of <code>x</code> .                                                                                                                                                                                                                                                                     |
| <code>math.sqrt(x)</code>         | Returns the non-negative square root of <code>x</code> .                                                                                                                                                                                                                                                                        |
| <code>math.tan(x)</code>          | Returns the trigonometric tangent function of <code>x</code> .                                                                                                                                                                                                                                                                  |
| <code>math.frexp()</code>         | Splits <code>x</code> into a fraction $f$ and exponent $n$ , such that $f$ is 0.0 or 0.5 $\leq  f  \leq 1.0$ , and $f * 2^n$ is equal to <code>x</code> . Both $f$ and $n$ are returned; $f, n = \text{math.frexp}(x)$ .                                                                                                        |
| <code>math.ldexp(x, n)</code>     | Returns the inverse of the <code>math.frexp()</code> function; it computes the value $x * 2^n$ .                                                                                                                                                                                                                                |
| <code>math.random([x],[y])</code> | When called without an argument, returns a pseudo-random real number in the range $[0, 1)$ .<br>When called with number <code>x</code> , returns a pseudo-random integer in the range $[1, n]$ .<br>When called with two arguments, <code>x</code> and <code>y</code> , returns a pseudo-random integer in the range $[x, y]$ . |
| <code>math.randomseed(x)</code>   | Sets a "seed" for the pseudo-random generator. Equal seeds produce equal sequences of numbers.                                                                                                                                                                                                                                  |

## Factory scripts

### Introduction

The Keithley Instruments Series 2600A System SourceMeter® instrument is shipped with one or more Factory Scripts saved in its flash firmware memory. A factory script is made up of a number of functions. Some of them can be called from the front panel LOAD TEST menu. All of them can be called using remote programming.



As Keithley Instruments develops additional factory scripts, they will be made available on the Keithley Instruments web site ([www.keithley.com](http://www.keithley.com)) as a flash firmware upgrade for the Series 2600A. See [Upgrading the firmware](#) for instructions on upgrading the flash firmware of your Series 2600A.

A factory script is similar to a user script, except a factory script is created by Keithley Instruments at the factory and is permanently stored in nonvolatile memory. The differences between a user script and a factory script include the following:

- A factory script cannot be deleted from nonvolatile memory.
- The script listing for a factory script can be retrieved and modified, but it will then be treated as a user script. A user script cannot be saved as a factory script.
- Factory scripts are not stored in global variables. The only references to factory scripts are in `script.factory.scripts`.

The `script.factory.catalog()` function returns an iterator that can be used in a for loop to iterate over all the factory scripts.

Example:

Retrieve the catalog listing for factory scripts:

```
for name in script.factory.catalog() do
 print(name)
end
```

As Keithley Instruments develops additional factory scripts, they will be available on the Keithley Instruments website ([www.keithley.com](http://www.keithley.com)) as a flash firmware upgrade for the Series 2600A.

## Running a factory script

Use either of the following commands to run a factory script:

```
script.factory.scripts.name()
script.factory.scripts.name.run()
```

where: `name` is the name of the factory script.

Example:

Run the factory script named “KIPulse”

```
script.factory.scripts.KIPulse()
```

### Running a factory script function from the Series 2600A front panel controls

1. Press the **LOAD** key.
2. Select **Factory**.
3. Select the function to run and press **RUN** key.

## Modifying a factory script

### Retrieving a factory script listing

The script listing for a factory script can be retrieved and modified. However, it cannot be saved as a factory script. The modified script can be saved as a user script using the same name or a new name.

---

**NOTE** An imported factory script can only be loaded back into the Series 2600A as a user script.

---

The following function retrieves a script listing. The script chunk is returned, along with the shell keywords (`loadscript` or `loadandrunscript`, and `endscript`):

```
script.factory.scripts.name.list()
```

where: `name` is the name of the factory script.

Example:

Retrieve the script listing for a factory script named “KIPulse”:

```
script.factory.scripts.KIPulse.list()
```

## Factory script information

### KISweep

The KISweep factory script provides simple sweep test programming and can be used as an example of how to use the sweeping function.

The KISweep factory script is made up of the following functions. All of these functions can be accessed from both the front panel and the remote interfaces. These functions provide simple sweeping operations and can be used as examples of how to use the sweeping functions. Details on these functions are provided in the tables that follow.

```
SweepILinMeasureV(smu, starti, stopi, stime, points)
SweepVLinMeasureI(smu, startv, stopv, stime, points)
SweepILogMeasureV(smu, starti, stopi, stime, points)
SweepVLogMeasureI(smu, startv, stopv, stime, points)
SweepIListMeasureV(smu, ilist, stime, points)
SweepVListMeasureI(smu, vlist, stime, points)
```

Table 19-3

#### KISweep TSP test script: SweepILinMeasureV

|                                                                   |
|-------------------------------------------------------------------|
| <b>TSP project name: KISweep</b>                                  |
| <b>TSP test script name: KISweep</b>                              |
| Function:<br>SweepILinMeasureV(smu, starti, stopi, stime, points) |

Table 19-3 (cont.)  
**KISweep TSP test script: SweepLinMeasureV**

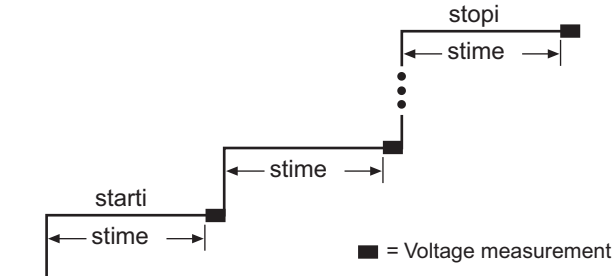
| <b>TSP project name: KISweep</b><br><b>TSP test script name: KISweep</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description                                                              | <p>Performs a linear current sweep with voltage measured at every step (point):</p> <ul style="list-style-type: none"> <li>• Sets the <code>smu</code> to output <code>starti</code> amps, allows the source to settle for <code>stime</code> seconds, and then performs a voltage measurement.</li> <li>• Sets the <code>smu</code> to output the next amps step, allows the source to settle for <code>stime</code> seconds, and then performs a voltage measurement.</li> <li>• Repeats the above sequence until the voltage is measured on the <code>stopi</code> amps step.</li> </ul> <p>The linear step size is automatically calculated as follows:<br/> <math>step = (stopi - starti) / (points - 1)</math></p>  <p style="text-align: right;">■ = Voltage measurement</p> |
| Parameters                                                               | <p><code>smu</code>, <code>starti</code>, <code>stopi</code>, <code>stime</code>, <code>points</code></p> <p><code>smu</code>: SourceMeter instrument Channel (A or B). Defaults to SMU A if all parameters are omitted when function is called.</p> <p><code>starti</code>: Sweep start current in amps.</p> <p><code>stopi</code>: Sweep stop current in amps.</p> <p><code>stime</code>: Settling time in seconds. Occurs after stepping the source and before performing a measurement.</p> <p><code>points</code>: Number of sweep points (must be <math>\geq 2</math>).</p>                                                                                                                                                                                                                                                                                     |
| Data                                                                     | Voltage measurements, current source values and timestamps are stored in <code>smuX.nvbuffer1</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Example                                                                  | <p><code>SweepLinMeasureV(smuA, -1E-3, 1E-3, 0, 100)</code></p> <p>This function performs a 100-point linear current sweep starting at -1mA and stopping at +1mA. Voltage is measured at every step (point) in the sweep. Since <code>stime</code> is set for 0s, voltage will be measured as fast as possible after each current step.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

Table 19-4  
**KISweep TSP test script: SweepVLinMeasureI**

| <b>TSP project name: KISweep</b><br><b>TSP test script name: KISweep</b> |                                                                   |
|--------------------------------------------------------------------------|-------------------------------------------------------------------|
| Function:                                                                | <code>SweepVLinMeasureI(smu, startv, stopv, stime, points)</code> |

Table 19-4 (cont.)  
**KISweep TSP test script: SweepVLinMeasureI**

|                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>TSP project name: KISweep</b><br/> <b>TSP test script name: KISweep</b></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <p>Description</p>                                                                | <p>Performs a linear voltage sweep with current measured at every step (point):</p> <ul style="list-style-type: none"> <li>• Sets the <code>smu</code> to output <code>startv</code> volts, allows the source to settle for <code>stime</code> seconds and then performs a current measurement.</li> <li>• Sets the <code>smu</code> to output the next volts step, allows the source to settle for <code>stime</code> seconds and then performs a current measurement.</li> <li>• Repeats the above sequence until the current is measured on the <code>stopv</code> volts step.</li> </ul> <p>The linear step size is automatically calculated as follows:<br/> <math display="block">step = (stopv - startv) / (points - 1)</math></p> |
| <p>Parameters</p>                                                                 | <p><code>smu, startv, stopv, stime, points</code></p> <p><code>smu</code>: SourceMeter instrument channel (A or B). Defaults to SMU A if all parameters are omitted when function is called.</p> <p><code>startv</code>: Sweep start voltage in volts.</p> <p><code>stopv</code>: Sweep stop voltage in volts.</p> <p><code>stime</code>: Settling time in seconds. Occurs after stepping the source and before performing a measurement.</p> <p><code>points</code>: Number of sweep points (must be <math>\geq 2</math>).</p>                                                                                                                                                                                                           |
| <p>Data</p>                                                                       | <p>Current measurements, voltage source values and timestamps are stored in <code>smuX.nvbuffer1</code>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <p>Example</p>                                                                    | <p><code>SweepVLinMeasureI(smua, -1, 1, 1E-3, 1000)</code></p> <p>This function performs a 1000-point linear voltage sweep starting at -1V and stopping at +1V. Current is measured at every step (point) in the sweep after a 1ms source settling period.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

Table 19-5

**KISweep TSP test script: SweepLogMeasureV**

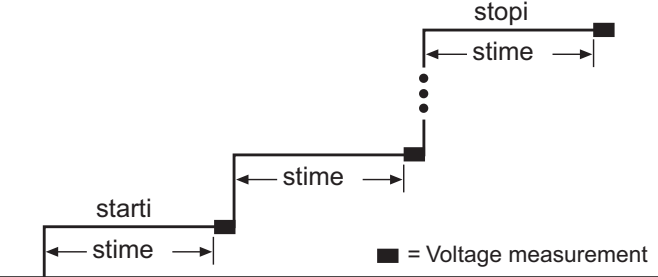
|                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KISweep</b>                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>TSP test script name: KISweep</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Function:<br>SweepLogMeasureV(smu, starti, stopi, stime, points) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Description                                                      | <p>Performs a logarithmic current sweep with voltage measured at every step (point):</p> <ul style="list-style-type: none"> <li>• Sets the smu to output starti amps, allows the source to settle for stime seconds and then performs a voltage measurement.</li> <li>• Sets the smu to output the next amps step, allows the source to settle for stime seconds and then performs a voltage measurement.</li> <li>• Repeats the above sequence until the voltage is measured on the stopi amps step.</li> </ul> <p>The source level at each step (SourceStepLevel) is automatically calculated as follows:</p> <p><b>MeasurePoint</b> = The step point number for a measurement. For example, for a 5-point sweep (points = 5), a measurement will be performed at MeasurePoint 1, 2, 3, 4 and 5.</p> <p><b>LogStepSize</b> = <math>(\log_{10}(\text{stopi}) - \log_{10}(\text{starti})) / (\text{points} - 1)</math></p> <p><b>LogStep</b> = <math>(\text{MeasurePoint} - 1) \times (\text{LogStepSize})</math></p> <p><b>SourceStepLevel</b> = <math>\text{antilog}(\text{LogStep}) \times \text{starti}</math></p>  |
| Parameters                                                       | <p>smu, starti, stopi, stime, points</p> <p>smu: SourceMeter instrument channel (A or B). Defaults to SMU A if all parameters are omitted when function is called.</p> <p>starti: Sweep start current in amps.</p> <p>stopi: Sweep stop current in amps.</p> <p>stime: Settling time in seconds. Occurs after stepping the source and before performing a measurement.</p> <p>points: Number of sweep measure points (must be <math>\geq 2</math>).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Data                                                             | Voltage measurements, current source values and timestamps are stored in smuX.nvbuffer1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

Table 19-5 (cont.)  
**KISweep TSP test script: SweepILogMeasureV**

| <b>TSP project name: KISweep</b>                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                     |                        |                |                        |   |      |     |       |   |      |      |           |   |      |     |           |   |      |      |           |   |      |     |      |
|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------|----------------|------------------------|---|------|-----|-------|---|------|------|-----------|---|------|-----|-----------|---|------|------|-----------|---|------|-----|------|
| <b>TSP test script name: KISweep</b>                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                     |                        |                |                        |   |      |     |       |   |      |      |           |   |      |     |           |   |      |      |           |   |      |     |      |
| Function:<br>SweepILogMeasureV(smu, starti, stopi, stime, points) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                     |                        |                |                        |   |      |     |       |   |      |      |           |   |      |     |           |   |      |      |           |   |      |     |      |
| Example                                                           | <p>SweepILogMeasureV(smua, 0.01, 0.1, 0.001, 5)</p> <p>This function performs a 5-point logarithmic current sweep starting at 10mA and stopping at 100mA. Voltage is measured at every step (point) in the sweep. The source will be allowed to settle on each step for 1ms before a measurement is performed.</p> <p>The following log values and corresponding source levels for the 5-point log sweep are listed as follows:</p> <table border="1"> <thead> <tr> <th><u>MeasurePoint</u></th> <th><u>LogStepSize</u></th> <th><u>LogStep</u></th> <th><u>SourceStepLevel</u></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0.25</td> <td>0.0</td> <td>0.01A</td> </tr> <tr> <td>2</td> <td>0.25</td> <td>0.25</td> <td>0.017783A</td> </tr> <tr> <td>3</td> <td>0.25</td> <td>0.5</td> <td>0.031623A</td> </tr> <tr> <td>4</td> <td>0.25</td> <td>0.75</td> <td>0.056234A</td> </tr> <tr> <td>5</td> <td>0.25</td> <td>1.0</td> <td>0.1A</td> </tr> </tbody> </table> | <u>MeasurePoint</u> | <u>LogStepSize</u>     | <u>LogStep</u> | <u>SourceStepLevel</u> | 1 | 0.25 | 0.0 | 0.01A | 2 | 0.25 | 0.25 | 0.017783A | 3 | 0.25 | 0.5 | 0.031623A | 4 | 0.25 | 0.75 | 0.056234A | 5 | 0.25 | 1.0 | 0.1A |
| <u>MeasurePoint</u>                                               | <u>LogStepSize</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <u>LogStep</u>      | <u>SourceStepLevel</u> |                |                        |   |      |     |       |   |      |      |           |   |      |     |           |   |      |      |           |   |      |     |      |
| 1                                                                 | 0.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.0                 | 0.01A                  |                |                        |   |      |     |       |   |      |      |           |   |      |     |           |   |      |      |           |   |      |     |      |
| 2                                                                 | 0.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.25                | 0.017783A              |                |                        |   |      |     |       |   |      |      |           |   |      |     |           |   |      |      |           |   |      |     |      |
| 3                                                                 | 0.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.5                 | 0.031623A              |                |                        |   |      |     |       |   |      |      |           |   |      |     |           |   |      |      |           |   |      |     |      |
| 4                                                                 | 0.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.75                | 0.056234A              |                |                        |   |      |     |       |   |      |      |           |   |      |     |           |   |      |      |           |   |      |     |      |
| 5                                                                 | 0.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1.0                 | 0.1A                   |                |                        |   |      |     |       |   |      |      |           |   |      |     |           |   |      |      |           |   |      |     |      |

Table 19-6

**KISweep TSP test script: SweepVLogMeasureI**

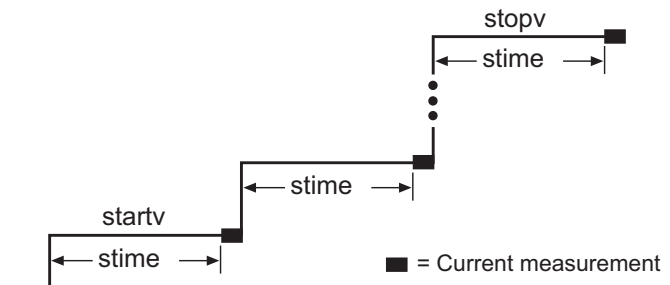
|                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KISweep</b>                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>TSP test script name: KISweep</b>                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Function:<br>SweepVLogMeasureI(smu, startv, stopv, stime, points) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Description                                                       | <p>Performs a logarithmic voltage sweep with current measured at every step (point):</p> <ul style="list-style-type: none"> <li>• Sets the smu to output startv volts, allows the source to settle for stime seconds and then performs a current measurement.</li> <li>• Sets the smu to output the next volts step, allows the source to settle for stime seconds and then performs a current measurement.</li> <li>• Repeats the above sequence until the current is measured on the stopi amps step.</li> </ul> <p>The source level at each step (SourceStepLevel) is automatically calculated as follows:</p> <p><b>MeasurePoint</b> = The step point number for a measurement. For example, for a 5-point sweep (points = 5), a measurement will be performed at MeasurePoint 1, 2, 3, 4 and 5.</p> <p><b>LogStepSize</b> = <math>(\log_{10}(\text{stopi}) - \log_{10}(\text{starti})) / (\text{points} - 1)</math></p> <p><b>LogStep</b> = <math>(\text{MeasurePoint} - 1) \times (\text{LogStepSize})</math></p> <p><b>SourceStepLevel</b> = <math>\text{antilog}(\text{LogStep}) \times \text{starti}</math></p>  |
| Parameters                                                        | <p>smu, startv, stopv, stime, points</p> <p>smu: SourceMeter instrument channel (A or B). Defaults to SMU A if all parameters are omitted when function is called.</p> <p>starti: Sweep start voltage in amps.</p> <p>stopi: Sweep stop voltage in amps.</p> <p>stime: Settling time in seconds. Occurs after stepping the source and before performing a measurement.</p> <p>points: Number of sweep measure points (must be <math>\geq 2</math>).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Data                                                              | Current measurements, voltage source values and timestamps are stored in smuX.nvbuffer1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

Table 19-6 (cont.)

**KISweep TSP test script: SweepVLogMeasureI**

| <b>TSP project name: KISweep</b>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |                        |                |                        |   |      |     |         |   |      |      |         |   |      |     |         |   |      |      |         |   |      |     |         |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------|----------------|------------------------|---|------|-----|---------|---|------|------|---------|---|------|-----|---------|---|------|------|---------|---|------|-----|---------|
| <b>TSP test script name: KISweep</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |                        |                |                        |   |      |     |         |   |      |      |         |   |      |     |         |   |      |      |         |   |      |     |         |
| Example                              | <pre>SweepVLogMeasureI(smua, 1, 10, 0.001, 5)</pre> <p>This function performs a 5-point logarithmic voltage sweep starting at 1V and stopping at 10V. Current is measured at every step (point) in the sweep. The source will be allowed to settle on each step for 1ms before a measurement is performed.</p> <p>The following log values and corresponding source levels for the 5-point log sweep are listed as follows:</p> <table border="1"> <thead> <tr> <th><u>MeasurePoint</u></th> <th><u>LogStepSize</u></th> <th><u>LogStep</u></th> <th><u>SourceStepLevel</u></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0.25</td> <td>0.0</td> <td>1.0000V</td> </tr> <tr> <td>2</td> <td>0.25</td> <td>0.25</td> <td>1.7783V</td> </tr> <tr> <td>3</td> <td>0.25</td> <td>0.5</td> <td>3.1623V</td> </tr> <tr> <td>4</td> <td>0.25</td> <td>0.75</td> <td>5.6234V</td> </tr> <tr> <td>5</td> <td>0.25</td> <td>1.0</td> <td>10.000V</td> </tr> </tbody> </table> | <u>MeasurePoint</u> | <u>LogStepSize</u>     | <u>LogStep</u> | <u>SourceStepLevel</u> | 1 | 0.25 | 0.0 | 1.0000V | 2 | 0.25 | 0.25 | 1.7783V | 3 | 0.25 | 0.5 | 3.1623V | 4 | 0.25 | 0.75 | 5.6234V | 5 | 0.25 | 1.0 | 10.000V |
| <u>MeasurePoint</u>                  | <u>LogStepSize</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <u>LogStep</u>      | <u>SourceStepLevel</u> |                |                        |   |      |     |         |   |      |      |         |   |      |     |         |   |      |      |         |   |      |     |         |
| 1                                    | 0.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0.0                 | 1.0000V                |                |                        |   |      |     |         |   |      |      |         |   |      |     |         |   |      |      |         |   |      |     |         |
| 2                                    | 0.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0.25                | 1.7783V                |                |                        |   |      |     |         |   |      |      |         |   |      |     |         |   |      |      |         |   |      |     |         |
| 3                                    | 0.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0.5                 | 3.1623V                |                |                        |   |      |     |         |   |      |      |         |   |      |     |         |   |      |      |         |   |      |     |         |
| 4                                    | 0.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0.75                | 5.6234V                |                |                        |   |      |     |         |   |      |      |         |   |      |     |         |   |      |      |         |   |      |     |         |
| 5                                    | 0.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1.0                 | 10.000V                |                |                        |   |      |     |         |   |      |      |         |   |      |     |         |   |      |      |         |   |      |     |         |

Table 19-7

**KISweep TSP test script: SweepIListMeasureV**

|                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KISweep</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>TSP test script name: KISweep</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Function:<br>SweepIListMeasureV(smua, 1, 10, 0.001, 5) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Description                                            | <p>Performs a current list sweep with voltage measured at every step (point):</p> <ul style="list-style-type: none"> <li>• Sets the smu to output the first <i>ilist</i> amps value, allows the source to settle for <i>stime</i> seconds and then performs a voltage measurement.</li> <li>• Sets the smu to output the next <i>ilist</i> amps value, allows the source to settle for <i>stime</i> seconds and then performs a voltage measurement.</li> <li>• Repeats the above sequence until the voltage is measured for the last amps value. The last point in the list to be measured is <i>points</i>.</li> </ul> |
| Parameters                                             | <p><i>smu</i>, <i>ilist</i>, <i>stime</i>, <i>points</i></p> <p><i>smu</i>: SourceMeter instrument Channel (A or B). Defaults to SMU A if all parameters are omitted when function is called.</p> <p><i>ilist</i>: Arbitrary list of current source values:<br/><i>ilist</i> = {value1, value2, ...valueN}</p> <p><i>stime</i>: Settling time in seconds. Occurs after sourcing a value and before performing a measurement.</p> <p><i>points</i>: Number of sweep measure points (must be ≥2).</p>                                                                                                                      |
| Data                                                   | Voltage measurements, current source values and timestamps are stored in <i>smuX.nvbuffer1</i> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Example                                                | <pre>myilist = {-100E-9, 100E-9, -1E-6, 1E-6, -1E-3, 1E-3}</pre> <pre>SweepIListMeasureV(smua, myilist, 500E-6, 6)</pre> <p>This function performs a 6-point current list sweep starting at the first point in <i>myilist</i>. Voltage is measured at every step (point) in the sweep. The source will be allowed to settle on each value for 500µs before a measurement is performed.</p>                                                                                                                                                                                                                               |



Table 19-8  
**KISweep TSP test script: SweepVListMeasureI**

|                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KISweep</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>TSP test script name: KISweep</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Function:<br>SweepVListMeasureI(smu, vlist, stime, points) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Description                                                | <p>Performs a voltage list sweep with current measured at every step (point):</p> <ul style="list-style-type: none"> <li>• Sets the <code>smu</code> to output the first <code>vlist</code> volts value, allows the source to settle for <code>stime</code> seconds and then performs a current measurement.</li> <li>• Sets the <code>smu</code> to output the next <code>vlist</code> volts value, allows the source to settle for <code>stime</code> seconds and then performs a current measurement.</li> <li>• Repeats the above sequence until the current is measured for the last volts value. The last point in the list to be measured is <code>points</code>.</li> </ul> |
| Parameters                                                 | <p><code>smu, vlist, stime, points</code></p> <p><code>smu</code>: SourceMeter instrument Channel (A or B). Defaults to SMU A if all parameters are omitted when function is called.</p> <p><code>vlist</code>: Arbitrary list of voltage source values:<br/> <code>vlist = {value1, value2, ...valueN}</code></p> <p><code>stime</code>: Settling time in seconds. Occurs after sourcing a value and before performing a measurement.</p> <p><code>points</code>: Number of sweep measure points (must be <math>\geq 2</math>).</p>                                                                                                                                                |
| Data                                                       | Current measurements, voltage source values and timestamps are stored in <code>smuX.nvbuffer1</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Example                                                    | <pre>myvlist = {-0.1, 0.1, -1, 1, -6, 6, -40, 40, 0, 0}</pre> <pre>SweepVListMeasureI(smua, myvlist, 500E-6, 10)</pre> <p>This function performs a 10-point voltage list sweep starting at the first point in <code>myvlist</code>. Current is measured at every step (point) in the sweep. The source will be allowed to settle on each value for 500<math>\mu</math>s before a measurement is performed.</p>                                                                                                                                                                                                                                                                      |

## KIPulse

The KIPulse factory script provides examples of how to generate pulses and to provide a simple pulsing interface. Pulses can be generated using the functions listed below.

---

**NOTE** This factory script only operates on the channels present in the SourceMeter instrument executing the pulse functions. These functions will not operate correctly if the user attempts to access SourceMeter instrument channels over the TSP-Link.

---

```
PulseIMeasureV
PulseVMeasureI
ConfigPulseIMeasureV
ConfigPulseVMeasureI
ConfigPulseIMeasureVSweepLin
ConfigPulseVMeasureISweepLin
ConfigPulseIMeasureVSweepLog
ConfigPulseVMeasureISweepLog
QueryPulseConfig
InitiatePulseTest
InitiatePulseTestDual
```

---

**NOTE** `PulseIMeasureV` and `PulseVMeasureI` may be accessed from the front panel. The remaining scripts may only be accessed remotely.

---

The “Config” functions are used to configure a pulse train and assign the configuration to the `tag` parameter. The `Initiate` functions are used to execute the pulse train(s) assigned to its `tag` argument(s). The conditions listed in the table below must be true for these functions to execute successfully.

Table 19-9  
Required true conditions for “Initiate” function execution

| Config                            | InitiatePulseTest                                               | InitiatePulseTestDual                                           |
|-----------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|
| Source auto-range (I and V) off.  | Output on.                                                      | Output on.                                                      |
| Measure auto-range (I and V) off. | Enough free space in buffer.                                    | Enough free space in buffer.                                    |
| Measure NPLC < ton.               | Buffer <code>appendmode</code> on when pulse train is >1 point. | Buffer <code>appendmode</code> on when pulse train is >1 point. |
| Measure autozero OFF or ONCE.     | Safety interlock engaged when using the 200V range.             | Safety interlock engaged when using the 200V range.             |
|                                   |                                                                 | Different unique SMUs for each <code>tag</code> .               |
|                                   |                                                                 | Same NPLC setting for each <code>tag</code> .                   |
|                                   |                                                                 | Same <code>toff</code> for each <code>tag</code> .              |

Table 19-10  
**KISweep TSP test script: PulseIMeasureV**

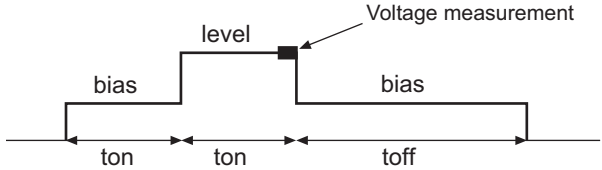
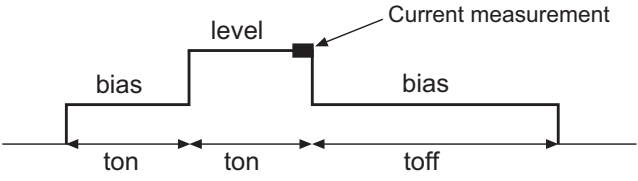
|                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b>                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>TSP test script name: KIPulse</b>                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Function:<br>PulseIMeasureV<br>PulseIMeasureV(smu, bias, level, ton, toff, points) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Description                                                                        | <p>Performs a specified number of pulse I, measure V cycles:</p> <ul style="list-style-type: none"> <li>• Sets the smu to output bias amps and dwell for ton seconds.</li> <li>• Sets the smu to output level amps and dwell for ton seconds.</li> <li>• Performs voltage measurement with source at level amps.</li> <li>• Sets the smu to output bias amps for toff seconds.</li> <li>• Repeats the above sequence for points pulse-measure cycles.</li> </ul>  |
| Parameters                                                                         | <p>smu, bias, level, ton, toff, points</p> <p>smu: SourceMeter instrument channel (A or B). Defaults to SMU A if all parameters are omitted when function is called.</p> <p>bias: Bias level in amps.</p> <p>level: Pulse level in amps.</p> <p>ton: Pulse on time in seconds.</p> <p>toff: Pulse off time in seconds.</p> <p>points: Number of pulse-measure cycles.</p>                                                                                                                                                                           |
| Data                                                                               | Pulsed voltage measurements, current levels, and timestamps are stored in smuX.nvbuffer1.                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Example                                                                            | <p>PulseIMeasureV(smua, 0.001, 1.0, 20E-3, 40E-3, 10)</p> <p>SMU A will output 1mA and dwell for 20ms, output 1A and dwell for 20ms, and then perform a voltage measurement. After the measurement, the output will return to 1mA and dwell for 40ms. This pulse-measure process will repeat 9 more times.</p>                                                                                                                                                                                                                                      |

Table 19-11  
KISweep TSP test script: PulseVMeasureI

|                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b>                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>TSP test script name: KIPulse</b>                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Function:<br>PulseVMeasureI<br>PulseVMeasureI(smu, bias, level, ton, toff, points) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Description                                                                        | <p>Performs a specified number of pulse V, measure I cycles:</p> <ul style="list-style-type: none"> <li>• Sets the smu to output bias volts and dwell for ton seconds.</li> <li>• Sets the smu to output level volts and dwell for ton seconds.</li> <li>• Performs current measurement with source at level amps.</li> <li>• Sets the smu to output bias volts for toff seconds.</li> <li>• Repeats the above sequence for points pulse-measure cycles.</li> </ul>  |
| Parameters                                                                         | <p>smu, bias, level, ton, toff, points</p> <p>smu: SourceMeter instrument channel (A or B). Defaults to SMU A if all parameters are omitted when function is called.</p> <p>bias: Bias level in volts.</p> <p>level: Pulse level in volts.</p> <p>ton: Pulse on-time in seconds.</p> <p>toff: Pulse off-time in seconds.</p> <p>points: Number of pulse-measure cycles.</p>                                                                                                                                                                            |
| Data                                                                               | Pulsed current measurements, voltage levels and timestamps are stored in smuX.nvbuffer1.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Example                                                                            | <p>PulseVMeasureI(smub, -1, 1, 1E-3, 2E-3, 20)</p> <p>SMU B will output -1V and dwell for 1ms, output 1V and dwell for 2ms, and then perform a current measurement. After the measurement, the output will return to -1V and dwell for 2ms. This pulse-measure process will repeat 19 more times.</p>                                                                                                                                                                                                                                                  |

## Advanced features

### Variable off time between pulses in a pulse train

The KIPulse “Configure” functions will accept the `off_time` parameter as a table as well as just a number. The table allows defining different off times to be used after each pulse.

The following should be noted:

1. If `off_time` is passed as a number or only a single value is used in the table, it will be used for all points in a multiple point pulse.
2. The number of times specified in the table must match the number of points called for in the sweep.
3. The times used in tables must match for dual channel pulsing.
4. Each specified `off_time` must adhere to the duty cycle limits for the specified pulsing region.

Example:

```

local timelist1 = { 1, 2, 3, 4, 5 }
local timelist2 = { }
for i = 1,5 do timelist2[i] = math.pow(10, i) end

```

Configure a pulse with 1 second on time and variable off time, no measurement:

```
f,msg = ConfigPulseVMeasureI(smua, 0, 1, 100e-3, 1, timelist1, 5, nil, 1)
```

### Simultaneous IV measurement during pulse

The KIPulse “Configure” functions will optionally accept an extra reading buffer in order to activate simultaneous IV measurements during pulsing.

Previous usage of passing in a reading buffer or a nil (for no measurement) is still supported.

Example:

```

rbi = smua.makebuffer(10)
rbv = smua.makebuffer(10)
rbi.appendmode = 1
rbv.appendmode = 1

rbs = { i = rbi, v = rbv }

f,msg = ConfigPulseVMeasureI(smua, 0, 10, 1e-3, 1e-3, 1e-3,
2, rbs, 1)

```

### Additional hardware triggering parameters

Parameters added to the “Configure” functions after the `sync_out` parameter:

- `*sync_in_timeout`: specifies the length of time (in seconds) to wait for input trigger (defaults to 10s).
- `*sync_in_abort` (true or false), whether to abort pulse if in put trigger is not received before timeout expires (defaults to true).
- If pulse aborts due to missed trigger, message returned to the user indicates timer timeout.

---

NOTE \*These parameters are new to firmware version 1.3.0.

---

Table 19-12

### KIPulse TSP test script: ConfigPulseIMeasureV

|                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b>                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>TSP test script name: KIPulse</b>                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Function:<br>ConfigPulseIMeasureV                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Usage:<br>f, msg = ConfigPulseIMeasureV<br>(smu,bias,level,limit,ton,toff,points,buffer,tag[,sync_in][,sync_out]<br>[,sync_in_timeout][,sync_in_abort]) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Description                                                                                                                                             | Configures a current pulse train with a voltage measurement at each point. Measurement(s) will be made at the end of the ton time. This function does not cause the specified smu to output a pulse train. It simply checks to see if all of the pulse dimensions are achievable and if so, assigns the indicated tag or index to the pulse train. The <code>InitiatePulseTest(tag)</code> and <code>InitiatePulseTestDual(tag)</code> functions are used to initiate a pulse train assigned to a valid tag. |

Table 19-12 (cont.)  
**KIPulse TSP test script: ConfigPulseIMeasureV**

|                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>TSP project name: KIPulse</b><br/> <b>TSP test script name: KIPulse</b></p>                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <p>Function:<br/>         ConfigPulseIMeasureV</p> <p>Usage:<br/>         f, msg = ConfigPulseIMeasureV<br/>         (smu,bias,level,limit,ton,toff,points,buffer,tag[,sync_in][,sync_out]<br/>         [,sync_in_timeout][,sync_in_abort])</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Parameters                                                                                                                                                                                                                                      | <p>smu,bias,level,limit,ton,toff,points,buffer,tag[,sync_in]<br/>         [,sync_out]</p> <p>smu: SourceMeter instrument channel (for example, smua).</p> <p>bias: Pulse bias level in amps.</p> <p>level: Pulse level in amps.</p> <p>limit: Voltage limit (for example, compliance) in volts.</p> <p>ton: Pulse width (for example, on-time) in seconds.</p> <p>toff: Pulse off time in seconds.</p> <p>points: Number of pulse-measure cycles.</p> <p>buffer: Reading buffer where pulsed measurements will be stored. If this is nil when the function is called, no measurements will be made when the pulse train is initiated.</p> <p>tag: Numeric identifier to be assigned to the defined pulse train.</p> <p>sync_in: Defines a digital I/O trigger input line. If programmed, the pulse train will wait for a trigger input before executing each pulse. This parameter is optional.</p> <p>sync_out: Defines a digital I/O trigger output line. If programmed, the pulse train will generate a trigger output immediately prior to the start of ton. This parameter is optional.</p> <p>sync_in_timeout: Specifies the length of time (in seconds) to wait for input trigger (defaults to 10s).</p> <p>sync_in_abort: (true or false) Whether to abort pulse if input trigger is not received before timeout expires (defaults to true).</p> |
| Waveform                                                                                                                                                                                                                                        | <p>The diagram illustrates the pulse train waveform. It shows a signal that starts at a baseline, rises to a 'bias level' for a duration 'ton', then falls to a lower level for a duration 'toff'. It then rises to a higher 'pulse level' for a duration 'Measurement (1/NPLC Seconds)'. The pulse level is higher than the bias level. The diagram shows two such pulses. Labels include 'Last source value before pulse train was initiated', 'Pulse initiated here', 'bias level', 'pulse level', 'Measurement (1/NPLC Seconds)', 'ton', and 'toff'.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Return values                                                                                                                                                                                                                                   | <p>f: A Boolean flag. This flag will be true when the pulse was successfully configured, false when errors were encountered.</p> <p>msg: A string message. If the f flag is false, msg will contain an error message. Otherwise, msg will contain a string indicating successful configuration.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Output Data                                                                                                                                                                                                                                     | <p>Pulsed voltage measurements are stored in the reading buffer specified by the buffer input argument.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

Table 19-12 (cont.)  
**KIPulse TSP test script: ConfigPulseIMeasureV**

|                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b>                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>TSP test script name: KIPulse</b>                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Function:<br>ConfigPulseIMeasureV                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Usage:<br>f, msg = ConfigPulseIMeasureV<br>(smu,bias,level,limit,ton,toff,points,buffer,tag[,sync_in][,sync_out]<br>[,sync_in_timeout][,sync_in_abort]) |                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Example                                                                                                                                                 | ConfigPulseIMeasureV(smua, 0, 5, 10, 0.001, 0.080, 1,<br>smua.nvbuffer1, 1)<br><br>Set up a pulse train that will use SourceMeter instrument Channel A. The pulse amplitude will be 5A and will return to 0A after 1ms. The pulse will remain at 0A for 80 ms and the voltage limit will be 10V during the pulse. The pulse train will consist of only 1 pulse and this pulse will be assigned a tag index of 1. |
| See also                                                                                                                                                | <a href="#">InitiatePulseTest</a> , <a href="#">InitiatePulseTestDual</a>                                                                                                                                                                                                                                                                                                                                        |

Table 19-13  
**KIPulse TSP test script: ConfigPulseVMeasureI**

|                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b>                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>TSP test script name: KIPulse</b>                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Function:<br>ConfigPulseVMeasureI                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Usage:<br>f, msg = ConfigPulseVMeasureI<br>(smu,bias,level,limit,ton,toff,points,buffer,tag[,sync_in][,sync_out]<br>[,sync_in_timeout][,sync_in_abort]) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Description                                                                                                                                             | Configures a voltage pulse train with a current measurement at each point. Measurement(s) will be made at the end of the <code>ton</code> time. This function does not cause the specified <code>smu</code> to output a pulse train. It simply checks to see if all of the pulse dimensions are achievable and if so, assigns the indicated <code>tag</code> or index to the pulse train. The <code>InitiatePulseTest(tag)</code> and <code>InitiatePulseTestDual(tag)</code> functions are used to initiate a pulse train assigned to a valid tag. |

Table 19-13 (cont.)  
**KIPulse TSP test script: ConfigPulseVMeasureI**

|                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>TSP project name: KIPulse</b><br/> <b>TSP test script name: KIPulse</b></p>                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <p>Function:<br/>         ConfigPulseVMeasureI</p> <p>Usage:<br/>         f, msg = ConfigPulseVMeasureI<br/>         (smu,bias,level,limit,ton,toff,points,buffer,tag[,sync_in][,sync_out]<br/>         [,sync_in_timeout][,sync_in_abort])</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <p>Parameters</p>                                                                                                                                                                                                                               | <p>smu,bias,level,limit,ton,toff,points,buffer,tag[,sync_in]<br/>         [,sync_out]</p> <p>smu: SourceMeter instrument channel. (for example, smua).</p> <p>bias: Pulse bias level in volts.</p> <p>level: Pulse level in volts.</p> <p>limit: Current limit (for example, compliance) in amps.</p> <p>ton: Pulse width (for example, on-time) in seconds.</p> <p>toff: Pulse off time in seconds.</p> <p>points: Number of pulse measure cycles.</p> <p>buffer: Reading buffer where pulsed measurements will be stored. If this is nil when the function is called, no measurements will be made when the pulse train is initiated.</p> <p>tag: Numeric identifier to be assigned to the defined pulse train.</p> <p>sync_in: Defines a digital I/O trigger input line. If programmed, the pulse train will wait for a trigger input before executing each pulse. This parameter is optional.</p> <p>sync_out: Defines a digital I/O trigger output line. If programmed, the pulse train will generate a trigger output immediately prior to the start of ton. This parameter is optional.</p> <p>sync_in_timeout: Specifies the length of time (in seconds) to wait for input trigger (defaults to 10s).</p> <p>sync_in_abort: (true or false) Whether to abort pulse if input trigger is not received before timeout expires (defaults to true).</p> |
| <p>Waveform</p>                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <p>Return values</p>                                                                                                                                                                                                                            | <p>f: A Boolean flag. This flag will be true when the pulse is successfully configured, false when errors were encountered.</p> <p>msg: A string message. If the f flag is false, msg will contain an error message. Otherwise, msg will contain a string indicating successful configuration.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |



Table 19-13 (cont.)  
**KIPulse TSP test script: ConfigPulseVMeasureI**

|                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b><br><b>TSP test script name: KIPulse</b>                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Function:<br>ConfigPulseVMeasureI                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Usage:<br>f, msg = ConfigPulseVMeasureI<br>(smu,bias,level,limit,ton,toff,points,buffer,tag[,sync_in][,sync_out]<br>[,sync_in_timeout][,sync_in_abort]) |                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Output Data                                                                                                                                             | Pulsed current measurements are stored in the reading buffer specified by the buffer input argument.                                                                                                                                                                                                                                                                                                            |
| Example                                                                                                                                                 | ConfigPulseVMeasureI(smub, 0, 20, 1, 0.001, 0.080, 10, smub.nvbuffer1, 2)<br><br>Set up a pulse train that will use SourceMeter instrument channel B. The pulse amplitude will be 20V and will return to 0V after 1ms. The pulse will remain at 0V for 80ms and the current limit will be 1A during the pulse. The pulse train will consist of 10 pulses and the pulse train will be assigned a tag index of 2. |
| See also                                                                                                                                                | <a href="#">InitiatePulseTest</a> , <a href="#">InitiatePulseTestDual</a>                                                                                                                                                                                                                                                                                                                                       |

Table 19-14  
**KIPulse TSP test script: ConfigPulseIMeasureVSweepLin**

|                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b><br><b>TSP test script name: KIPulse</b>                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Function:<br>ConfigPulseIMeasureVSweepLin                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Usage:<br>f, msg = ConfigPulseIMeasureVSweepLin<br>(smu,bias,start,stop,limit,ton,toff,points,buffer,tag[,sync_in]<br>[,sync_out][,sync_in_timeout][,sync_in_abort]) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Description                                                                                                                                                          | Configures a linear pulsed current sweep with a voltage measurement at each point. Measurement(s) will be made at the end of the <code>ton</code> time. The magnitude of the first pulse will be <code>start</code> amps. The magnitude of the last pulse will be <code>stop</code> amps. The magnitude of each pulse in between will be <code>step</code> amps larger than the previous pulse where:<br><br>$step = (stop - start) / (points - 1)$<br><br>This function does not cause the specified <code>smu</code> to output a pulse train. It simply checks to see if all of the pulse dimensions are achievable and if so, assigns the indicated <code>tag</code> or index to it. The <code>InitPulseTest(tag)</code> and <code>InitPulseTestDual(tag)</code> functions are used to initiate a pulse train assigned to a valid <code>tag</code> . |

Table 19-14 (cont.)  
**KIPulse TSP test script: ConfigPulseIMeasureVSweepLin**

|                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>TSP project name: KIPulse</b><br/> <b>TSP test script name: KIPulse</b></p>                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <p>Function:<br/>         ConfigPulseIMeasureVSweepLin</p> <p>Usage:<br/>         f, msg = ConfigPulseIMeasureVSweepLin<br/>         (smu,bias,start,stop,limit,ton,toff,points,buffer,tag[,sync_in]<br/>         [,sync_out][,sync_in_timeout][,sync_in_abort])</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Parameters                                                                                                                                                                                                                                                           | <p>smu,bias,start,stop,limit,ton,toff,points,buffer,tag<br/>         [,sync_in][,sync_out])</p> <p>smu: SourceMeter instrument channel (for example, smua).</p> <p>bias: Pulse bias level in amps.</p> <p>start: Pulse sweep start level in amps.</p> <p>stop: Pulse sweep stop level in amps.</p> <p>limit: Voltage limit (for example, compliance) in volts.</p> <p>ton: Pulse width (for example, on-time) in seconds.</p> <p>toff: Pulse off time in seconds.</p> <p>points: Number of pulse measure cycles.</p> <p>buffer: Reading buffer where pulsed measurements will be stored. If this is nil when the function is called, no measurements will be made when the pulse train is initiated.</p> <p>tag: Numeric identifier to be assigned to the defined pulse train.</p> <p>sync_in: Defines a digital I/O trigger input line. If programmed, the pulse train will wait for a trigger input before executing each pulse. This parameter is optional.</p> <p>sync_out: Defines a digital I/O trigger output line. If programmed, the pulse train will generate a trigger output immediately prior to the start of ton. This parameter is optional.</p> <p>sync_in_timeout: Specifies the length of time (in seconds) to wait for input trigger (defaults to 10s). <i>New to Firmware 1.3.0</i></p> <p>sync_in_abort: (true or false) Whether to abort pulse if input trigger is not received before timeout expires (defaults to true). <i>New to Firmware 1.3.0</i></p> |
| Waveform                                                                                                                                                                                                                                                             | <p>step = (stop - start)/(points - 1)</p> <p>stop</p> <p>step</p> <p>start</p> <p>step</p> <p>step</p> <p>ton</p> <p>toff</p> <p>Measurement (1/NPLC seconds)</p> <p>Pulse initiated here</p> <p>Last source value before pulse train was initiated</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

Table 19-14 (cont.)

**KIPulse TSP test script: ConfigPulseIMeasureVSweepLin**

|                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b>                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>TSP test script name: KIPulse</b>                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Function:<br>ConfigPulseIMeasureVSweepLin                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Usage:<br>f, msg = ConfigPulseIMeasureVSweepLin<br>(smu,bias,start,stop,limit,ton,toff,points,buffer,tag[,sync_in]<br>[,sync_out][,sync_in_timeout][,sync_in_abort]) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Return values                                                                                                                                                        | f: A Boolean flag. This flag will be true when the pulse was successfully configured, false when errors were encountered.<br><br>msg: A string message. If the f flag is false, msg will contain an error message. Otherwise, msg will contain a string indicating successful configuration.                                                                                                                                                                                                                            |
| Output Data                                                                                                                                                          | Pulsed voltage measurements are stored in the reading buffer specified by the buffer input argument.                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Example                                                                                                                                                              | ConfigPulseIMeasureVSweepLin(smua, 0, 0.01, 0.05, 1, 1e-3, 0.1, 20, smua.nvbuffer2, 3)<br><br>Set up a pulsed sweep that will use SourceMeter instrument Channel A. The pulsed sweep will start at 10mA, end at 50mA, and return to a 0mA bias level between pulses. Each pulsed step will be on for 1ms and then at the bias level for 100ms. The voltage limit will be 1V during the entire pulsed sweep. The pulse train will be comprised of 20 pulsed steps and the pulse train will be assigned a tag index of 4. |
| See also                                                                                                                                                             | <a href="#">InitiatePulseTest</a> , <a href="#">InitiatePulseTestDual</a>                                                                                                                                                                                                                                                                                                                                                                                                                                               |

Table 19-15

**KIPulse TSP test script: ConfigPulseVMeasureISweepLin**

|                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b>                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>TSP test script name: KIPulse</b>                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Function:<br>ConfigPulseVMeasureISweepLin                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Usage:<br>f, msg = ConfigPulseVMeasureISweepLin<br>(smu,bias,start,stop,limit,ton,toff,points,buffer,tag[,sync_in]<br>[,sync_out][,sync_in_timeout][,sync_in_abort]) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Description                                                                                                                                                          | Configures a linear pulsed voltage sweep with a current measurement at each point. Measurement(s) will be made at the end of the ton time. The magnitude of the first pulse will be start volts. The magnitude of the last pulse will be stop volts. The magnitude of each pulse in between will be step volts larger than the previous pulse where:<br><br>$step = (stop - start) / (points - 1)$<br><br>This function does not cause the specified smu to output a pulse train. It simply checks to see if all of the pulse dimensions are achievable and if so, assigns the indicated tag or index to it. The InitPulseTest(tag) and InitPulseTestDual(tag) functions are used to initiate a pulse train assigned to a valid tag. |

Table 19-15 (cont.)  
**KIPulse TSP test script: ConfigPulseVMeasureISweepLin**

|                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>TSP project name: KIPulse</b><br/> <b>TSP test script name: KIPulse</b></p>                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <p>Function:<br/>         ConfigPulseVMeasureISweepLin</p> <p>Usage:<br/>         f, msg = ConfigPulseVMeasureISweepLin<br/>         (smu,bias,start,stop,limit,ton,toff,points,buffer,tag[,sync_in]<br/>         [,sync_out][,sync_in_timeout][,sync_in_abort])</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Parameters                                                                                                                                                                                                                                                           | <p>smu,bias,start,stop,limit,ton,toff,points,buffer,tag<br/>         [,sync_in][,sync_out])</p> <p>smu: SourceMeter instrument channel (for example, smua).</p> <p>bias: Pulse bias level in volts.</p> <p>start: Pulse sweep start level in volts.</p> <p>stop: Pulse sweep stop level in volts.</p> <p>limit: Current limit (for example, compliance) in amps.</p> <p>ton: Pulse width (for example, on-time) in seconds.</p> <p>toff: Pulse off time in seconds.</p> <p>points: Number of pulse measure cycles.</p> <p>buffer: Reading buffer where pulsed measurements will be stored. If this is nil when the function is called, no measurements will be made when the pulse train is initiated.</p> <p>tag: Numeric identifier to be assigned to the defined pulse train.</p> <p>sync_in: Defines a digital I/O trigger input line. If programmed, the pulse train will wait for a trigger input before executing each pulse. This parameter is optional.</p> <p>sync_out: Defines a digital I/O trigger output line. If programmed, the pulse train will generate a trigger output immediately prior to the start of ton. This parameter is optional.</p> <p>sync_in_timeout: Specifies the length of time (in seconds) to wait for input trigger (defaults to 10s). <i>New to Firmware 1.3.0</i></p> <p>sync_in_abort: (true or false) Whether to abort pulse if input trigger is not received before timeout expires (defaults to true). <i>New to Firmware 1.3.0</i></p> |
| Waveform                                                                                                                                                                                                                                                             | <p>step = (stop - start)/(points - 1)</p> <p>stop</p> <p>step</p> <p>start</p> <p>step</p> <p>bias level</p> <p>ton</p> <p>toff</p> <p>Measurement (1/NPLC seconds)</p> <p>Pulse initiated here</p> <p>Last source value before pulse train was initiated</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

Table 19-15 (cont.)

**KIPulse TSP test script: ConfigPulseVMeasureISweepLin**

|                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b><br><b>TSP test script name: KIPulse</b>                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Function:<br>ConfigPulseVMeasureISweepLin<br>Usage:<br>f, msg = ConfigPulseVMeasureISweepLin<br>(smu,bias,start,stop,limit,ton,toff,points,buffer,tag[,sync_in]<br>[,sync_out][,sync_in_timeout][,sync_in_abort]) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Return values                                                                                                                                                                                                     | f: A Boolean flag. This flag will be true when the pulse was successfully configured, false when errors were encountered.<br>msg: A string message. If the f flag is false, msg will contain an error message. Otherwise, msg will contain a string indicating successful configuration.                                                                                                                                                                                                                          |
| Output Data                                                                                                                                                                                                       | Pulsed current measurements are stored in the reading buffer specified by the buffer input argument.                                                                                                                                                                                                                                                                                                                                                                                                              |
| Example                                                                                                                                                                                                           | ConfigPulseVMeasureISweepLin(smub, 0, 1, 10, 1, 10e-3, 20e-3, 16, smub.nvbuffer1, 4)<br><br>Set up a pulsed sweep that will use SourceMeter instrument Channel B. The pulsed sweep will start at 1V, end at 10V, and return to a 0V bias level between pulses. Each pulsed step will be on for 10ms and then at the bias level for 20ms. The current limit will be 1A during the entire pulsed sweep. The pulse train will be comprised of 16 pulsed steps and the pulse train will be assigned a tag index of 4. |
| See also                                                                                                                                                                                                          | <a href="#">InitiatePulseTest</a> , <a href="#">InitiatePulseTestDual</a>                                                                                                                                                                                                                                                                                                                                                                                                                                         |

Table 19-16

**KIPulse TSP test script: ConfigPulseIMeasureVSweepLog**

|                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b><br><b>TSP test script name: KIPulse</b>                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Function:<br>ConfigPulseIMeasureVSweepLog<br>Usage:<br>f, msg = ConfigPulseIMeasureVSweepLog<br>(smu,bias,start,stop,limit,ton,toff,points,buffer,tag[,sync_in]<br>[,sync_out][,sync_in_timeout][,sync_in_abort]) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Description                                                                                                                                                                                                       | Configures a logarithmic pulsed current sweep with a voltage measurement at each point. Measurement(s) will be made at the end of the ton time. The magnitude of the first pulse will be start amps. The magnitude of the last pulse will be stop amps. The magnitude of each pulse in between will be $LogStep_n$ amps larger than the previous pulse where:<br><br>$LogStepSize = (\log_{10}(stop) - \log_{10}(start)) / (points - 1)$<br>$LogStep_n = (n - 1) \times (LogStepSize)$ where $n = [1, points]$<br>$SourceStepLevel_n = \text{antilog}(LogStep_n) \times start$<br><br>This function does not cause the specified smu to output a pulse train. It simply checks to see if all of the pulse dimensions are achievable and if so, assigns the indicated tag or index to it. The <a href="#">InitiatePulseTest(tag)</a> and <a href="#">InitiatePulseTestDual(tag)</a> functions are used to initiate a pulse train assigned to a valid tag. |

Table 19-16 (cont.)  
**KIPulse TSP test script: ConfigPulseIMeasureVSweepLog**

|                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>TSP project name: KIPulse</b><br/> <b>TSP test script name: KIPulse</b></p>                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <p>Function:<br/>         ConfigPulseIMeasureVSweepLog</p> <p>Usage:<br/>         f, msg = ConfigPulseIMeasureVSweepLog<br/>         (smu,bias,start,stop,limit,ton,toff,points,buffer,tag[,sync_in]<br/>         [,sync_out][,sync_in_timeout][,sync_in_abort])</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Parameters                                                                                                                                                                                                                                                           | <p>smu,bias,start,stop,limit,ton,toff,points,buffer,tag<br/>         [,sync_in][,sync_out])</p> <p>smu: SourceMeter instrument channel. (for example, smua).</p> <p>bias: Pulse bias level in amps.</p> <p>start: Pulse sweep start level in amps.</p> <p>stop: Pulse sweep stop level in amps.</p> <p>limit: Voltage limit (for example, compliance) in volts.</p> <p>ton: Pulse width (for example, on-time) in seconds.</p> <p>toff: Pulse off time in seconds.</p> <p>points: Number of pulse measure cycles.</p> <p>buffer: Reading buffer where pulsed measurements will be stored. If this is nil when the function is called, no measurements will be made when the pulse train is initiated.</p> <p>tag: Numeric identifier to be assigned to the defined pulse train.</p> <p>sync_in: Defines a digital I/O trigger input line. If programmed, the pulse train will wait for a trigger input before executing each pulse. This parameter is optional.</p> <p>sync_out: Defines a digital I/O trigger output line. If programmed, the pulse train will generate a trigger output immediately prior to the start of ton. This parameter is optional.</p> <p>sync_in_timeout: Specifies the length of time (in seconds) to wait for input trigger (defaults to 10s).</p> <p>sync_in_abort: (true or false) Whether to abort pulse if input trigger is not received before timeout expires (defaults to true).</p> |
| Waveform                                                                                                                                                                                                                                                             | <p> <math>LogStepSize = (\log_{10}stop) - \log_{10}start) / (points - 1)</math><br/> <math>LogStep_n = (n - 1) \times LogStepSize</math> where <math>n = [1, points]</math><br/> <math>SourceStepLevel_n = \text{antilog}(LogStep_n) \times start</math> </p> <p> <math>LogStep_2</math><br/> <math>LogStep_3</math><br/>         start<br/>         stop<br/>         bias level<br/>         ton<br/>         toff<br/>         Measurement (1/NPLC seconds)<br/>         Pulse initiated here<br/>         Last source value before pulse train was initiated     </p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

Table 19-16 (cont.)

**KIPulse TSP test script: ConfigPulseIMeasureVSweepLog**

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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b><br><b>TSP test script name: KIPulse</b>                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Function:<br>ConfigPulseIMeasureVSweepLog<br>Usage:<br>f, msg = ConfigPulseIMeasureVSweepLog<br>(smu, bias, start, stop, limit, ton, toff, points, buffer, tag[, sync_in]<br>[, sync_out][, sync_in_timeout][, sync_in_abort]) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Return values                                                                                                                                                                                                                  | f: A Boolean flag. This flag will be true when the pulse was successfully configured, false when errors were encountered.<br>msg: A string message. If the f flag is false, msg will contain an error message. Otherwise, msg will contain a string indicating successful configuration.                                                                                                                                                                                                                                   |
| Output Data                                                                                                                                                                                                                    | Pulsed voltage measurements are stored in the reading buffer specified by the buffer input argument.                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Example                                                                                                                                                                                                                        | ConfigPulseIMeasureVSweepLog(smua, 0, 1e-3, 0.01, 1, 1e-3, 10e-3, 10, smua.nvbuffer1, 5)<br><br>Set up a pulsed log sweep that will use SourceMeter instrument Channel A. The pulsed sweep will start at 1mA, end at 10mA, and return to a 0A bias level between pulses. Each pulsed step will be on for 1ms and then at the bias level for 10ms. The voltage limit will be 1V during the entire pulsed sweep. The pulse train will be comprised of 10 pulsed steps and the pulse train will be assigned a tag index of 5. |
| See also                                                                                                                                                                                                                       | <a href="#">InitiatePulseTest</a> , <a href="#">InitiatePulseTestDual</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

Table 19-17

**KIPulse TSP test script: ConfigPulseVMeasureISweepLog**

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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b><br><b>TSP test script name: KIPulse</b>                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Function:<br>ConfigPulseVMeasureISweepLog<br>Usage:<br>f, msg = ConfigPulseVMeasureISweepLog<br>(smu, bias, start, stop, limit, ton, toff, points, buffer, tag[, sync_in]<br>[, sync_out][, sync_in_timeout][, sync_in_abort]) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Description                                                                                                                                                                                                                    | Configures a logarithmic pulsed voltage sweep with a current measurement at each point. Measurement(s) will be made at the end of the ton time. The magnitude of the first pulse will be start volts. The magnitude of the last pulse will be stop volts. The magnitude of each pulse in between will be LogStep <sub>n</sub> volts larger than the previous pulse where:<br><br>$\text{LogStepSize} = (\log_{10}(\text{stop}) - \log_{10}(\text{start})) / (\text{points} - 1)$ $\text{LogStep}_n = (n - 1) \times (\text{LogStepSize}) \text{ where } n = [1, \text{points}]$ $\text{SourceStepLevel}_n = \text{antilog}(\text{LogStep}_n) \times \text{start}$<br><br>This function does not cause the specified smu to output a pulse train. It simply checks to see if all of the pulse dimensions are achievable and if so, assigns the indicated tag or index to it. The <a href="#">InitiatePulseTest(tag)</a> and <a href="#">InitiatePulseTestDual(tag)</a> functions are used to initiate a pulse train assigned to a valid tag. |

Table 19-17 (cont.)  
**KIPulse TSP test script: ConfigPulseVMeasureISweepLog**

|                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>TSP project name: KIPulse</b><br/> <b>TSP test script name: KIPulse</b></p>                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <p>Function:<br/>         ConfigPulseVMeasureISweepLog</p> <p>Usage:<br/> <code>f, msg = ConfigPulseVMeasureISweepLog</code><br/> <code>(smu, bias, start, stop, limit, ton, toff, points, buffer, tag[, sync_in]</code><br/> <code>[, sync_out][, sync_in_timeout][, sync_in_abort])</code></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Parameters                                                                                                                                                                                                                                                                                       | <p><code>smu, bias, start, stop, limit, ton, toff, points, buffer, tag</code><br/> <code>[, sync_in][, sync_out])</code></p> <p><code>smu</code>: SourceMeter instrument channel. (for example, <code>smua</code>).</p> <p><code>bias</code>: Pulse bias level in volts.</p> <p><code>start</code>: Pulse sweep start level in volts.</p> <p><code>stop</code>: Pulse sweep stop level in volts.</p> <p><code>limit</code>: Current limit (for example, compliance) in amps.</p> <p><code>ton</code>: Pulse width (for example, on-time) in seconds.</p> <p><code>toff</code>: Pulse off time in seconds.</p> <p><code>points</code>: Number of pulse measure cycles.</p> <p><code>buffer</code>: Reading buffer where pulsed measurements will be stored. If this is <code>nil</code> when the function is called, no measurements will be made when the pulse train is initiated.</p> <p><code>tag</code>: Numeric identifier to be assigned to the defined pulse train.</p> <p><code>sync_in</code>: Defines a digital I/O trigger input line. If programmed, the pulse train will wait for a trigger input before executing each pulse. This parameter is optional.</p> <p><code>sync_out</code>: Defines a digital I/O trigger output line. If programmed, the pulse train will generate a trigger output immediately prior to the start of <code>ton</code>. This parameter is optional.</p> <p><code>sync_in_timeout</code>: Specifies the length of time (in seconds) to wait for input trigger (defaults to 10s).</p> <p><code>sync_in_abort</code>: (true or false) Whether to abort pulse if input trigger is not received before <code>timeout</code> expires (defaults to true).</p> |
| Configuration                                                                                                                                                                                                                                                                                    | <p> <math>LogStepSize = (\log_{10}(stop) - \log_{10}(start)) / (points - 1)</math><br/> <math>LogStep_n = (n - 1) \times LogStepSize</math> where <math>n = [1, points]</math><br/> <math>SourceStepLevel_n = \text{antilog}(LogStep_n) \times start</math> </p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |



Table 19-17 (cont.)

**KIPulse TSP test script: ConfigPulseVMeasureISweepLog**

|                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b><br><b>TSP test script name: KIPulse</b>                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Function:<br>ConfigPulseVMeasureISweepLog                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Usage:<br>f, msg = ConfigPulseVMeasureISweepLog<br>(smu,bias,start,stop,limit,ton,toff,points,buffer,tag[,sync_in]<br>[,sync_out][,sync_in_timeout][,sync_in_abort]) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Return values                                                                                                                                                        | f: A Boolean flag. This flag will be <code>true</code> when the pulse was successfully configured, <code>false</code> when errors were encountered.<br><br>msg: A string message. If the <code>f</code> flag is <code>false</code> , <code>msg</code> will contain an error message. Otherwise, <code>msg</code> will contain a string indicating successful configuration.                                                                                                                                           |
| Output Data                                                                                                                                                          | Pulsed current measurements are stored in the reading buffer specified by the <code>buffer</code> input argument.                                                                                                                                                                                                                                                                                                                                                                                                     |
| Example                                                                                                                                                              | ConfigPulseVMeasureISweepLog(smub, 0, 1, 10, 1, 10e-3, 20e-3, 10, smub.nvbuffer1, 6)<br><br>Set up a pulsed log sweep that will use SourceMeter instrument Channel B. The pulsed sweep will start at 1V, end at 10V, and return to a 0V bias level between pulses. Each pulsed step will be on for 10ms and then at the bias level for 20ms. The current limit will be 1A during the entire pulsed sweep. The pulse train will be comprised of 10 pulsed steps and the pulse train will be assigned a tag index of 6. |
| See also                                                                                                                                                             | <a href="#">InitiatePulseTest</a> , <a href="#">InitiatePulseTestDual</a>                                                                                                                                                                                                                                                                                                                                                                                                                                             |

Table 19-18  
**KIPulse TSP test script: QueryPulseConfig**

|                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b>      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>TSP test script name: KIPulse</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Function:<br>QueryPulseConfig         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Usage:<br>tbl = QueryPulseConfig(tag) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Description                           | Once a pulse train has been configured and assigned to a tag, it is often desirable to inspect the settings of this pre-configured pulse train. QueryPulseConfig() can be used for this purpose. This function will return a table containing the various settings associated with the tag input parameter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Parameters                            | tag: Numeric identifier of pulse train configuration being queried.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Return values                         | <p>tostring(): A function that returns most elements in a string convenient for printing.</p> <p>tag: Identifying tag for this pulse train.</p> <p>smu: The smu configured for pulsing.</p> <p>func: Pulse function: smuX.OUTPUT_DCAMPS or smuX.OUTPUT_DCVOLTS</p> <p>bias: Pulse bias level.</p> <p>level: Pulse level for non sweeping pulses.</p> <p>start: Starting level for sweep pulses.</p> <p>stop: Ending level for sweep pulses.</p> <p>limit: Limit value.</p> <p>ton: On time in seconds.</p> <p>toff: Off time in seconds.</p> <p>points: The number of points in this pulse train.</p> <p>buf: Reference to buffer containing measurement data</p> <p>sync_in: The sync_in digio line, if used.</p> <p>sync_out: The sync_out digio line, if used.</p> <p>sourcevalues: A table containing the source value for each point in the pulse train.</p> |
| Output Data                           | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

Table 19-18 (cont.)  
**KIPulse TSP test script: QueryPulseConfig**

|                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b><br><b>TSP test script name: KIPulse</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Function:<br>QueryPulseConfig<br>Usage:<br>tbl = QueryPulseConfig(tag)   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Example(s)                                                               | <pre> smua.reset()  smua.source.rangev      = 5 smua.source.rangei      = 1 smua.source.levelv      = 0 smua.measure.rangev     = 5 smua.measure.rangei     = 1 smua.measure.nplc       = 0.01 smua.measure.autozero   = smua.AUTOZERO_ONCE smua.nvbuffer1.clear() smua.nvbuffer1.appendmode = 1 smua.source.output      = smua.OUTPUT_ON  f1, msg1 = ConfigPulseVMeasureI(smua, 0, 5, 1, 0.002, 0.2, 10,smua.nvbuffer1, 1)  print(QueryPulseConfig(1).toString())  <u>Output from commands above</u>  &gt;&gt; tag = 1 &gt;&gt; smu = smua &gt;&gt; func = volts &gt;&gt; type = pulse &gt;&gt; bias = 0 &gt;&gt; level = 5 &gt;&gt; limit = 1 &gt;&gt; time on = 0.002 &gt;&gt; time off = 0.2 &gt;&gt; points = 10 &gt;&gt; measure = yes &gt;&gt; sync_in = 0 &gt;&gt; sync_out = 0 &gt;&gt; sync_in_timeout = 0 &gt;&gt; sync_out_abort = 0 &gt;&gt; { 5, 5, 5, 5, 5, 5, 5, 5, 5, 5 }</pre> <p>Configure Channel A to generate a pulse train then query configuration and display as a string. Channel A will pulse voltage from a bias level of 0V to pulse level of 5V. The pulse level will be present for 2ms and the bias level for 200 ms, with a 1A limit setting. A total of 10 pulses will be generated and the measurement data will be stored in SMU A.nvbuffer1. This pulse train will be assigned to tag = 1</p> |

Table 19-18 (cont.)  
**KIPulse TSP test script: QueryPulseConfig**

|                                       |                                                                                                                                                                                                                                                                                                              |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b>      |                                                                                                                                                                                                                                                                                                              |
| <b>TSP test script name: KIPulse</b>  |                                                                                                                                                                                                                                                                                                              |
| Function:<br>QueryPulseConfig         |                                                                                                                                                                                                                                                                                                              |
| Usage:<br>tbl = QueryPulseConfig(tag) |                                                                                                                                                                                                                                                                                                              |
| See also                              | <a href="#">ConfigPulseIMeasureV</a> , <a href="#">ConfigPulseVMeasureI</a> ,<br><a href="#">ConfigPulseIMeasureVSweepLin</a> ,<br><a href="#">ConfigPulseVMeasureISweepLin</a> ,<br><a href="#">KIPulse TSP test script: ConfigPulseIMeasureVSweepLog</a> ,<br><a href="#">ConfigPulseVMeasureISweepLog</a> |

Table 19-19  
**KIPulse TSP test script: InitiatePulseTest**

|                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b>          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>TSP test script name: KIPulse</b>      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Function:<br>InitiatePulseTest            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Usage:<br>f, msg = InitiatePulseTest(tag) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Description                               | This function initiates the pulse configuration assigned tag.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Parameters                                | tag: Numeric identifier of pulse train configuration to be initiated.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Return values                             | f: A Boolean flag. This flag will be true when the pulse was successfully configured, false when errors were encountered.<br><br>msg: A string message. If the f flag is false, msg will contain an error message. Otherwise, msg will contain a string indicating successful configuration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Output Data                               | None.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Example                                   | <p>Configure SourceMeter instrument Channel A to generate a pulse train. If no errors are encountered, initiate the pulse train. Channel A will pulse voltage from a bias level of 0V to pulse level of 5V. The pulse level will be present for 2 ms and the bias level for 200 ms, with a 1A limit setting. A total of 10 pulses will be generated and the measurement data will be stored in smua.nvbuffer1. This pulse train will be assigned to tag = 1.</p> <pre> smua.reset() smua.source.rangev      = 5 smua.source.rangei      = 1 smua.source.levelv      = 0 smua.measure.rangev     = 5 smua.measure.rangei     = 1 smua.measure.nplc       = 0.01 smua.measure.autozero   = smua.AUTOZERO_ONCE smua.nvbuffer1.clear() smua.nvbuffer1.appendmode = 1 smua.source.output      = smua.OUTPUT_ON  f1, msg1 = ConfigPulseVMeasureI(smua, 0, 5, 1, 0.002, 0.2, 10, smua.nvbuffer1, 1) if (f1 == true) then f2, msg2 = InitiatePulseTest(1) print("Initiate message:", msg2) else print("Config errors:", msg1) end </pre> |
| See Also                                  | <a href="#">ConfigPulseVMeasureV</a> , <a href="#">ConfigPulseVMeasureI</a> ,<br><a href="#">ConfigPulseVMeasureVSweepLin</a> ,<br><a href="#">ConfigPulseVMeasureISweepLin</a> ,<br><a href="#">ConfigPulseVMeasureVSweepLog</a> ,<br><a href="#">ConfigPulseVMeasureISweepLog</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

Table 19-20  
**KIPulse TSP test script: InitiatePulseTestDual**

|                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>TSP project name: KIPulse</b><br/> <b>TSP test script name: KIPulse</b></p>                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <p>Function:<br/>         InitiatePulseTestDual<br/>         Usage:<br/> <code>f, msg = InitiatePulseTestDual(tag1, tag2)</code></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <p>Description</p>                                                                                                                   | <p>This function initiates the pulse configurations assigned to <code>tag1</code> and <code>tag2</code>. The pulse trains associated with the indicated tags will be generated simultaneously. This is useful when testing devices such as voltage regulators where the input signal and output load must be applied to the instrument at the same time. When using this function, each <code>tag1</code> pulse will encapsulate each <code>tag2</code> pulse in time. That is, the <code>tag1</code> pulse will transition from its bias level to its pulse level before the <code>tag2</code> pulse. Both the <code>tag1</code> and <code>tag2</code> pulses will return to their respective bias levels at approximately the same time. Measurements for both pulse trains take place at the same time. (See Waveform below).</p> <p>To provide this encapsulation, the following rules are enforced:</p> <ul style="list-style-type: none"> <li>• The <code>tag1</code> pulse on time, <code>ton1</code>, must be configured to be at <math>&gt; 40\mu\text{s}</math> longer than the <code>tag2</code> pulse on time.</li> <li>• The <code>tag1</code> and <code>tag2</code> pulse off times, <code>toff</code>, must be the same.</li> </ul> |
| <p>Waveform</p>                                                                                                                      | <p>The waveform diagram illustrates the timing of two pulse trains. The top trace shows a pulse with a long on-time (<code>ton1</code>) and a short on-time (<code>ton2</code>) for a second pulse. The bottom trace shows a pulse with a shorter on-time (<code>ton2</code>) and a longer on-time (<code>ton1</code>) for a second pulse. The off-time (<code>toff</code>) is the same for both. A measurement window of 1/NPLC seconds is shown. Labels include 'Pulse initiated here', 'Last source value before pulse train was initiated', and 'Measurements (1/NPLC seconds)'.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <p>Parameters</p>                                                                                                                    | <p><code>tag1</code>: Numeric identifier of the first pulse train configuration to be initiated.</p> <p><code>tag2</code>: Numeric identifier of the second pulse train configuration to be initiated.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <p>Return values</p>                                                                                                                 | <p><code>f</code>: A Boolean flag. This flag will be <code>true</code> when the pulse was successfully configured, <code>false</code> when errors were encountered.</p> <p><code>msg</code>: A string message. If the <code>f</code> flag is <code>false</code>, <code>msg</code> will contain an error message. Otherwise, <code>msg</code> will contain a string indicating successful configuration.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <p>Output Data</p>                                                                                                                   | <p>None</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

Table 19-20 (cont.)  
**KIPulse TSP test script: InitiatePulseTestDual**

|                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>TSP test script name: KIPulse</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Function:<br>InitiatePulseTestDual                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Usage:<br>f, msg = InitiatePulseTestDual(tag1, tag2) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Example(s)                                           | <pre> smua.reset() smua.source.rangev = 5 smua.source.rangei = 1 smua.source.levelv = 0 smua.measure.rangev = 5 smua.measure.rangei = 1 smua.measure.nplc = 0.01 smua.measure.autozero = smua.AUTOZERO_ONCE smua.nvbuffer1.clear() smua.nvbuffer1.appendmode = 1 smua.source.output = smua.OUTPUT_ON  smub.reset() smub.source.func = smub.OUTPUT_DCAMPS smub.source.rangei = 1 smub.source.rangev = 5 smub.source.leveli = 0 smub.measure.rangei = 1 smub.measure.rangev = 5 smub.measure.nplc = 0.01 smub.measure.autozero = smub.AUTOZERO_ONCE smub.nvbuffer1.clear() smub.nvbuffer1.appendmode = 1 smub.source.output = smub.OUTPUT_ON </pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Example(s)                                           | <pre> f1, msg1 = ConfigPulseVMeasureI(smua, 0, 5, 1, 0.002, 0.2, 10, smua.nvbuffer1, 1) f2, msg2 = ConfigPulseIMeasureV(smub, 0, -1, 5, 0.001, 0.2, 10, smub.nvbuffer1, 2) if (f1 == true) and (f2 == true) then f3, msg3 = InitiatePulseTestDual(1,2) print("Initiate message:", msg3) else print("Config errors:", msg1, msg2) end </pre> <p>Set up SourceMeter instrument Channels A and B for pulse operation, configure pulse trains for each channel, initiate the pulse trains if no errors are encountered. Channel A will pulse voltage from a bias level of 0V to pulse level of 5V. The pulse level will be present for 2ms and the bias level for 200ms, with a 1A limit setting. A total of 10 pulses will be generated and the measurement data will be stored in SMU A.nvbuffer1. This pulse train will be assigned to tag = 1. Channel B will pulse current from a bias level of 0A to pulse level of 1A. The pulse level will be present for 1 ms and the bias level for 200ms, with a 5V limit setting. A total of 10 pulses will be generated and the measurement data will be stored in smub.nvbuffer1. This pulse train will be assigned to tag = 2.</p> |

Table 19-20 (cont.)

**KIPulse TSP test script: InitiatePulseTestDual**

|                                                      |                                                                                                                                                                                                                                                                                     |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIPulse</b>                     |                                                                                                                                                                                                                                                                                     |
| <b>TSP test script name: KIPulse</b>                 |                                                                                                                                                                                                                                                                                     |
| Function:<br>InitiatePulseTestDual                   |                                                                                                                                                                                                                                                                                     |
| Usage:<br>f, msg = InitiatePulseTestDual(tag1, tag2) |                                                                                                                                                                                                                                                                                     |
| See also                                             | <a href="#">ConfigPulseIMeasureV</a> , <a href="#">ConfigPulseVMeasureI</a> ,<br><a href="#">ConfigPulseIMeasureVSweepLin</a> ,<br><a href="#">ConfigPulseVMeasureISweepLin</a> ,<br><a href="#">ConfigPulseIMeasureVSweepLog</a> ,<br><a href="#">ConfigPulseVMeasureISweepLog</a> |



## KIHighC

The KIHighC factory script is made up of two functions: `i_leakage_measure()` and `i_leakage_threshold()`. These functions are intended to be used when HighC mode is active. Output is generally at a non-zero voltage prior to calling these functions. These functions can also be used to step the voltage to zero volts in order to measure the leakage current.

Table 19-21

### KIHighC TSP test script: `i_leakage_measure()`

|                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIHighC</b>                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>TSP test script name: KIHighC</b>                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Function:<br><code>i_leakage_measure(smu, levelv, limiti, sourcedelay, measurei, measuredelay)</code> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Description                                                                                           | Performs a single current measurement.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Parameters                                                                                            | <code>smu, levelv, limiti, sourcedelay, measurei, measuredelay</code><br><code>smu</code> : SourceMeter instrument Channel (A or B).<br><code>levelv</code> : Voltage level to step to.<br><code>limiti</code> : Current limit setting for the voltage step.<br><code>sourcedelay</code> : Delay to wait before lowering the current limit for measurement.<br><code>measurei</code> : Measure range for the current measurement. Note the current limit is lower at this level and it is presumed (because HIGHC mode is active) the measure range will follow.<br><code>measuredelay</code> : Delay to wait after lowering the current limit before taking the measurement. |
| Return values                                                                                         | <code>imeas</code> : The measured current.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Output Data                                                                                           | The measured current.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Example                                                                                               | <pre>smua.source.levelv = 5      --charge the cap smua.source.output = smua.OUTPUT_ON delay(1) imeas = i_leakage_measure(smua, 0, 1, 300e-3, 10e-6, 100e-3)</pre> <p>The parameters passed on to the <code>i_leakage_measure()</code> function are as follows:</p> <ul style="list-style-type: none"> <li>• <code>smu</code> = <code>smua</code></li> <li>• <code>levelv</code> = 0V</li> <li>• <code>limiti</code> = 1A</li> <li>• <code>sourcedelay</code> = 300ms</li> <li>• <code>measurei</code> = 10 uA range</li> <li>• <code>measuredelay</code> = 100 ms</li> </ul> <p>The levels and delays will depend on the value and type of capacitor used.</p>                |

Table 19-22  
**KIHighC TSP test script: i\_leakage\_threshold()**

|                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIHighC</b>                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>TSP test script name: KIHighC</b>                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Function:<br>i_leakage_threshold(smu, levelv, limiti, sourcedelay, measurei, measuredelay, threshold, timeout) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Description                                                                                                    | Measures the current and compares it to a threshold until either the measured current drops below the threshold or the timeout expires.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Parameters                                                                                                     | <p>smu, levelv, limiti, sourcedelay, measurei, measuredelay, threshold, timeout</p> <p>smu: SourceMeter instrument Channel (A or B).</p> <p>levelv: Voltage level to step to.</p> <p>limiti: Current limit setting for the voltage step.</p> <p>sourcedelay: Delay to wait before lowering the current limit for measurement.</p> <p>measurei: Measure range for the current measurement.<br/>Note the current limit is lower at this level and it is presumed (because HIGHC mode is active) the measure range will follow.</p> <p>measuredelay: Delay to wait after lowering the current limit before taking the measurement.</p> <p>threshold: The specified current that establishes the test limit.</p> <p>timeout: Amount of time (in seconds) to wait for the current to drop after all the delays have occurred.</p> |
| Return values                                                                                                  | f: A Boolean flag. This flag will be true when the current is below the threshold, false when the timeout expires.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Example                                                                                                        | <pre>smua.source.levelv = 5      --charge the cap smua.source.output = smua.OUTPUT_ON delay(1) pass = i_leakage_threshold(smua, 0, 1, 300e-3, 10e-6, 100e-3, 1e-6, 1) Returns true if the current is measured below 1 µA in less than 1 second.</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

## KIParlib

The KIParlib factory script is made up of two functions: `gm_vsweep()` and `gm_ismweep()`.

Table 19-23

### KIParlib TSP test script: `gm_vsweep()`

|                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIParlib</b>                                 |                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>TSP test script name: KIParlib</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Function:<br><code>gm_vsweep(smu, start_v, stop_v, points)</code> |                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Description                                                       | The <code>gm_vsweep()</code> function performs a linear voltage sweep, measuring voltage and current and then calculates the transconductance (Gm) at each point using the central difference method. It can return an array of Gm values, a reading buffer with the measured currents, and a reading buffer with the measured voltages.                                                                                    |
| Parameters                                                        | <code>smu, start_v, stop_v, points</code><br><code>smu</code> : SourceMeter instrument Channel (A or B).<br><code>start_v</code> : Starting voltage level of the sweep.<br><code>stop_v</code> : Ending voltage level of the sweep.<br><code>points</code> : Number of measurements between <code>start_v</code> and <code>stop_v</code> (must be $\geq 2$ ).                                                               |
| Return values                                                     | <ul style="list-style-type: none"> <li><code>gm_array</code>: a Lua table containing the calculated Gm values at each point.</li> <li><code>ibuf</code>: a reading buffer containing the measured current at each point.</li> <li><code>vbuf</code>: a reading buffer containing the measured voltage at each point.</li> </ul>                                                                                             |
| Output Data                                                       | Transconductance values, reading buffer with measured currents, reading buffer with measured currents and voltages.                                                                                                                                                                                                                                                                                                         |
| Examples                                                          | <ul style="list-style-type: none"> <li><code>gm_array = gm_vsweep(smua, 0, 5, 20)</code><br/>SMU A returns Gm values only.</li> <li><code>gm_array, ibuf = gm_vsweep(smua, 0, 5, 20)</code><br/>SMU A returns Gm and reading buffer with measured currents.</li> <li><code>gm_array, ibuf, vbuf = gm_vsweep(smua, 0, 5, 20)</code><br/>SMU A returns Gm and reading buffers with measured currents and voltages.</li> </ul> |

Table 19-24  
**KIParlib TSP test script: gm\_isweep()**

|                                                      |                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KIParlib</b>                    |                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>TSP test script name: KIParlib</b>                |                                                                                                                                                                                                                                                                                                                                                                                               |
| Function:<br>gm_isweep(smu, start_i, stop_i, points) |                                                                                                                                                                                                                                                                                                                                                                                               |
| Description                                          | The gm_isweep() function performs a linear current sweep, measuring voltage and current and then calculates the transconductance (Gm) at each point using the central difference method. It can return an array of Gm values, a reading buffer with the measured voltages and a reading buffer with the measured currents.                                                                    |
| Parameters                                           | smu, start_i, stop_i, points<br>smu: SourceMeter instrument Channel (A or B).<br>start_i: Starting current level of the sweep.<br>stop_i: Ending current level of the sweep.<br>points: Number of measurements between start_i and stop_i (must be ≥2).                                                                                                                                       |
| Examples                                             | <ul style="list-style-type: none"> <li>gm_array = gm_isweep(smua, 0, 0.01, 20)<br/>SMU A returns Gm values only.</li> <li>gm_array, vbuf = gm_isweep(smua, 0, 0.01, 20)<br/>SMU A returns Gm and reading buffer with measured voltages.</li> <li>gm_array, vbuf, ibuf = gm_isweep(smua, 0, 0.01, 20)<br/>SMU A returns Gm and reading buffers with measured voltages and currents.</li> </ul> |

## KISavebuffer

The KISavebuffer script has one function: savebuffer().

Table 19-25  
**KISavebuffer TSP test script: savebuffer()**

|                                                          |                                                                                                                                                                                                                     |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TSP project name: KISavebuffer</b>                    |                                                                                                                                                                                                                     |
| <b>TSP test script name: KISavebuffer</b>                |                                                                                                                                                                                                                     |
| Function:<br>savebuffer(IBuffer, IFormatType, IFileName) |                                                                                                                                                                                                                     |
| Description                                              | The savebuffer() function saves reading buffers as either a .CSV file or an .XML file                                                                                                                               |
| Parameters                                               | IBuffer, IFormatType, IFileName<br>IBuffer: The reading buffer to save.<br>IFormatType: A string to indicate which file type to use: "csv" and "xml" are accepted.<br>IFileName: The file name of the saved buffer. |
| Return values                                            | None.                                                                                                                                                                                                               |
| Output Data                                              | None.                                                                                                                                                                                                               |
| Example                                                  | <pre>savebuffer(smua.nvbuffer1, "csv", "mybuffer.csv")</pre> Save smua nonvolatile reading Buffer 1 as a .CSV file named "mybuffer.csv".                                                                            |

**In this section:**

| <b>Topic</b>                            | <b>Page</b> |
|-----------------------------------------|-------------|
| <b>Introduction</b> .....               | <b>20-1</b> |
| <b>Environmental conditions</b> .....   | <b>20-2</b> |
| Temperature and relative humidity ..... | 20-2        |
| Warm-up period .....                    | 20-2        |
| Line power .....                        | 20-2        |
| <b>Calibration considerations</b> ..... | <b>20-2</b> |
| Calibration cycle .....                 | 20-3        |
| Recommended calibration equipment ..... | 20-3        |
| Calibration errors .....                | 20-5        |
| <b>Calibration</b> .....                | <b>20-5</b> |
| Calibration steps .....                 | 20-5        |
| Calibration commands .....              | 20-8        |
| Calibration procedure .....             | 20-9        |

## Introduction

Use the procedures in this section to calibrate the Keithley Instruments Series 2600A System SourceMeter® instrument (Models 2601A, 2602A, 2611A, 2612A, 2635A, and 2636A). These procedures require accurate test equipment to measure precise DC voltages and currents.

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**WARNING** *The information in this section is intended for qualified service personnel only. Do not attempt these procedures unless you are qualified to do so. Some of these procedures may expose you to hazardous voltages.*

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## Environmental conditions

### Temperature and relative humidity

Conduct the calibration procedures at an ambient temperature of 18°C to 28°C (65°F to 82°F), with relative humidity of less than 70% (unless otherwise noted).

### Warm-up period

Allow the Series 2600A to warm up for at least two hours before performing calibration.

If the instrument has been subjected to temperature extremes (those outside the ranges stated above), allow additional time for the instrument's internal temperature to stabilize. Typically, allow one extra hour to stabilize a unit that is 10°C (18°F) outside the specified temperature range.

Also, allow the test equipment to warm up for the minimum time specified by the manufacturer.

### Line power

The Series 2600A requires a line voltage of 100V to 240V at line frequency of 50Hz or 60Hz. The instrument must be calibrated within this range.

## Calibration considerations

When performing the calibration procedures:

- Make sure that the test equipment is properly warmed up and connected to the correct Model 2600A terminals.
- Always allow the source signal to settle before calibrating each point.
- Do not connect test equipment to the Series 2600A through a scanner or other switching equipment.
- If an error occurs during calibration, the Series 2600A will generate an appropriate error message. See [Error summary](#) in [Appendix A](#) for more information.

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**WARNING** *The maximum common-mode voltage (voltage between LO and chassis ground) is 250V DC. Exceeding this value may cause a breakdown in insulation, creating a shock hazard that could result in personal injury or death.*

*The Input/Output terminals of the Series 2600As are rated for connection to circuits rated Installation Category I only, with transients rated less than 1500V peak. Do not connect the Series 2600A terminals to CAT II, CAT III, or CAT IV circuits. Connection of the Series 2600A terminals to circuits higher than CAT I can cause damage to the equipment or expose the operator to hazardous voltage.*

*Hazardous voltages may be present on the output and guard terminals. To prevent electrical shock that could cause injury or death, NEVER make or break connections to the Series 2600A while the unit is on. Power off the equipment from the front panel or disconnect the main power cord from the rear of the Series 2600A before handling cables connected to the outputs. Putting the equipment into standby mode does not guarantee the outputs are not powered if a hardware or software fault occurs.*

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## Calibration cycle

Perform calibration at least once a year to ensure the unit meets or exceeds its specifications.

## Recommended calibration equipment

[Table 20-1](#) lists the recommended equipment for the calibration procedures. You can use alternate equipment as long as that equipment has specifications equal to or greater than those listed in the table. When possible, test equipment specifications should be at least four times better than corresponding Series 2600A specifications.

Table 20-1  
**Recommended calibration equipment**

| Description                          | Manufacturer/Model                                        | Accuracy                                                 |                                                                      |                                                                                |
|--------------------------------------|-----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------|
| 1GΩ, 200V, 1% standard               | Keithley Instruments<br>Model 2600-STD-RES                | Resistance <sup>5</sup>                                  | 1GΩ:                                                                 | <100 PPM                                                                       |
| Digital Multimeter                   | Keithley Instruments<br>Model 2002<br>or<br>Agilent 3458A | DC Voltage <sup>1</sup><br>(2601A/2602A)                 | 90mV:<br>0.9V:<br>5.4V:<br>36V:                                      | ±8ppm<br>±5ppm<br>±4ppm<br>±6ppm                                               |
|                                      |                                                           | DC Voltage <sup>2</sup><br>(2611A/2612A/<br>2635A/2636A) | 190mV:<br>1.8V:<br>18V:<br>180V:                                     | ±5ppm<br>±4ppm<br>±6ppm<br>±6ppm                                               |
|                                      |                                                           | DC current <sup>3</sup>                                  | 90nA:<br>0.9μA:<br>9μA:<br>90μA:<br>0.9mA:<br>9mA:<br>90mA:<br>0.9A: | ±430ppm<br>±45ppm<br>±25ppm<br>±23ppm<br>±20ppm<br>±20ppm<br>±35ppm<br>±110ppm |
| 0.5Ω , 250W, 0.1% Precision Resistor | Isotek<br>RUG-Z-R500-0.1-TK3                              | Resistance <sup>4</sup>                                  | 0.5Ω :                                                               | ±125ppm                                                                        |
| 50Ω Resistors (2)                    | Any suitable. <sup>5</sup>                                |                                                          |                                                                      |                                                                                |
| 1GΩ , 200V, 1% standard              | Keithley Instruments<br>Model 2600-STD-RES                | Resistance <sup>6</sup>                                  | 1GΩ :                                                                | +/-250ppm                                                                      |

1. 90-day specifications show full-range accuracy of recommended model used for specified calibration point.
2. Id.
3. Id.
4. Resistor used to calibrate Model 2601A/2602A 3A and 10A ranges and Model 2611A/2612A/2635A/2636A 1.5A and 10A ranges should be characterized to uncertainty shown using resistance function of a digital multimeter before use.
5. Used for contact check calibration. Characterize resistors using ohms function of digital multimeter before use.
6. Standard is a guarded and characterized 1GΩ resistor used to test Model 2635A/2636A 100pA to 100nA current ranges.



## Calibration errors

The Series 2600A checks for errors after each calibration step, minimizing the possibility that improper calibration may occur due to operator error.

You can detect errors while in remote by testing the state of EAV (Error Available) bit (bit 2) in the status byte. (Use the `*STB?` query to request the status byte.) Query the instrument for the type of error by using the `errorqueue.next` command. The Series 2600A will respond with the nature of the error. See [Appendix A](#) for error messages and [Appendix C](#) for status byte information.

## Calibration

Use the following procedure to perform remote calibration by sending commands over the IEEE-488 bus, RS-232 port, or LAN. The remote commands and appropriate parameters are separately summarized for each step.

### Calibration steps

#### Step sequence

Calibration steps must be performed in the order shown in [Table 20-2](#) (Model 2601A/2602A), or [Table 20-3](#) (Model 2611A/2612A), or [Table 20-5](#) (Model 2635A/2636A). Note that all steps are performed using 2-wire (local sensing) except as noted. Calibration of each range is performed as a four-point calibration:

- + ZERO
- + FULL SCALE
- - ZERO
- - FULL SCALE.

Table 20-2  
Model 2601A/2602A calibration steps

| Function <sup>1</sup>      | Calibration steps <sup>2</sup> | Calibration points <sup>4</sup>     | Sense mode <sup>5</sup> |
|----------------------------|--------------------------------|-------------------------------------|-------------------------|
| Voltage Source and Measure | 100mV                          | $\pm 1\text{e-}12, \pm 90\text{mV}$ | smuX.SENSE_LOCAL        |
|                            | 100mV                          | $\pm 1\text{e-}10, \pm 90\text{mV}$ | smuX.SENSE_REMOTE       |
|                            | 1V                             | $\pm 1\text{e-}10, \pm 0.9\text{V}$ | smuX.SENSE_LOCAL        |
|                            | 1V                             | $\pm 1\text{e-}10, \pm 0.9\text{V}$ | smuX.SENSE_CALA         |
|                            | 6V                             | $\pm 1\text{e-}10, \pm 5.4\text{V}$ | smuX.SENSE_LOCAL        |
|                            | 40V                            | $\pm 1\text{e-}10, \pm 36\text{V}$  | smuX.SENSE_LOCAL        |

1. Calibrate only the source for the SENSE\_CALA sense steps.
2. Steps must be performed in the order shown.
3. 10A range for changing calibration of range only and is not available for normal use.
4. Do not use actual 0 values for zero calibration points. Send very small values such as  $\pm 1\text{e-}10$ .  
Calibration polarities must also be set as shown in the procedures.
5. Output must be off before changing to the CALA sense mode.

Table 20-2  
**Model 2601A/2602A calibration steps**

| Function <sup>1</sup>      | Calibration steps <sup>2</sup> | Calibration points <sup>4</sup> | Sense mode <sup>5</sup> |
|----------------------------|--------------------------------|---------------------------------|-------------------------|
| Current Source and Measure | 100nA                          | ±1e-10, ±90nA                   | smuX.SENSE_LOCAL        |
|                            | 1µA                            | ±1e-10, ±0.9µA                  | smuX.SENSE_LOCAL        |
|                            | 10µA                           | ±1e-10, ±9µA                    | smuX.SENSE_LOCAL        |
|                            | 100µA                          | ±1e-10, ±90µA                   | smuX.SENSE_LOCAL        |
|                            | 1mA                            | ±1e-10, ±0.9mA                  | smuX.SENSE_LOCAL        |
|                            | 1mA                            | ±1e-10, ±0.9mA                  | smuX.SENSE_CALA         |
|                            | 10mA                           | ±1e-10, ±9mA                    | smuX.SENSE_LOCAL        |
|                            | 100mA                          | ±1e-10, ±90mA                   | smuX.SENSE_LOCAL        |
|                            | 1A                             | ±1e-10, ±0.9A                   | smuX.SENSE_LOCAL        |
|                            | 3A                             | ±1e-10, ±2.4A                   | smuX.SENSE_LOCAL        |
|                            | 10A <sup>3</sup>               | ±1e-10, ±2.4A                   | smuX.SENSE_LOCAL        |

1. Calibrate only the source for the SENSE\_CALA sense steps.
2. Steps must be performed in the order shown.
3. 10A range for changing calibration of range only and is not available for normal use.
4. Do not use actual 0 values for zero calibration points. Send very small values such as ±1e-10. Calibration polarities must also be set as shown in the procedures.
5. Output must be off before changing to the CALA sense mode.

Table 20-3  
**Model 2611A/2612A calibration steps**

| Function <sup>1</sup>      | Calibration steps <sup>2</sup> | Calibration points <sup>3</sup> | Sense mode <sup>4</sup> |
|----------------------------|--------------------------------|---------------------------------|-------------------------|
| Voltage Source and Measure | 200mV                          | ±1e-10, ±180mV                  | smuX.SENSE_LOCAL        |
|                            | 200mV                          | ±1e-10, ±180mV                  | smuX.SENSE_REMOTE       |
|                            | 2V                             | ±1e-10, ±1.8V                   | smuX.SENSE_LOCAL        |
|                            | 2V                             | ±1e-10, ±1.8V                   | smuX.SENSE_CALA         |
|                            | 20V                            | ±1e-10, ±18V                    | smuX.SENSE_LOCAL        |
|                            | 200V                           | ±1e-10, ±180V                   | smuX.SENSE_LOCAL        |
| Current Source and Measure | 100nA                          | ±1e-10, ±90nA                   | smuX.SENSE_LOCAL        |
|                            | 1µA                            | ±1e-10, ±0.9µA                  | smuX.SENSE_LOCAL        |
|                            | 10µA                           | ±1e-10, ±9µA                    | smuX.SENSE_LOCAL        |
|                            | 100µA                          | ±1e-10, ±90µA                   | smuX.SENSE_LOCAL        |
|                            | 1mA                            | ±1e-10, ±0.9mA                  | smuX.SENSE_LOCAL        |
|                            | 1mA                            | ±1e-10, ±0.9mA                  | smuX.SENSE_CALA         |
|                            | 10mA                           | ±1e-10, ±9mA                    | smuX.SENSE_LOCAL        |
|                            | 100mA                          | ±1e-10, ±90mA                   | smuX.SENSE_LOCAL        |
|                            | 1A                             | ±1e-10, ±0.9A                   | smuX.SENSE_LOCAL        |
|                            | 1.5A                           | ±1e-10, ±1.35A                  | smuX.SENSE_LOCAL        |
|                            | 10A                            | ±1e-10, ±2.4A                   | smuX.SENSE_LOCAL        |

1. Calibrate only the source for the SENSE\_CALA sense steps.
2. Steps must be performed in the order shown.
3. Do not use actual 0 values for zero calibration points. Send very small values such as ±1e-10. Calibration polarities must also be set as shown in the procedures.
4. Output must be off before changing to the CALA sense mode.

Table 20-4  
**Model 2635A/2636A calibration steps**

| Model 2635A/2636A calibration steps |                                |                                 |                         |
|-------------------------------------|--------------------------------|---------------------------------|-------------------------|
| Function <sup>1</sup>               | Calibration steps <sup>2</sup> | Calibration points <sup>3</sup> | Sense mode <sup>4</sup> |
| Voltage Source and Measure          | 200mV                          | ±1e-12, ±180mV                  | smuX.SENSE_LOCAL        |
|                                     | 200mV                          | ±1e-12, ±180mV                  | smuX.SENSE_REMOTE       |
|                                     | 2V                             | ±1e-12, ±1.8V                   | smuX.SENSE_LOCAL        |
|                                     | 2V                             | ±1e-12, ±1.8V                   | smuX.SENSE_CALA         |
|                                     | 20V                            | ±1e-12, ±18V                    | smuX.SENSE_LOCAL        |
|                                     | 200V                           | ±1e-12, ±180V                   | smuX.SENSE_LOCAL        |
| Current Source and Measure          | 10nA                           | ±1e-12, +/-9nA                  | smuX.SENSE_LOCAL        |
|                                     | 1nA                            | ±1e-12, +/-0.9nA                | smuX.SENSE_LOCAL        |
|                                     | 100pA <sup>5</sup>             | ±1e-12, +/-90pA                 | smuX.SENSE_LOCAL        |
|                                     | 100nA                          | ±1e-12, ±90nA                   | smuX.SENSE_LOCAL        |
|                                     | 1µA                            | ±1e-12, ±0.9µA                  | smuX.SENSE_LOCAL        |
|                                     | 10µA                           | ±1e-12, ±9µA                    | smuX.SENSE_LOCAL        |
|                                     | 100µA                          | ±1e-12, ±90µA                   | smuX.SENSE_LOCAL        |
|                                     | 1mA                            | ±1e-12, ±0.9mA                  | smuX.SENSE_LOCAL        |
|                                     | 1mA                            | ±1e-12, ±0.9mA                  | smuX.SENSE_CALA         |
|                                     | 10mA                           | ±1e-12, ±9mA                    | smuX.SENSE_LOCAL        |
|                                     | 100mA                          | ±1e-12, ±90mA                   | smuX.SENSE_LOCAL        |
|                                     | 1A                             | ±1e-12, ±0.9A                   | smuX.SENSE_LOCAL        |
|                                     | 1.5A                           | ±1e-12, ±1.35A                  | smuX.SENSE_LOCAL        |

1. Calibrate only the source for the SENSE\_CALA sense steps.
2. Steps must be performed in the order shown.
3. Do not use actual 0 values for zero calibration points. Send very small values such as ±1e-10. Calibration polarities must also be set as shown in the procedures.
4. Output must be off before changing to the CALA sense mode.
5. For Current Measure only.

**Parameter values**

The full-scale parameters are actually 90% of full-scale as indicated in [Table 20-2](#), [Table 20-3](#), and [Table 20-5](#). Note that you cannot send a value of exactly 0 for the two zero parameters, but must instead send a very small value, for example 1e-10 or -1e-10.

**Sense modes**

[Table 20-2](#), [Table 20-3](#), and [Table 20-5](#) list sense modes for the calibration steps. Note that all source and measure ranges are calibrated using the LOCAL sense mode. In addition, the 100mV or 200mV source and measure ranges are also calibrated using the REMOTE sense mode, and the 1mA and 1V or 2V source ranges are also calibrated using the CALA sense mode.

## Calibration commands

Table 20-5 summarizes remote calibration commands. For a more complete description of these commands, refer to [Section 19](#).

Table 20-5  
Calibration commands

| Command <sup>1</sup>                                                                                                                                                  | Description                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre>smuX.cal.adjustdate = caldate smuX.cal.date = caldate smuX.cal.due = caldue smuX.cal.lock() smuX.cal.password = "newpassword" smuX.cal.polarity = polarity</pre> | <p>Set calibration adjustment date for 2635A/2636A only.<br/>Set calibration date (caldate of 0 indicated date not set).<br/>Set calibration due date (caldue of 0 indicated date not set).<br/>Lock out calibration.<br/>Change password to "newpassword".<br/>Set polarity:<br/>    smuX.CAL_AUTO (auto polarity).<br/>    smuX.CAL_NEGATIVE (negative polarity).<br/>    smuX.CAL_POSITIVE (positive polarity).</p> |
| <pre>smuX.cal.restore([calset])</pre>                                                                                                                                 | <p>Load calibration set of constants:<br/>    smuX.CALSET_NOMINAL (nominal constants).<br/>    smuX.CALSET_FACTORY (factory constants).<br/>    smuX.CALSET_DEFAULT (normal constants).<br/>    smuX.CALSET_PREVIOUS (previous constants).</p>                                                                                                                                                                         |
| <pre>smuX.cal.save()</pre>                                                                                                                                            | <p>Store constants in nonvolatile memory as DEFAULT calibration set.</p>                                                                                                                                                                                                                                                                                                                                               |
| <pre>calstate = smuX.cal.state</pre>                                                                                                                                  | <p>Request calibration state:<br/>    smuX.CALSTATE_CALIBRATING<br/>    smuX.CALSTATE_LOCKED<br/>    smuX.CALSTATE_UNLOCKED</p>                                                                                                                                                                                                                                                                                        |
| <pre>smuX.cal.unlock("password")</pre>                                                                                                                                | <p>Unlock calibration (default password: KI0026XX)</p>                                                                                                                                                                                                                                                                                                                                                                 |
| <pre>smuX.measure.calibratei(range, cp1measured, cplreference, cp2measured, cp2reference)</pre>                                                                       | <p>Calibrate current measure range:<sup>2</sup><br/>    ±range (measurement range to calibrate).<br/>    cp1measured (Series 2600A measured value for cal. point 1).<br/>    cp1reference (reference measurement for cal. point 1).<br/>    cp2measured (Series 2600A measured value for cal. point 2).<br/>    cp2reference (reference measurement for cal. point 2).</p>                                             |
| <pre>smuX.measure.calibratev(range, cp1measured, cplreference, cp2measured, cp2reference)</pre>                                                                       | <p>Calibrate voltage measure range:<sup>2</sup><br/>    ±range (measurement range to calibrate).<br/>    cp1measured (Series 2600A measured value for cal. point 1).<br/>    cp1reference (reference measurement for cal. point 1).<br/>    cp2measured (Series 2600A measured value for cal. point 2).<br/>    cp2reference (reference measurement for cal. point 2).</p>                                             |

1. smuX = smua for the Model 2601A/2611A/2635A; smuX = smua (Channel A) or smub (Channel B) for the Model 2602A/2612A/2636A.
2. Calibration point 1 should be performed at approximately 0% of range; calibration point 2 should be performed at approximately 90% of range. See [Table 20-2](#) or [Table 20-3](#) for calibration points.

Table 20-5 (cont.)

**Calibration commands**

| Command <sup>1</sup>                                                                                           | Description                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>smuX.source.calibratei(range, cp1expected, cp1reference, cp2expected, cp2reference)</code>               | Calibrate current source range: <sup>2</sup><br>±range (range to calibrate).<br>cp1expected (source value programmed for cal. point 1).<br>cp1reference (reference measurement for cal. point 1).<br>cp2expected (source value programmed for cal. point 2).<br>cp2reference (reference measurement for cal. point 2). |
| <code>smuX.source.calibratev(range, cp1expected, cp1reference, cp2expected, cp2reference)</code>               | Calibrate voltage source range: <sup>2</sup><br>±range (range to calibrate).<br>cp1expected (source value programmed for cal. point 1).<br>cp1reference (reference measurement for cal. point 1).<br>cp2expected (source value programmed for cal. point 2).<br>cp2reference (reference measurement for cal. point 2). |
| <code>smuX.contact.calibratelo</code><br>( <code>cp1measured, cp1reference, cp2measured, cp2reference</code> ) | Calibrate the low/sense low contact check measurement.<br>cp1measured (value measured by SMU for cal. point 1).<br>cp1reference (reference measurement for cal. point 1).<br>cp2measured (value measured by SMU for cal. point 2).<br>cp2reference (reference measurement for cal. point 2).                           |
| <code>smuX.contact.calibratehi</code><br>( <code>cp1measured, cp1reference, cp2measured, cp2reference</code> ) | Calibrate the high/sense high contact check measurement.<br>cp1measured (value measured by SMU for cal. point 1).<br>cp1reference (reference measurement for cal. point 1).<br>cp2measured (value measured by SMU for cal. point 2).<br>cp2reference (reference measurement for cal. point 2).                         |

1. smuX = smua for the Model 2601A/2611A/2635A; smuX = smua (Channel A) or smub (Channel B) for the Model 2602A/2612A/2636A.

2. Calibration point 1 should be performed at approximately 0% of range; calibration point 2 should be performed at approximately 90% of range. See [Table 20-2](#) or [Table 20-3](#) for calibration points.

## Calibration procedure

### Step 1. Prepare the Series 2600A for calibration

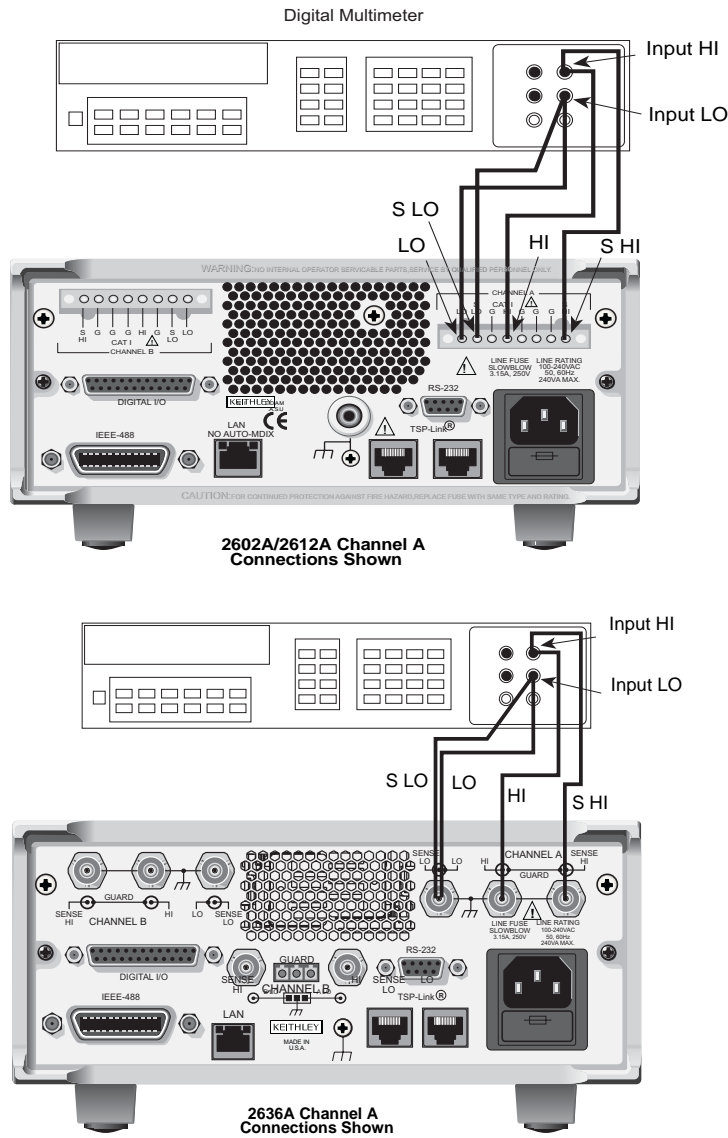
- Connect the Series 2600A to the controller IEEE-488 interface, RS-232 port, or LAN using an appropriate interface cable.
- Turn on the Series 2600A and the test equipment, and allow them to warm up for at least two hours before performing calibration.
- Make sure the IEEE-488, RS-232, or LAN interface parameters are set up properly (press **MENU** > **RS232**, **MENU** > **LAN**, or **MENU** > **GPIO** to configure the interface).

### Step 2. Voltage Calibration

- Connect the Series 2600A to the digital multimeter using the 4-wire connections shown in [Figure 20-1](#), and select the multimeter DC volts function.
- Send the following commands in order to initialize voltage calibration:

```
smua.cal.unlock("KI0026XX")
smua.reset()
smua.source.func = smua.OUTPUT_DCVOLTS
```

Figure 20-1  
Connections for voltage calibration



- c. Perform each calibration step listed in [Table 20-2](#) (Model 2601A/2602A), or [Table 20-3](#) (Model 2611A/2612A), or (Model 2635A/2636A) as follows:
  - 1) Select the range being calibrated with this command:  
`smua.source.rangev = range`

---

**NOTE** (Note that it is not necessary to set the measure range for calibration.) For example, for the Model 2601A/2602A 1V range, the following command would be sent:

```
smua.source.rangev = 1
```

For Models 2611A/2612A/2635A/2636A 2V range, the following command would be sent:

```
smua.source.rangev = 2
```

---

- 2) Select the correct sense mode based on the calibration step from [Table 20-2](#), or [Table 20-3](#), or , for example:

```
smua.sense = smua.SENSE_LOCAL
```

- 3) Select positive polarity, then set the source output to the positive zero value:

```
smua.cal.polarity = smua.CAL_POSITIVE
```

```
smua.source.levelv = 1e-10
```

- 4) Turn on the output:

```
smua.source.output = smua.OUTPUT_ON
```

- 5) Allow the readings to settle, then get both the multimeter and Series 2600A voltage readings at the positive zero value (the Series 2600A measurement is not necessary if this calibration step is being done on the CALA sense mode). The two measurements should be made as close as possible in time. Use this command for the Series 2600A:

```
Z_rdg = smua.measure.v()
```

- 6) Turn off the output:

```
smua.source.output = smua.OUTPUT_OFF
```

- 7) Set the source output to the positive full-scale value for the present range, for example:

```
smua.source.levelv = 0.9 Model 2601A/2602A
```

```
smua.source.levelv = 1.8 Model 2611A/2612A/2635A/2636A
```

- 8) Turn on the output:

```
smua.source.output = smua.OUTPUT_ON
```

- 9) Allow the readings to settle, then get both the multimeter and Series 2600A voltage readings at the positive full-scale output value (the Series 2600A measurement is not necessary if this calibration step is being done on the CALA sense mode). The two measurements should be made as close as possible in time. Use this command for the Series 2600A:

```
FS_rdg = smua.measure.v()
```

- 10) Turn off the output:

```
smua.source.output = smua.OUTPUT_OFF
```

- 11) Send the source calibration command using the range, +zero and +FS multimeter readings, and +zero and +FS source values for the parameters:

```
smua.source.calibratev(range,src_Z,DMM_Z_rdg,
```

```
src_FS,DMM_FS_rdg)
```

Where:

|            |                                    |
|------------|------------------------------------|
| range      | -- present calibration range       |
| src_Z      | -- +zero 2600A source output value |
| DMM_Z_rdg  | -- +zero DMM measurement           |
| src_FS     | -- +FS 2600A source output value   |
| DMM_FS_rdg | -- +FS DMM measurement             |

Typical values for the Model 2601A/2602A 1V range:

```
smua.source.calibratev(1,1e-10,1e-5,0.9,0.903)
```

Typical values for the Models 2611A/2612A/2635A/2636A 2V range:

```
smua.source.calibratev(2,1e-10,1e-5,1.8,1.802)
```

- 12) If this step is not on the CALA sense mode, send the measure calibration command using the multimeter and Series 2600A readings, and range setting for the parameters:

```
smua.measure.calibratev(range,Z_rdg,DMM_Z_rdg,
FS_rdg,DMM_FS_rdg)
```

Where:

|            |                              |
|------------|------------------------------|
| range      | -- present calibration range |
| Z_rdg      | -- +zero 2600A measurement   |
| DMM_Z_rdg  | -- +zero DMM measurement     |
| FS_rdg     | -- +FS 2600A measurement     |
| DMM_FS_rdg | -- +FS DMM measurement       |

Typical Model 2601A/2602A 1V range values:

```
smua.measure.calibratev(1,1e-4,1e-5,0.92,0.903)
```

Typical Model 2611A/2612A/2635A/2636A 2V range values:

```
smua.measure.calibratev(2,1e-4,1e-5,1.82,1.802)
```

- 13) Select negative polarity, then set the source output to the negative zero value, for example:

```
smua.cal.polarity = smua.CAL_NEGATIVE
smua.source.levelv = -1e-10
```

- 14) Turn on the output:

```
smua.source.output = smua.OUTPUT_ON
```

- 15) Allow the readings to settle, then get both the multimeter and Series 2600A voltage readings at the negative zero value. (The Series 2600A measurement is not necessary if this calibration step is being done on the CALA sense mode.) The two measurements should be made as close as possible in time. Use this command for the Series 2600A:

```
Z_rdg = smua.measure.v()
```

- 16) Turn off the output:

```
smua.source.output = smua.OUTPUT_OFF
```

- 17) Set the source output to the negative full-scale value, for example:

```
smua.source.levelv = -0.9 (Models 2601A/2602A)
smua.source.levelv = -1.8 (Models 2611A/2612A/2635A/2636A)
```

- 18) Turn on the output:

```
smua.source.output = smua.OUTPUT_ON
```

- 19) Allow the readings to settle, then get both the multimeter and Series 2600A voltage readings at the negative full-scale output value (the Series 2600A measurement is not necessary if this calibration step is being done on the CALA sense mode). The two measurements should be made as close as possible in time. Use this command for the Series 2600A:

```
FS_rdg = smua.measure.v()
```

- 20) Turn off the output:

```
smua.source.output = smua.OUTPUT_OFF
```

- 21) Send the source calibration command using the range, -zero and -FS multimeter readings, and -zero and -FS source values for the parameters:

```
smua.source.calibratev(-range,src_Z,DMM_Z_rdg,
src_FS,DMM_FS_rdg)
```

Where:

|           |                                              |
|-----------|----------------------------------------------|
| -range    | -- negative of the present calibration range |
| src_Z     | -- zero 2600A source output value            |
| DMM_Z_rdg | -- zero DMM measurement                      |



```
src_FS -- FS 2600A source output value
DMM_FS_rdg -- FS DMM measurement
```

Typical values for the Model 2601A/2602A 1V range:

```
smua.source.calibratev(-1,-1e-10,-1e-4,-0.9,-0.896)
```

Typical values for the Model 2611A/2612A/2635A/2636A 2V range:

```
smua.source.calibratev(-2,-1e-10,-1e-4,-1.8,-1.805)
```

- 22) If this step is not on the CALA sense mode, send the measure calibration command using the multimeter and Series 2600A readings, and range setting for the parameters:

```
smua.measure.calibratev(-range,Z_rdg,DMM_Z_rdg,
FS_rdg,DMM_FS_rdg)
```

Where:

```
range -- negative of the present calibration range
Z_rdg -- zero 2600A measurement
DMM_Z_rdg -- zero DMM measurement
FS_rdg -- FS 2600A measurement
DMM_FS_rdg -- FS DMM measurement
```

Typical Model 2601A/2602A 1V range values:

```
smua.measure.calibratev(-1,-1e-4,-1e-6,-0.89,-0.896)
```

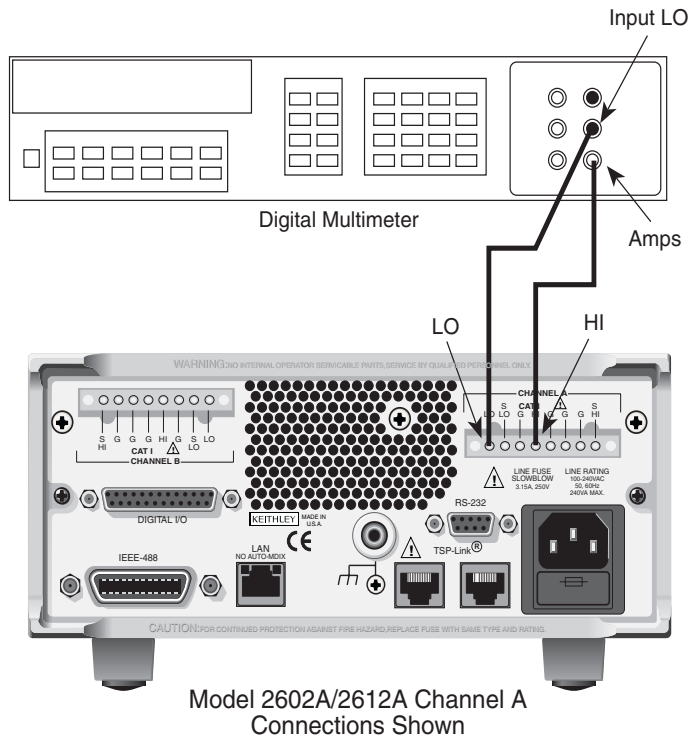
Typical Model 2611A/2612A/2635A/2636A 2V range values:

```
smua.measure.calibratev(-2,-1e-4,-1e-6,-1.81,-1.805)
```

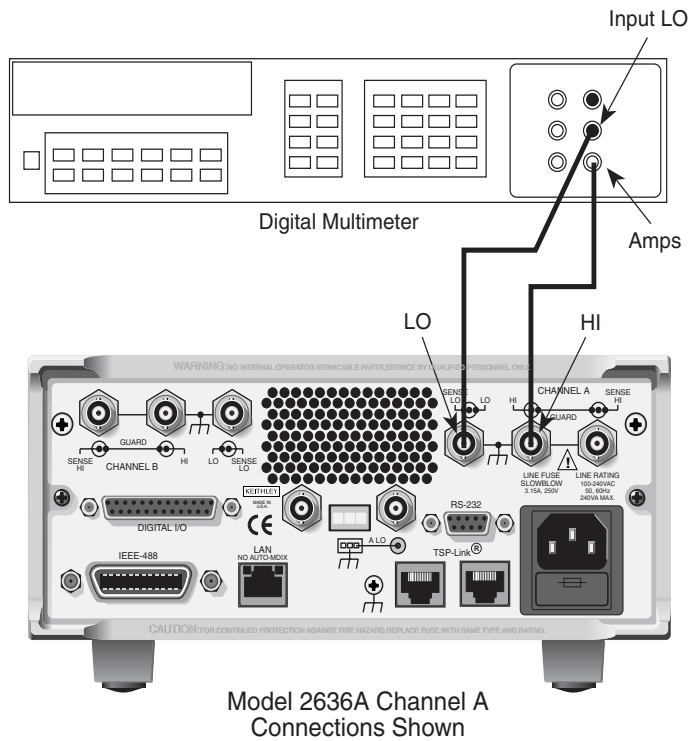
- d. Be sure to complete steps a through v for all six voltage steps in [Table 20-2](#), [Table 20-3](#), or [Table 20-5](#) before continuing with current calibration.
- e. Select auto polarity mode:

```
smua.cal.polarity = smua.CAL_AUTO
```

Figure 20-2  
**Connections for current calibration (100nA to 1A ranges)**



**Connections for current calibration (1uA to 1A ranges)**



### Step 3. Current Calibration

#### Models 2601A/2602A/2611A/2612A:

1. Connect the Series 2600A to the digital multimeter (see [Figure 20-2](#)), and select the multimeter DC current function.
2. Send this command to initialize current calibration:  
`smua.source.func = smua.OUTPUT_DCAMPS`
3. Perform each calibration step listed in [Table 20-2](#) (Model 2601A/2602A), [Table 20-3](#) (Model 2611A/2612A), or (Model 2635A/2636A):
  - a. Select the range being calibrated with this command:  
`smua.source.rangei = range`  
(Note that it is not necessary to set the measure range for calibration.) For example, for the 1A range, the following command would be sent:  
`smua.source.rangei = 1`
  - b. Select the correct sense mode based on the calibration step from [Table 20-2](#), [Table 20-3](#), or , for example:  
`smua.sense = smua.SENSE_LOCAL`
  - c. Select positive polarity, then set the source output to the positive zero value:  
`smua.cal.polarity = smua.CAL_POSITIVE`  
`smua.source.leveli = 1e-10`
  - d. Turn on the output:  
`smua.source.output = smua.OUTPUT_ON`
  - e. Allow the readings to settle, then get both the multimeter and Series 2600A current readings at the positive zero value (the Series 2600A measurement is not necessary if this calibration step is being done on the CALA sense mode). The two measurements should be made as close as possible in time. Use this command for the Series 2600A:  
`Z_rdg = smua.measure.i()`
  - f. Turn off the output:  
`smua.source.output = smua.OUTPUT_OFF`
  - g. Set the source output to the positive full-scale value for the present range, for example:  
`smua.source.leveli = 0.9`
  - h. Turn on the output:  
`smua.source.output = smua.OUTPUT_ON`
  - i. Allow the readings to settle, then get both the multimeter and Series 2600A voltage readings at the positive full-scale output value (the Series 2600A measurement is not necessary if calibration is being done on the CALA sense mode). The two measurements should be made as close as possible in time. Use this command for the Series 2600A:  
`FS_rdg = smua.measure.i()`
  - j. Turn off the output:  
`smua.source.output = smua.OUTPUT_OFF`

- k. Send the source calibration command using the range, zero and +FS multimeter readings, and zero and +FS source values for the parameters:  
`smua.source.calibratei(range,src_Z,DMM_Z_rdg, src_FS,DMM_FS_rdg)`

Where: `range` -- present calibration range  
`src_Z` -- +zero 2600A source output value  
`DMM_Z_rdg` -- +zero DMM measurement  
`src_FS` -- +FS 2600A source output value  
`DMM_FS_rdg` -- +FS DMM measurement

Typical values for the 1A range:

`smua.source.calibratei(1,1e-10,1e-4,0.9,0.88)`

- l. If this step is not on the CALA sense mode, send the measure calibration command using the multimeter and Series 2600A readings, and range setting for the parameters:  
`smua.measure.calibratei(range,Z_rdg,DMM_Z_rdg,FS_rdg,DMM_FS_rdg)`

Where: `range` -- present calibration range  
`Z_rdg` -- +zero 2600A measurement  
`DMM_Z_rdg` -- +zero DMM measurement  
`FS_rdg` -- +FS 2600A measurement  
`DMM_FS_rdg` -- +FS DMM measurement

Typical 1A range values:

`smua.measure.calibratei(1,1e-5,1e-4,0.89,0.88)`

- m. Select negative polarity, then set the source output to the negative zero value, for example:  
`smua.cal.polarity = smua.CAL_NEGATIVE`  
`smua.source.level1 = -1e-10`
- n. Turn on the output:  
`smua.source.output = smua.OUTPUT_ON`
- o. Allow the readings to settle, then get both the multimeter and Series 2600A current readings at the negative zero full-scale value (the Series 2600A measurement is not necessary if this calibration step is being done on the CALA sense mode). The two measurements should be made as close as possible in time. Use this command for the Series 2600A:  
`Z_rdg = smua.measure.i()`
- p. Turn off the output:  
`smua.source.output = smua.OUTPUT_OFF`
- q. Set the source output to the negative full-scale value, for example:  
`smua.source.level1 = -0.9`
- r. Turn on the output:  
`smua.source.output = smua.OUTPUT_ON`
- s. Allow the readings to settle, then get both the multimeter and Series 2600A current readings at the negative full-scale output value (the Series 2600A measurement is not necessary if this calibration step is being done on the CALA sense mode). The two measurements should be made as close as possible in time. Use this command for the Series 2600A:  
`FS_rdg = smua.measure.v()`
- t. Turn off the output:  
`smua.source.output = smua.OUTPUT_OFF`

- u. Send the source calibration command using the -range, -zero and -FS multimeter readings, and -zero and -FS source values for the parameters:

```
smua.source.calibratei(-range,src_Z,DMM_Z_rdg,
src_FS,DMM_FS_rdg)
```

Where:

|            |                                              |
|------------|----------------------------------------------|
| -range     | -- negative of the present calibration range |
| src_Z      | -- zero 2600A source output value            |
| DMM_Z_rdg  | -- zero DMM measurement                      |
| src_FS     | -- FS 2600A source output value              |
| DMM_FS_rdg | -- FS DMM measurement                        |

Typical values for the 1A range:

```
smua.source.calibratei(-1,-1e-10,-1e-5,-0.9,-0.892)
```

- v. If this step is not on the CALA sense mode, send the measure calibration command using the multimeter and Series 2600A readings, and range setting for the parameters:

```
smua.measure.calibratei(-range,Z_rdg,DMM_Z_rdg,
FS_rdg,DMM_FS_rdg)
```

Where:

|            |                                              |
|------------|----------------------------------------------|
| -range     | -- negative of the present calibration range |
| Z_rdg      | -- zero 2600A measurement                    |
| DMM_Z_rdg  | -- zero DMM measurement                      |
| FS_rdg     | -- FS 2600A measurement                      |
| DMM_FS_rdg | -- FS DMM measurement                        |

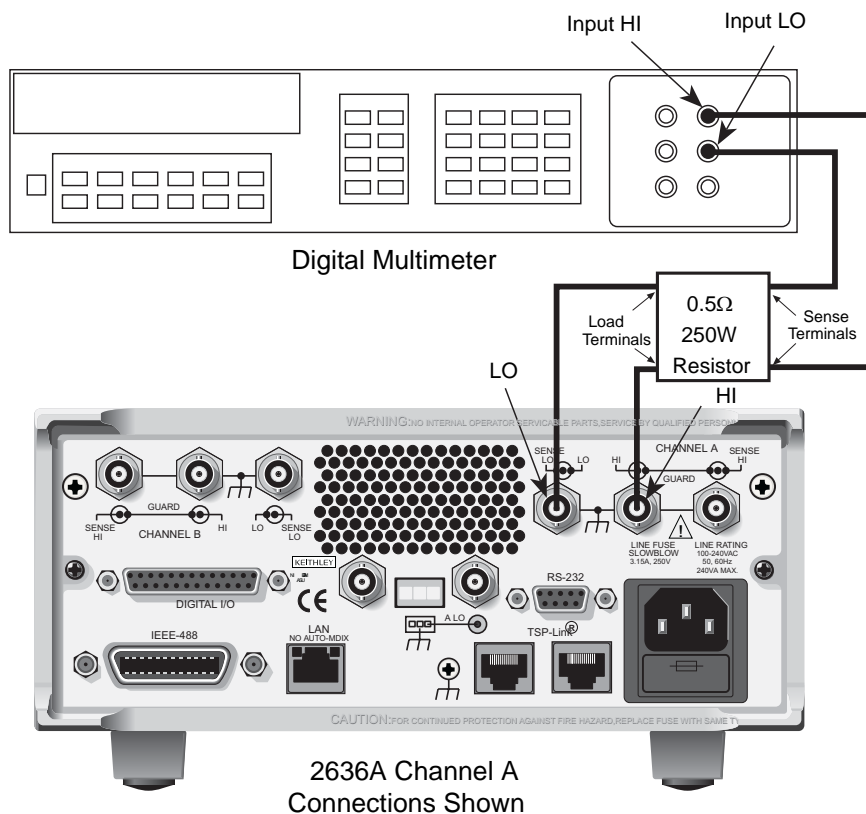
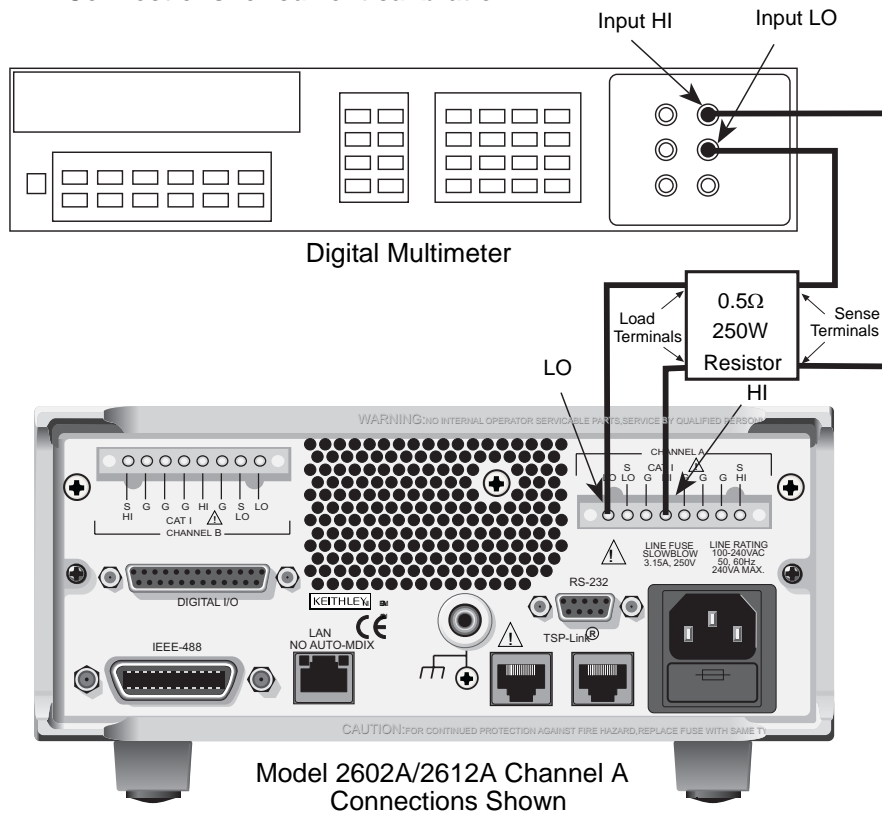
Typical 1A range values:

```
smua.measure.calibratei(-1,-1e-4,-1e-5,-0.91,-0.892)
```

4. Be sure to complete steps a through v for the 100nA to 1A ranges before continuing with 3A and 10A range calibration (Model 2601A/2602A) or 1.5A and 10A range calibration (Model 2611A/2612A/2635A/2636A).
5. Change connections as shown in [Figure 20-3](#) (use 4-wire connections to the 0.5Ω resistor as shown).
6. Select the DMM DC volts function.
7. Repeat steps a through v for the 3A and 10A ranges (Model 2601A/2602A) or 1.5A and 10A ranges (Model 2611A/2612A/2635A/2636A). Compute the current reading from the DMM voltage reading and characterized 0.5Ω resistance value:  $I = V/R$ .
8. Select auto polarity mode:  

```
smua.cal.polarity = smua.CAL_AUTO
```

Figure 20-3  
Connections for current calibration



**Models 2635A and 2636A:**

1. Connect the Series 2600A to the digital multimeter (see [Figure 20-2](#)), and select the multimeter DC current function.
2. Calibrate the low current ranges (100pA, 1nA, 10nA, 100nA<sup>1</sup>) using a suitably guarded and characterized 1G $\Omega$  resistance standard, such as the Keithley Instruments Model 2600-STD-RES (see [Table 20-1](#)). Step-by-step procedures, connection diagrams, and a factory script for calibrating the low current ranges are included with the Model 2600-STD-RES. The general process entails forcing a characterized voltage across the 1G $\Omega$  resistor and comparing the 2635A/2636A measured results against the standard resistance and voltage derived current.
  - a. Characterize the appropriate +/- V source values with the Digital Multimeter according to .
  - b. Characterize the desired Model 2635A/2636A current ranges.
    - 1) Connect the guarded resistance standard.
    - 2) Source the appropriate voltage for +/- full-scale reading.
    - 3) Wait 30 seconds for stable measurement.
    - 4) Capture the Model 2635A/2636A reported current measurement.
    - 5) Initiate HI-Z mode to open the resistor standard (source zero current) and the characterize offset.
    - 6) Repeat the above steps for each low current range.

Table 20-6

**Settings of Model 2635A/2636A Characterization of Voltage Source**

| Low Current Range | Voltage Source | Compliance |
|-------------------|----------------|------------|
| 100pA             | +/- 100.00mV   | 1.5A       |
| 1nA               | +/- 1.0000mV   | 1.5A       |
| 10nA              | +/- 10.000mV   | 1.5A       |
| 100nA             | +/- 100.00V    | 100mA      |

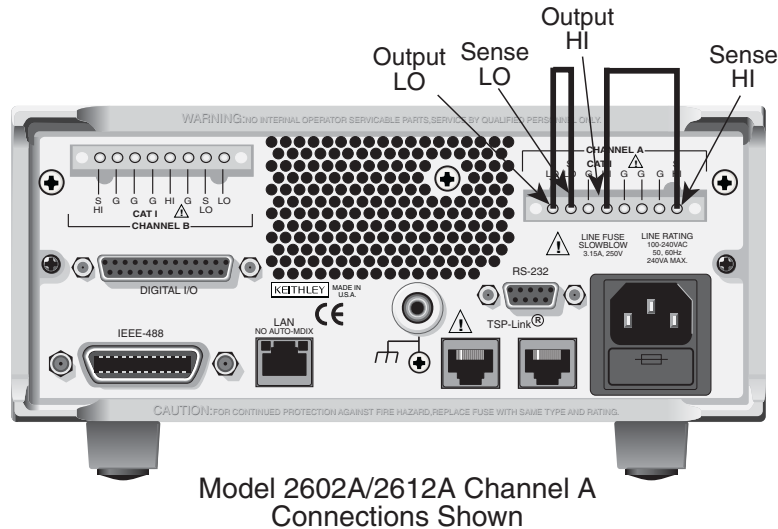
**Step 4. Contact check calibration (For 2601A/2602A/2611A/2612A only)**

- a. Short the Series 2600A sense low and output low terminals, as shown in [Figure 20-4](#). Also short the sense high and output high terminals together, as shown in the figure.

---

1. The 2601A/2602A/2611A/2612A could be calibrated with this method for the 100nA setting only if desired.

Figure 20-4

**Connections for contact check 0Ω calibration**

- b. Allow the readings to settle, then get the Series 2600A readings:  
`r0_hi, r0_lo = smua.contact.r()`
- c. Connect a 50Ω resistor between the sense low and output low terminals, as shown in [Figure 20-5](#). Also connect a second 50Ω resistor between the sense high and output high terminals as shown in the figure.
- d. Allow the readings to settle, then get the Series 2600A readings:  
`r50_hi, r50_lo = smua.contact.r()`
- e. Send the contact check low calibration command:  
`smua.contact.calibratelo(r0_lo, Z_actual, r50_lo, 50_ohm_actual)`

Where:

|                            |                                     |
|----------------------------|-------------------------------------|
| <code>r0_lo</code>         | -- Series 2600A 0W low measurement  |
| <code>Z_actual</code>      | -- actual zero value                |
| <code>r50_lo</code>        | -- Series 2600A 50W low measurement |
| <code>50_ohm_actual</code> | -- actual 50W resistor value        |

## Typical values:

```
smua.contact.calibratelo(r0_lo, 0, r50_lo, 50.15)
```

- f. (Where `r0_lo` and `r50_lo` are measurements taken in steps 2 and 4 above.)
- g. Send the contact check high calibration command:  
`smua.contact.calibratehi(r0_hi, Z_actual, r50_hi, 50_ohm_actual)`

Where:

|                            |                                      |
|----------------------------|--------------------------------------|
| <code>r0_hi</code>         | -- Series 2600A 0W high measurement  |
| <code>Z_actual</code>      | -- actual zero value                 |
| <code>r50_hi</code>        | -- Series 2600A 50W high measurement |
| <code>50_ohm_actual</code> | -- actual 50W resistor value         |

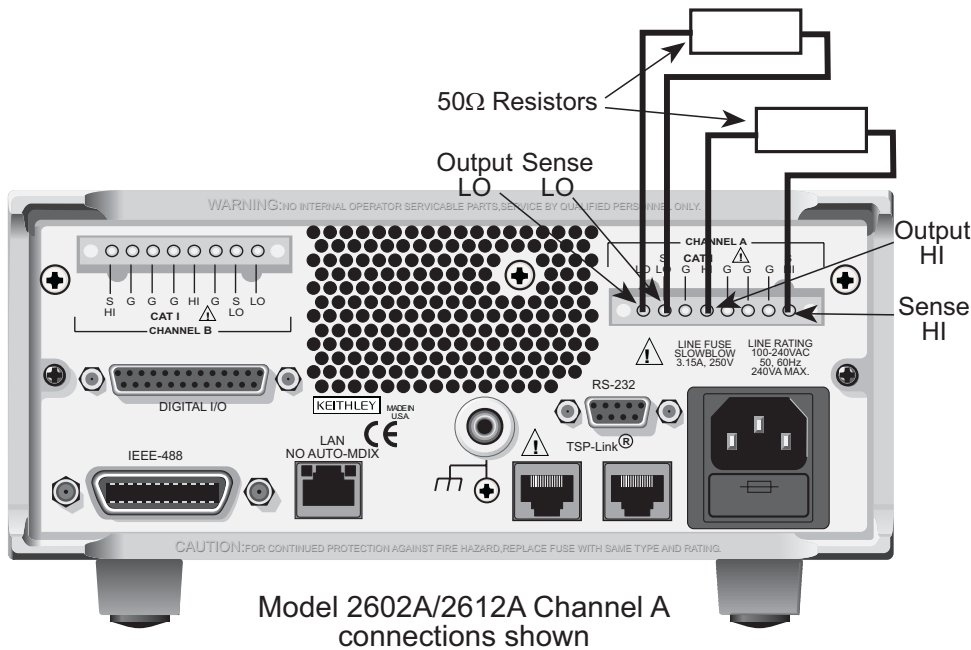
## Typical values:

```
smua.contact.calibratehi(r0_hi, 0, r50_hi, 50.15)
```

(Where `r0_hi` and `r50_hi` are measurements taken in steps 2 and 4 above.)



Figure 20-5  
Connections for contact check 50Ω calibration



### Step 5. Program calibration dates

Use the following command to set the calibration adjustment date:

```
smua.cal.adjustdate = os.time{year=2005, month=1, day=1}
```

Optionally, it is possible to set the calibration date and calibration due date with the following commands:

```
smua.cal.date = os.time{year=2005, month=1, day=1}
smua.cal.due = os.time{year=2006, month=1, day=1}
```

If you do not wish to set a calibration date or calibration due date and want to clear the previous values, use the following commands:

```
smua.cal.date = 0
smua.cal.due = 0
```

The actual year, month, and day, as well as (optional) hour, and minute should be used (seconds can be given but will essentially be ignored due to the precision of the internal date storage format). The allowable range for the `year` is from 2005 to 2037, the `month` is from 1 to 12, and the `day` is from 1 to 31.

### Step 6. Save calibration constants

Calibration is now complete, so you can store the calibration constants in nonvolatile memory by sending the following command:

```
smua.cal.save()
```

Calibration just performed will be temporary unless you send the `save` command.

**Step 7. Lock out calibration**

To lock out further calibration, send the following command after completing the calibration procedure:

```
smua.cal.lock()
```

**Step 8. Repeat calibration procedure for Model 2602A/2612A/2636A Channel B**

For the Models 2602A, 2612A, and 2636A only, repeat the entire procedure above for Channel B. Be sure to:

- Make test connections to Channel B terminals.
- Substitute “smub” for “smua” in all commands.

---

**Routine Maintenance****In this section:**

| <b>Topic</b>                               | <b>Page</b> |
|--------------------------------------------|-------------|
| <b>Introduction</b>                        | <b>21-1</b> |
| <b>Line fuse replacement</b> .....         | <b>21-2</b> |
| <b>Front panel tests</b> .....             | <b>21-3</b> |
| Keys test .....                            | 21-3        |
| Display Patterns test .....                | 21-3        |
| <b>Upgrading the firmware</b> .....        | <b>21-4</b> |
| Using TSB for flash firmware upgrade ..... | 21-4        |

## Introduction

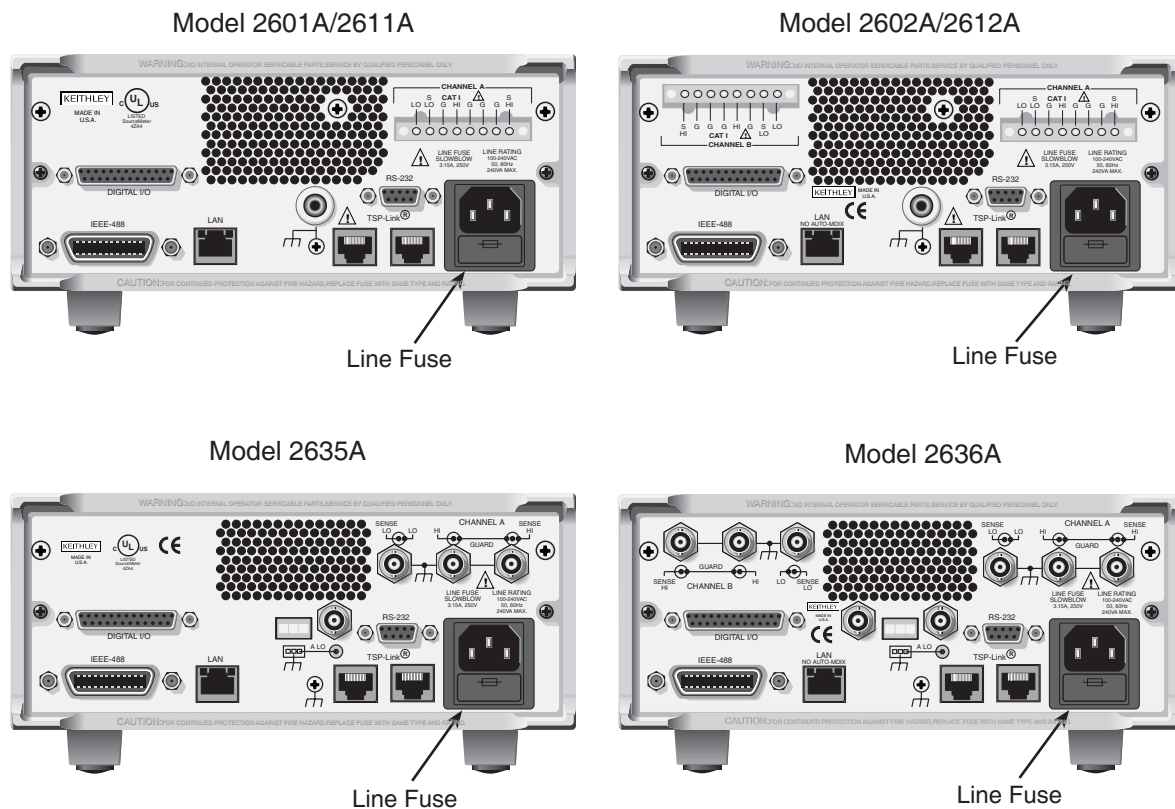
The information in this section deals with routine maintenance of the Keithley Instruments Series 2600A System SourceMeter® instrument that can be performed by the operator.

## Line fuse replacement

**WARNING** *Disconnect the line cord at the rear panel, and remove all test leads connected to the instrument before replacing the line fuse. Failure to do so could expose the operator to hazardous voltages that could result in personal injury or death.*

**NOTE** The power line fuse is accessible from the rear panel, just below the AC power receptacle (Figure 21-1).

Figure 21-1  
Line fuse replacement



Perform the following steps to replace the line fuse:

1. Carefully grasp and squeeze together the locking tabs that secure the fuse carrier to the fuse holder.
2. Pull out the fuse carrier, and replace the fuse with the type specified in [Table 21-1](#).

---



---

**CAUTION** To prevent instrument damage, use only the fuse type specified in [Table 21-1](#).

---



---

3. Reinstall the fuse carrier.

If the power line fuse continues to blow, a circuit malfunction exists and must be corrected. Return the unit to Keithley Instruments for repair.

Table 21-1

**Line fuse**

| Line voltage | Rating                          | Keithley Instruments part no. |
|--------------|---------------------------------|-------------------------------|
| 100-240V     | 250V, 3.15A, Slow Blow 5 × 20mm | FU-106-3.15                   |

## Front panel tests

There are two front panel tests: one to test the functionality of the front panel keys and one to test the display.

### Keys test

The KEYS test lets you check the functionality of each front panel key. Perform the following steps to run the KEYS test.

1. Press **MENU > DISPLAY > TEST**.
2. Select **DISPLAY-TESTS**, and press **ENTER** or the **navigation wheel**.
3. Select **KEYS**, and press **ENTER** or the **navigation wheel** to start the test. When a key is pressed, the label name for that key will be displayed to indicate that it is functioning properly. When the key is released, the message “No keys pressed” is displayed.
4. Pressing **EXIT** tests the **EXIT** key. However, the second consecutive press of **EXIT** aborts the test and returns the instrument to the DISPLAY menu. Continue pressing **EXIT** to back out of the menu structure.

### Display Patterns test

The Display Patterns test lets you verify that each pixel and indicator in the vacuum fluorescent display is working properly. Perform the following steps to run the display test:

1. Press **MENU > DISPLAY > TEST**.
2. Select **DISPLAY-TESTS**, and press **ENTER** or the **navigation wheel**.
3. Select **DISPLAY\_PATTERNS**, and press **ENTER** or the **navigation wheel** to start the display test. There are three parts to the display test. Each time **ENTER** or the **navigation wheel** is pressed, the next part of the test sequence is selected. The three parts of the test sequence are as follows:

- Checkerboard pattern and the indicators that are on during normal operation.
  - Checkerboard pattern (alternate pixels on) and all indicators.
  - Each digit (and adjacent indicator) is sequenced. All of the pixels of the selected digit are on.
4. When finished, abort the display test by pressing **EXIT**. The instrument returns to the FRONT PANEL TESTS MENU. Continue pressing **EXIT** to back out of the menu structure.

## Upgrading the firmware

You can use USB flash drive to upgrade and install the firmware.

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**CAUTION** Disconnect the input and output terminals before you upgrade.

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Complete the following steps to upgrade the firmware.

1. From your PC, go to **www.keithley.com** and then download the latest version of firmware from the website.
2. Insert the USB flash drive into the USB port on your PC.
3. Transfer the firmware file to the USB flash drive.
4. Insert a USB flash drive into the USB port on the front panel of the Series 2600A.
5. From the front panel, press **MENU > UPGRADE**.
6. Select the appropriate version of firmware on the USB flash drive.
7. Press **ENTER** to upgrade the firmware.

---



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**CAUTION** Do not turn the Series 2600A off while an upgrade is in progress.

---



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## Using TSB for flash firmware upgrade

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**CAUTION** Disconnect input/output terminals before performing a flash upgrade.

---



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After downloading the new flash file from the Keithley Instruments website, use the Test Script Builder (TSB) to upgrade the firmware of your Series 2600A:

1. On the PC desktop, double-click the icon for the Test Script Builder.
2. On the Instrument Console toolbar, click the Open Instrument icon and then select your communication interface from the Select Instrument Resource dialog box. Details on opening communications are provided in Figure 2-8.

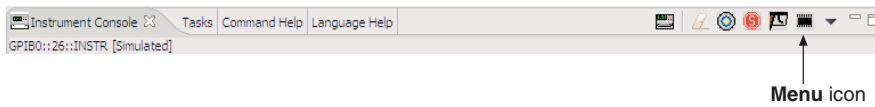
Figure 21-2  
Pulse sweep example



Open Instrument icon

3. On the Instrument Console toolbar, click the Menu icon to display the menu.

Figure 21-3  
**Pulse sweep example**



4. From the drop-down menu, select Instrument and then click Flash.
5. From the Select A Firmware Data File dialog box, use the browser to select the File name of the new firmware and click Open to upgrade the firmware of the Series 2600A.

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**Performance Verification**
**In this section:**

| Topic                                                                         | Page         |
|-------------------------------------------------------------------------------|--------------|
| <b>Introduction</b> .....                                                     | <b>22-2</b>  |
| <b>Verification test requirements</b> .....                                   | <b>22-2</b>  |
| Environmental conditions .....                                                | 22-2         |
| Warm-up period .....                                                          | 22-2         |
| Line power .....                                                              | 22-3         |
| Recommended test equipment .....                                              | 22-3         |
| Verification limits .....                                                     | 22-3         |
| <b>Restoring factory defaults</b> .....                                       | <b>22-4</b>  |
| <b>Performing the verification test procedures</b> .....                      | <b>22-5</b>  |
| Test summary .....                                                            | 22-5         |
| Test considerations .....                                                     | 22-5         |
| Setting the source range and output value .....                               | 22-5         |
| Setting the measurement range .....                                           | 22-6         |
| <b>Output voltage accuracy</b> .....                                          | <b>22-6</b>  |
| <b>Voltage measurement accuracy</b> .....                                     | <b>22-8</b>  |
| <b>Output current accuracy</b> .....                                          | <b>22-9</b>  |
| Series 2600A output current accuracy 100nA and higher .....                   | 22-9         |
| Model 2635A/2636A output current accuracy 1nA to 100nA<br>ranges .....        | 22-11        |
| <b>Current measurement accuracy</b> .....                                     | <b>22-14</b> |
| Series 2600A current measurement accuracy 100nA and higher .....              | 22-14        |
| Model 2635A/2636A current measurement accuracy 100pA to<br>100nA ranges ..... | 22-15        |

## Introduction

Use the procedures in this section to verify that the Keithley Instruments Series 2600A System SourceMeter® instrument accuracy is within the limits stated in the instrument's one-year accuracy specifications. Perform the verification procedures:

- When you first receive the instrument to make sure that it was not damaged during shipment.
- To verify that the unit meets factory specifications.
- To determine if calibration is required.
- Following calibration to make sure it was performed properly.

---

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**WARNING** *The information in this section is intended for qualified service personnel only. Do not attempt these procedures unless you are qualified to do so. Some of these procedures may expose you to hazardous voltages, which could cause personal injury or death if contacted. Use appropriate safety precautions when working with hazardous voltages.*

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**NOTE** If the instrument is still under warranty and its performance is outside specified limits, contact your Keithley Instruments representative or the factory to determine the correct course of action.

---

## Verification test requirements

Be sure that you perform the verification tests:

- Under the proper environmental conditions.
- After the specified warm-up period.
- Using the correct line voltage.
- Using the proper test equipment.
- Using the specified output signal and reading limits.

## Environmental conditions

Conduct your performance verification procedures in a test environment with:

- An ambient temperature of 18-28°C (65-82°F).
- A relative humidity of less than 70% unless otherwise noted.

## Warm-up period

Allow the Series 2600A to warm up for at least two hours before conducting the verification procedures. If the instrument has been subjected to temperature extremes (those outside the ranges stated above), allow additional time for the instrument's internal temperature to stabilize. Typically, allow one extra hour to stabilize a unit that is 10°C (18°F) outside the specified temperature range.

Also, allow the test equipment to warm up for the minimum time specified by the manufacturer.

## Line power

The Series 2600A requires a line voltage of 100V to 240V and a line frequency of 50Hz or 60Hz. Verification tests should be performed within this range.

## Recommended test equipment

Table 22-1 summarizes recommended verification equipment. You can use alternate equipment as long as that equipment has specifications equal to or greater than those listed in Table 22-1. Keep in mind, however, that test equipment uncertainty will add to the uncertainty of each measurement. Generally, test equipment uncertainty should be at least four times better than corresponding Series 2600A specifications. Table 22-1 lists the uncertainties of the recommended test equipment.

Table 22-1  
Recommended verification equipment

| Description                            | Manufacturer/Model                                        | Accuracy                                                                                                                                                  |
|----------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Digital Multimeter                     | Keithley Instruments<br>Model 2002<br>or<br>Agilent 3458A | DC Voltage <sup>1</sup><br>(2601A/2602A) 90mV: ±8ppm<br>0.9V: ±5ppm<br>5.4V: ±4ppm<br>36V: ±6ppm                                                          |
|                                        |                                                           | DC Voltage <sup>2</sup><br>(2611A/2612A/<br>2635A/2636A) 190mV: ±5ppm<br>1.8V: ±4ppm<br>18V: ±6ppm<br>180V: ±6ppm                                         |
|                                        |                                                           | DC current <sup>3</sup><br>90nA: ±430ppm<br>0.9µA: ±45ppm<br>9µA: ±25ppm<br>90µA: ±23ppm<br>0.9mA: ±20ppm<br>9mA: ±20ppm<br>90mA: ±35ppm<br>0.9A: ±110ppm |
| 0.5Ω, 250W, 0.1%<br>Precision Resistor | Isotek<br>RUG-Z-R500-0.1-TK3                              | Resistance <sup>4</sup> 0.5Ω : ±125ppm                                                                                                                    |
| 1GΩ, 200V, 1%<br>standard              | Keithley Instruments<br>Model 2600-STD-RES                | Resistance <sup>5</sup> 1GΩ : 250ppm                                                                                                                      |

- 90-day specifications show full-range accuracy of recommended model used for specified measurement point.
- Id.
- Id.
- Resistor used to test Model 2601A/2602A 3A range and Model 2611A/2612A/2635A/2636A 1.5A range only should be characterized to uncertainty shown using resistance function of digital multimeter before use.
- Standard is a guarded and characterized 1 GΩ resistor used to test Model 2635A/2636A 100pA to 100nA current ranges.

## Verification limits

The verification limits stated in this section have been calculated using only the Series 2600A one-year accuracy specifications, and they do not include test equipment uncertainty. If a

particular measurement falls outside the allowable range, recalculate new limits based both on the Series 2600A specifications and corresponding test equipment specifications.

### Example limits calculations

#### Model 2601A/2602A example

As an example of how verification limits are calculated, assume you are testing the Model 2601A/2602A 6V DC output range using a 5.4V output value. Using the Model 2601A/2602A one-year accuracy specification for 5.4V DC output of  $\pm (0.02\% \text{ of output} + 1.8\text{mV offset})$ , the calculated output limits are:

$$\text{Output limits} = 5.4\text{V} \pm [(5.4\text{V} \times 0.02\%) + 1.8\text{mV}]$$

$$\text{Output limits} = 5.4\text{V} \pm (0.00108 + 0.0018)$$

$$\text{Output limits} = 5.4\text{V} \pm 0.00288\text{V}$$

$$\text{Output limits} = 5.39712\text{V to } 5.40288\text{V}$$

#### Model 2611A/2612A/2635A/2636A example

Similarly, assume you are testing the Model 2611A/2612A/2635A/2636A 20V DC output range using an 18V output value. Using the Model 2611A/2612A/2635A/2636A one-year accuracy specification for 18V DC output of  $\pm (0.02\% \text{ of output} + 5\text{mV offset})$ , the calculated output limits are:

$$\text{Output limits} = 18\text{V} \pm [(18\text{V} \times 0.02\%) + 5\text{mV}]$$

$$\text{Output limits} = 18\text{V} \pm (0.0036 + 0.005)$$

$$\text{Output limits} = 18\text{V} \pm 0.0086\text{V}$$

$$\text{Output limits} = 17.9914\text{V to } 18.0086\text{V}$$

## Restoring factory defaults

Before performing the verification procedures, restore the instrument to its factory front panel (bench) defaults as follows:

1. Press **MENU** > **SETUP** then press the **ENTER** key.
2. Select **RECALL** then press the **ENTER** key.
3. Select **INTERNAL** then press the **ENTER** key.
4. Select **FACTORY** then press the **ENTER** key to restore defaults.

## Performing the verification test procedures

### Test summary

- DC voltage output accuracy
- DC voltage measurement accuracy
- DC current output accuracy
- DC current measurement accuracy

If the Series 2600A is not within specifications and not under warranty, see the calibration procedures in [Section 20](#) for information on calibrating the unit.

### Test considerations

When performing the verification procedures:

- Be sure to restore factory front panel defaults as outlined above.
- Make sure that the test equipment is properly warmed up and connected to the Series 2600A output terminals (use 4-wire sensing for voltage).
- Make sure the Series 2600A is set to the correct source range.
- Be sure the Series 2600A output is turned on before making measurements.
- Be sure the test equipment is set up for the proper function and range.
- Allow the Series 2600A output signal to settle before making a measurement.
- Do not connect test equipment to the Series 2600A through a scanner, multiplexer, or other switching equipment.

---

---

**WARNING** *The maximum common-mode voltage (voltage between LO and chassis ground) is 250V DC. Exceeding this value may cause a break down in insulation, creating a shock hazard. The Input/Output terminals of the Series 2600A are rated for connection to circuits rated Installation Category I only, with transients rated less than 1500V peak. Do not connect the Series 2600A terminals to CAT II, CAT III, or CAT IV circuits. Connection of the Series 2600A terminals to circuits higher than CAT I can cause damage to the equipment or expose the operator to hazardous voltage.*

*Hazardous voltages may be present on the output and guard terminals. To prevent electrical shock that could cause injury or death, NEVER make or break connections to the Series 2600A while the unit is on. Power off the equipment from the front panel or disconnect the main power cord from the rear of the Series 2600A before handling cables connected to the outputs. Putting the equipment into standby mode does not guarantee the outputs are not powered if a hardware or software fault occurs.*

---

---

### Setting the source range and output value

Before testing each verification point, you must properly set the source range and output value as outlined below:

1. Press the **SRC** key to select the appropriate source function.
2. Press the **navigation wheel** or the **ENTER** key to enable the edit mode (EDIT indicator on).
3. When the cursor in the source display field is flashing, set the source range to the lowest possible range for the value being sourced. Use the up or down **RANGE** key to set the value.
4. Use the **navigation wheel** and **CURSOR** keys to set the source value to the required value, then press the **ENTER** key or the **navigation wheel** to complete editing.

## Setting the measurement range

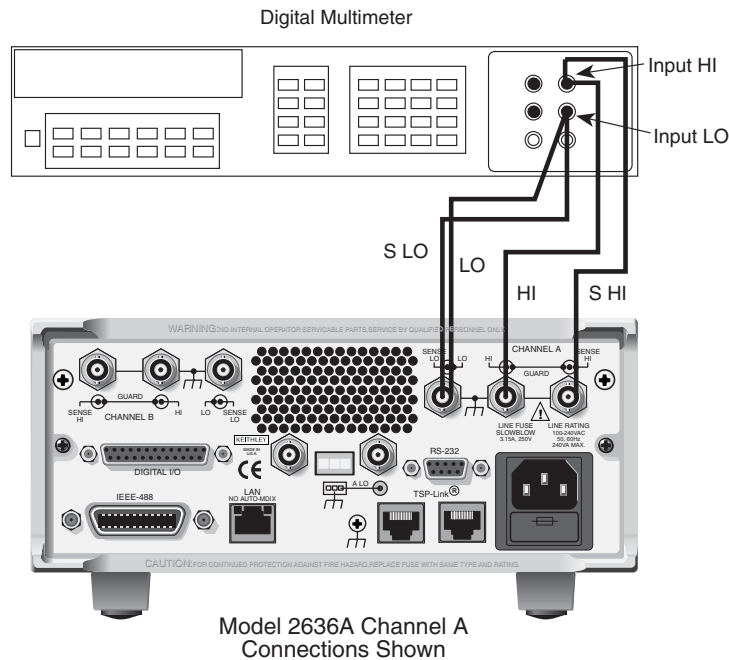
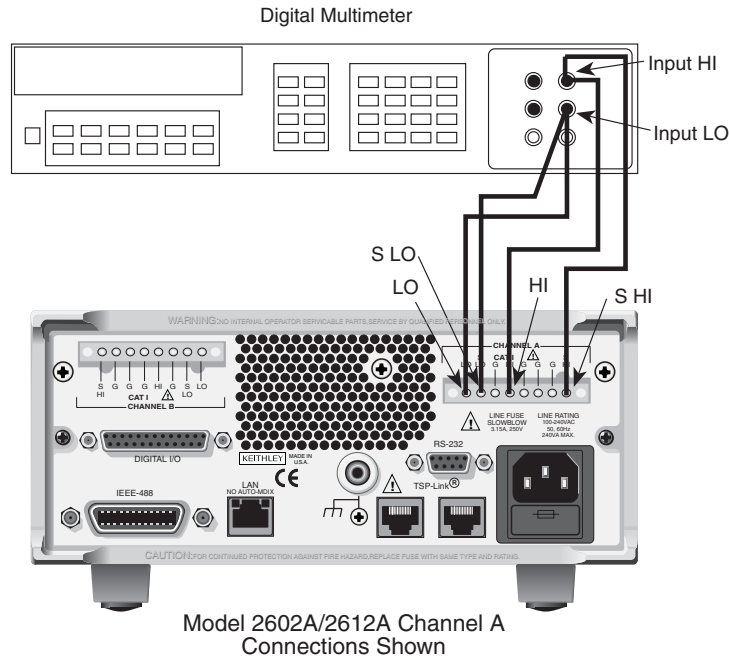
When simultaneously sourcing and measuring either voltage or current, the measure range is coupled to the source range, and you cannot independently control the measure range. Thus, it is not necessary for you to set the range when testing voltage or current measurement accuracy.

## Output voltage accuracy

Follow the steps below to verify that the Series 2600A output voltage accuracy is within specified limits. This test involves setting the output voltage to each full-range value and measuring the voltages with a precision digital multimeter.

1. With the power off, connect the digital multimeter (DMM) to the Series 2600A output terminals using 4-wire connections, as shown in [Figure 22-1](#).

Figure 22-1  
Connections for voltage verification



2. Select the multimeter DC volts measuring function.
3. Select the Model 2602A/2612A/2636A single-channel display mode. Press the **SRC** key to source voltage and make sure the source output is turned on.
4. Enable the Series 2600A 4-wire (remote sense) mode by pressing **CONFIG** then **SRC**, then select **V-SOURCE** > **SENSE-MODE** > **4-WIRE**.
5. Verify output voltage accuracy for each of the voltages listed in [Table 22-2](#) (Model 2601A/2602A) or [Table 22-3](#) (Model 2611A/2612A/2635A/2636A). For each test point:
  - Select the correct source range.

- Set the Series 2600A output voltage to the indicated value.
  - Verify that the multimeter reading is within the limits given in the table.
1. Repeat the procedure for negative output voltages with the same magnitudes as those listed in [Table 22-2](#) or [Table 22-3](#).

Table 22-2

**Model 2601A/2602A output voltage accuracy limits**

| Model 2601A/2602A source range | Model 2601A/2602A output voltage setting | Output voltage limits (1 year, 18°C–28°C) |
|--------------------------------|------------------------------------------|-------------------------------------------|
| 100mV                          | 90.000mV                                 | 89.732 to 90.268mV                        |
| 1V                             | 0.90000V                                 | 0.89942 to 0.90058V                       |
| 6V                             | 5.4000V                                  | 5.39712 to 5.40288V                       |
| 40V                            | 36.000V                                  | 35.9808 to 36.0192V                       |

Table 22-3

**Model 2611A/2612A/2635A/2636A output voltage accuracy limits**

| Model 2611A/2612A/2635A/2636A source range | Model 2611A/2612A/2635A/2636A output voltage setting | Output voltage limits (1 year, 18°C–28°C) |
|--------------------------------------------|------------------------------------------------------|-------------------------------------------|
| 200mV                                      | 180.000mV                                            | 179.589 to 180.411mV                      |
| 2V                                         | 1.80000V                                             | 1.79904 to 1.80096V                       |
| 20V                                        | 18.000V                                              | 17.9914 to 18.0086V                       |
| 200V                                       | 180.000V                                             | 179.914 to 180.086V                       |

2. For the Model 2602A/2612A/2636A, repeat the above procedure for the other channel.

## Voltage measurement accuracy

Follow the steps below to verify that the Series 2600A voltage measurement accuracy is within specified limits. The test involves setting the source voltage, as measured by a precision digital multimeter, and then verifying that the Series 2600A voltage readings are within required limits.

1. With the power off, connect the digital multimeter to the Series 2600A output terminals using 4-wire connections, as shown in [Figure 22-1](#).
2. Select the multimeter DC volts function.
3. Select the Model 2602A/2612A/2636A single-channel display mode.
4. Enable the Series 2600A 4-wire (remote sense) mode by pressing **CONFIG** then **MEAS**, then select **V-MEAS > SENSE-MODE > 4-WIRE**.
5. Set the Series 2600A to both source and measure voltage by pressing the **SRC** and **MEAS** keys, and make sure the source output is turned on.
6. Verify voltage measurement accuracy for each of the voltages listed in [Table 22-4](#) (Model 2601A/2602A) or [Table 22-5](#) (Model 2611A/2612A/2635A/2636A). For each test point:
  - Select the correct source range.
  - Set the Series 2600A output voltage to the indicated value as measured by the digital multimeter.
  - If necessary, press the **TRIG** key to display readings.
  - Verify that the Series 2600A voltage reading is within the limits given in the table. It may not be possible to set the voltage source to the required value. Use the closest possible setting, and modify reading limits accordingly.
7. Repeat the procedure for negative source voltages with the same magnitudes as those listed in [Table 22-4](#) or [Table 22-5](#).



8. For the Model 2602A/2612A/2636A, repeat the above procedure for the other channel.

Table 22-4

**Model 2601A/2602A voltage measurement accuracy limits**

| Model 2601A/2602A source and measure range <sup>1</sup> | Source voltage <sup>2</sup> | Model 2601A/2602A voltage reading limits (1 year, 18°C–28°C) |
|---------------------------------------------------------|-----------------------------|--------------------------------------------------------------|
| 100mV                                                   | 90.000mV                    | 89.8365 to 90.1635mV                                         |
| 1V                                                      | 0.90000V                    | 0.899665 to 0.900335V                                        |
| 6V                                                      | 5.4000V                     | 5.39819 to 5.40181V                                          |
| 40V                                                     | 36.000V                     | 35.9866 to 36.0134V                                          |

1. Measure range coupled to source range when simultaneously sourcing and measuring voltage.
2. As measured by precision digital multimeter. Use closest possible value, and modify reading limits accordingly if necessary.

Table 22-5

**Model 2611A/2612A/2635A/2636A voltage measurement accuracy limits**

| Model 2611A/2612A/2635A/2636A source and measure range <sup>1</sup> | Source voltage <sup>2</sup> | Model 2611A/2612A/2635A/2636A voltage reading limits (1 year, 18°C–28°C) |
|---------------------------------------------------------------------|-----------------------------|--------------------------------------------------------------------------|
| 200mV                                                               | 180.000mV                   | 179.748 to 180.252mV                                                     |
| 2V                                                                  | 1.80000V                    | 1.79929 to 1.80071V                                                      |
| 20V                                                                 | 18.0000V                    | 17.9923 to 18.0077V                                                      |
| 200V                                                                | 180.000V                    | 179.923 to 180.077V                                                      |

1. Measure range coupled to source range when simultaneously sourcing and measuring voltage.
2. As measured by precision digital multimeter. Use closest possible value, and modify reading limits accordingly if necessary.

## Output current accuracy

### Series 2600A output current accuracy 100nA and higher

Follow the steps below to verify that the Series 2600A output current accuracy is within specified limits.

---

**NOTE** An alternate procedure for 100nA current accuracy is shown in the 1nA to 100nA Output current accuracy procedure for the Model 2635A/2636A.

---

1. With the power off, connect the digital multimeter to the Series 2600A output terminals, as shown in [Figure 22-2](#).
2. Select the multimeter DC current measuring function.
3. Select the Model 2602A/2612A/2636A single-channel display mode.
4. Press the Series 2600A **SRC** key to source current, and make sure the source output is turned on.
5. Verify output current accuracy for each of the currents for the 1µA to 1A ranges listed in [Table 22-6](#) (Model 2601A/2602A), or [Table 22-7](#) (Model 2611A/2612A), or [Table 22-8](#) (Model 2635A/2636A). For each test point:

- Select the correct source range.
  - Set the Series 2600A output current to the correct value.
  - Verify that the multimeter reading is within the limits given in the table.
6. Repeat the procedure for negative output currents with the same magnitudes as those listed in [Table 22-6](#), or [Table 22-7](#), or [Table 22-8](#).

Table 22-6

**Model 2601A/2602A output current accuracy limits**

| Model 2601A/2602A source range | Model 2601A/2602A output current setting | Output current limits (1 year, 18°C–28°C) |
|--------------------------------|------------------------------------------|-------------------------------------------|
| 100nA                          | 90.000nA                                 | 89.846 to 90.154nA                        |
| 1µA                            | 0.90000µA                                | 0.89913 to 0.90087µA                      |
| 10µA                           | 9.0000µA                                 | 8.9953 to 9.0047µA                        |
| 100µA                          | 90.000µA                                 | 89.943 to 90.057µA                        |
| 1mA                            | 0.90000mA                                | 0.89953 to 0.90047mA                      |
| 10mA                           | 9.0000mA                                 | 8.9943 to 9.0057mA                        |
| 100mA                          | 90.000mA                                 | 89.953 to 90.047mA                        |
| 1A                             | 0.90000A                                 | 0.89865 to 0.90135A                       |
| 3A                             | 2.40000A                                 | 2.39706 to 2.40294A                       |

Table 22-7

**Model 2611A/2612A output current accuracy limits**

| Model 2611A/2612A source range | Model 2611A/2612A output current setting | Output current limits (1 year, 18°C–28°C) |
|--------------------------------|------------------------------------------|-------------------------------------------|
| 100nA                          | 90.000nA                                 | 89.846 to 90.154nA                        |
| 1µA                            | 0.90000µA                                | 0.89893 to 0.90107µA                      |
| 10µA                           | 9.0000µA                                 | 8.9923 to 9.0077µA                        |
| 100µA                          | 90.000µA                                 | 89.913 to 90.087µA                        |
| 1mA                            | 0.90000mA                                | 0.89943 to 0.90057mA                      |
| 10mA                           | 9.0000mA                                 | 8.9913 to 9.0087mA                        |
| 100mA                          | 90.000mA                                 | 89.943 to 90.057mA                        |
| 1A                             | 0.90000A                                 | 0.89775 to 0.90225A                       |
| 1.5A                           | 1.35000A                                 | 1.34519 to 1.35481A                       |

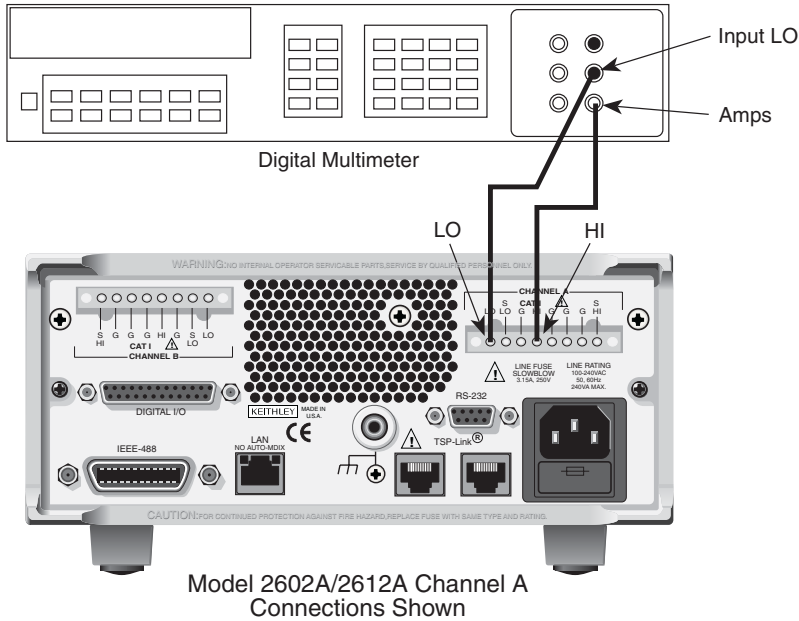
7. Turn the output off, and change connections as shown in [Figure 22-3](#) (use 4-wire connections to the 0.5Ω resistor as shown).
8. Select the DMM DC volts function.
9. Repeat steps 4 through 7 for the 3A range (Model 2601A/2602A) or 1.5A range (Model 2611A/2612A/2635A/2636A). Calculate the current from the DMM voltage reading and characterized 0.5Ω resistance value:  $I=V/R$ .
10. For the Model 2602A/2612A/2636A, repeat the above procedure for the other channel.

## Model 2635A/2636A output current accuracy 1nA to 100nA ranges

A suitably guarded and characterized 1 G $\Omega$  resistance standard, such as the Keithley Instruments Model 2600-STD-RES is necessary for the following measurements. Step-by-step procedures and connection diagrams for verifying the output current accuracy for the low current ranges are included with the Model 2600-STD-RES. The general process entails measuring the voltage across the characterized 1G $\Omega$  resistor for a given output current and comparing the derived current to the current accuracy of Table 15-8 for each current range.

1. Connect the guarded resistance standard to the 2635A/2636A and the DMM.
2. Source the appropriate current for +/- full-scale reading.
3. Wait 30 seconds for stable measurement.
4. Capture the reported voltage measurement.
5. Calculate the current from measured voltage and characterized resistance.
6. Verify output current accuracy for each of the currents for the 1nA to 100nA ranges listed in [Table 22-8](#) (Model 2635A/2636A).

Figure 22-2  
**Current verification connections (2602A/2612A(3A); 2636A(1.5A))**



**Current verification connections (1uA to 1A ranges)**

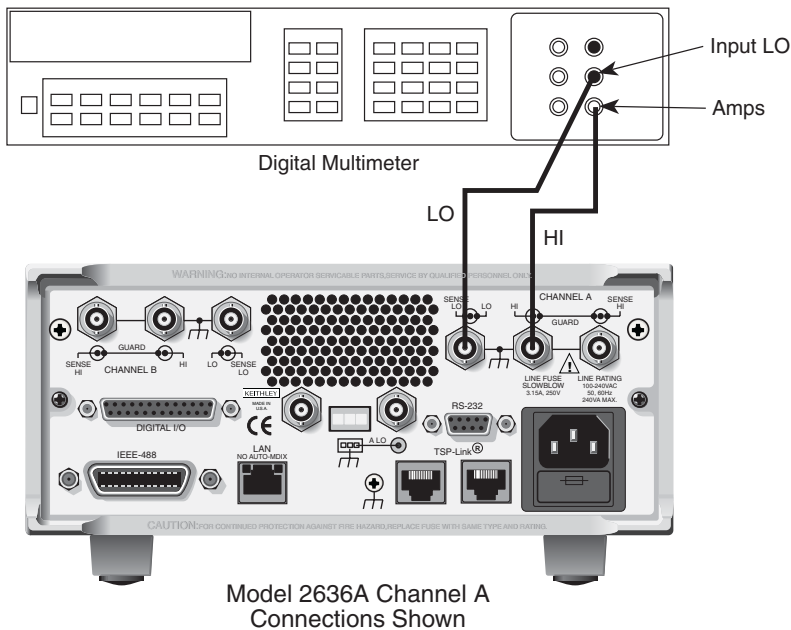


Figure 22-3  
**Connection ranges (2601A/2602A (3A); 2611A/2612A/2635A/2636A (1.5A))**

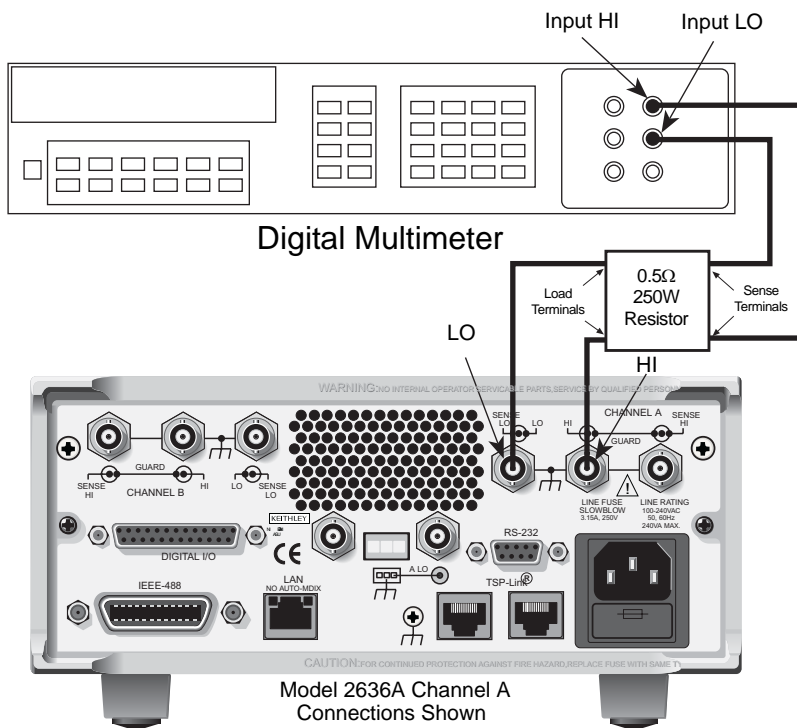
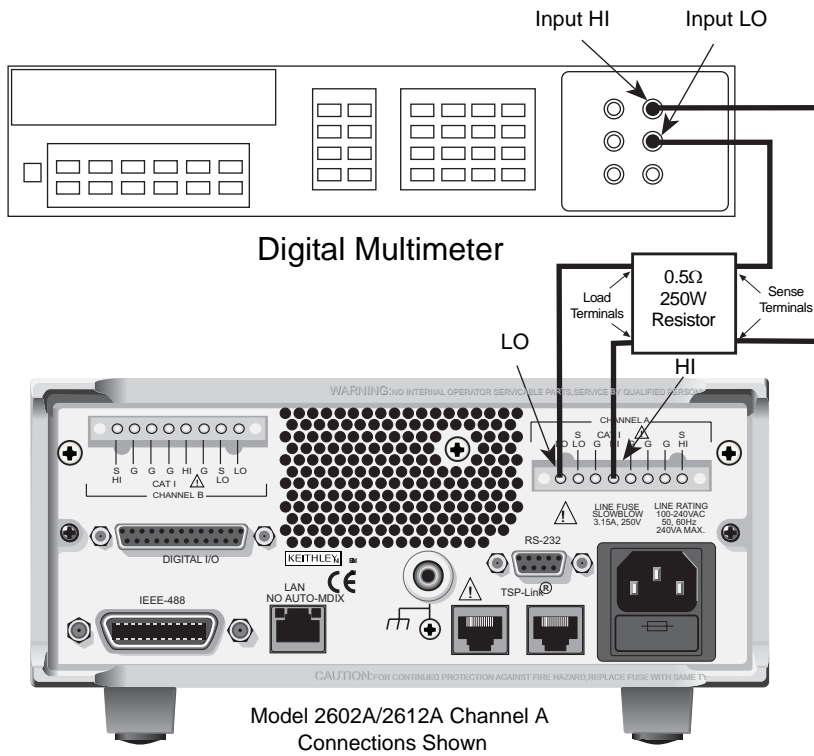


Table 22-8  
**Model 2635A/2636A output current accuracy limits**

| 2635A/2636A Source range | 2635A/2636A output current setting | Output current limits (1 year 18C - 28C) |
|--------------------------|------------------------------------|------------------------------------------|
| 1nA                      | 0.90000nA                          | 0.89665 to 0.90335nA                     |
| 10nA                     | 9.0000nA                           | 8.9815 to 9.0185nA                       |
| 100nA                    | 90.000nA                           | 89.8960 to 90.0140nA                     |
| 1uA                      | 0.90000uA                          | 0.89903 to 0.90097uA                     |
| 10uA                     | 9.0000uA                           | 8.9923 to 9.0077uA                       |
| 100uA                    | 90.000uA                           | 89.913 to 90.087uA                       |
| 1mA                      | 0.90000mA                          | 0.89943 to 0.90057mA                     |
| 10mA                     | 9.0000mA                           | 8.9913 to 9.0087mA                       |
| 100mA                    | 90.000mA                           | 89.943 to 90.057mA                       |
| 1A                       | 0.90000A                           | 0.89775 to 0.90225A                      |
| 1.5A                     | 1.35000A                           | 1.34519 to 1.35481A                      |

## Current measurement accuracy

### Series 2600A current measurement accuracy 100nA and higher

Follow the steps below to verify that Series 2600A current measurement accuracy is within specified limits. The procedure involves applying accurate currents from the Series 2600A current source and then verifying that Series 2600A current measurements are within required limits.

1. With the power off, connect the digital multimeter to the Series 2600A terminals as shown in [Figure 22-2](#).
2. Select the multimeter DC current function.
3. Select the Model 2602A/2612A/2636A single-channel display mode.
4. Set the Series 2600A to both source and measure current by pressing the **SRC** and **MEAS** keys, and make sure the source output is turned on.
5. Verify measure current accuracy for each of the currents listed in [Table 22-10](#) (Model 2601A/2602A), or [Table 22-11](#) (Model 2611A/2612A), or [Table 22-12](#) (Model 2635A/2636A). For each measurement:
  - Select the correct source range.
  - Set the Series 2600A source output to the correct value as measured by the digital multimeter.
  - If necessary, press the **TRIG** key to display readings.
  - Verify that the Series 2600A current reading is within the limits given in the table. It may not be possible to set the current source to the required value. Use the closest possible setting, and modify reading limits accordingly.
6. Repeat the procedure for negative calibrator currents with the same magnitudes as those listed in [Table 22-10](#), [Table 22-11](#), and [Table 22-12](#).
7. Turn the output off, change connections as shown in [Figure 22-3](#), then select the DMM volts function.
8. Repeat steps 4 through 6 for the 3A range (Model 2601A/2602A) or 1.5A range (Model 2611A/2612A/2635A/2636A). Calculate the current from the DMM voltage reading and characterized 0.5Ω resistance value.
9. For the Model 2602A/2612A/2636A, repeat the above procedure for the other channel.

## Model 2635A/2636A current measurement accuracy 100pA to 100nA ranges

A suitably guarded and characterized 1 G $\Omega$  resistance standard, such as the Keithley Instruments Model 2600-STD-RES is necessary for the following measurements. Step-by-step procedures and connection diagrams for verifying the current measurement accuracy for the low current ranges are included with the Model 2600-STD-RES. The general process entails forcing a characterized voltage across the 1G $\Omega$  resistor and comparing the Model 2636A/2636A measured results against the standard resistance and voltage derived current.

1. Characterize the appropriate +/- V source values with the DMM according to [Table 22-9](#).

Table 22-9

### Model 2635A/2636A Characterization of Voltage Source settings

| Low Current Range | Voltage Source | Compliance |
|-------------------|----------------|------------|
| 100 pA            | +/- 100.00 mV  | 1.5 A      |
| 1 nA              | +/- 1.0000 V   | 1.5 A      |
| 10 nA             | +/- 10.000 V   | 1.5 A      |
| 100 nA            | +/- 100.00 V   | 100 mA     |

2. Characterize the desired Model 2635A/2636A current ranges.
  - a. Connect guarded resistance standard.
  - b. Source the appropriate voltage for +/- full-scale reading.
  - c. Wait 30 seconds for stable measurement.
  - d. Capture the Model 2635A/2636A reported current measurement.
  - e. Verify output current accuracy for each of the currents for the 100pA to 100nA ranges listed in [Table 22-12](#) (Model 2635A/2636A).

Table 22-10

### Model 2601A/2602A current measurement accuracy limits

| Model 2601A/2602A source and measure range <sup>1</sup> | Source current <sup>2</sup> | Model 2601A/2602A current reading limits (1 year, 18°C–28°C) |
|---------------------------------------------------------|-----------------------------|--------------------------------------------------------------|
| 100nA                                                   | 90.000nA                    | 89.855 to 90.145nA                                           |
| 1 $\mu$ A                                               | 0.9000 $\mu$ A              | 0.899475 to 0.900525 $\mu$ A                                 |
| 10 $\mu$ A                                              | 9.0000 $\mu$ A              | 8.99625 to 9.00375 $\mu$ A                                   |
| 100 $\mu$ A                                             | 90.000 $\mu$ A              | 89.957 to 90.043 $\mu$ A                                     |
| 1mA                                                     | 0.9000mA                    | 0.89962 to 0.90038mA                                         |
| 10mA                                                    | 9.0000mA                    | 8.9957 to 9.0043mA                                           |
| 100mA                                                   | 90.000mA                    | 89.962 to 90.038mA                                           |
| 1A                                                      | 0.90000A                    | 0.89823 to 0.90177A                                          |
| 3A                                                      | 2.4000A                     | 2.3953 to 2.4047A                                            |

1. Measure range coupled to source range when simultaneously sourcing and measuring current.
2. As measured by precision digital multimeter. Use closest possible value, and modify reading limits accordingly if necessary.

Table 22-11  
**Model 2611A/2612A current measurement accuracy limits**

| Model 2611A/2612A source and measure range <sup>1</sup> | Source current <sup>2</sup> | Model 2611A/2612A current reading limits (1 year, 18°C–28°C) |
|---------------------------------------------------------|-----------------------------|--------------------------------------------------------------|
| 100nA                                                   | 90.000nA                    | 89.855 to 90.145nA                                           |
| 1µA                                                     | 0.9000µA                    | 0.899275 to 0.900725µA                                       |
| 10µA                                                    | 9.0000µA                    | 8.99625 to 9.00375µA                                         |
| 100µA                                                   | 90.000µA                    | 89.957 to 90.043µA                                           |
| 1mA                                                     | 0.9000mA                    | 0.89962 to 0.90038mA                                         |
| 10mA                                                    | 9.0000mA                    | 8.9957 to 9.0043mA                                           |
| 100mA                                                   | 90.000mA                    | 89.962 to 90.038mA                                           |
| 1A                                                      | 0.90000A                    | 0.89823 to 0.90177A                                          |
| 1.5A                                                    | 1.3500A                     | 1.345825 to 1.354175A                                        |

1. Measure range coupled to source range when simultaneously sourcing and measuring current.
2. As measured by precision digital multimeter. Use closest possible value, and modify reading limits accordingly if necessary.

Table 22-12  
**Model 2635A/2636A current measurement accuracy limits**

| 2635A/2636A Source and measure range <sup>a</sup> | 35/36 Source current <sup>b</sup> | Current reading limits (1 year 18C - 28C) |
|---------------------------------------------------|-----------------------------------|-------------------------------------------|
| 100pA                                             | 90.000pA                          | 89.7850 to 90.2150pA                      |
| 1nA                                               | 0.90000nA                         | 0.89841 to 0.90159nA                      |
| 10nA                                              | 9.0000nA                          | 8.9835 to 9.0165nA                        |
| 100nA                                             | 90.000nA                          | 89.9060 to 90.0940nA                      |
| 1uA                                               | 0.90000uA                         | 0.899375 to 0.900625uA                    |
| 10uA                                              | 9.0000uA                          | 8.99625 to 9.00375uA                      |
| 100uA                                             | 90.000uA                          | 89.957 to 90.043uA                        |
| 1mA                                               | 0.90000mA                         | 0.89962 to 0.90038mA                      |
| 10mA                                              | 9.0000mA                          | 8.9957 to 9.0043mA                        |
| 100mA                                             | 90.000mA                          | 89.962 to 90.038mA                        |
| 1A                                                | 0.90000A                          | 0.89823 to 0.90177A                       |
| 1.5A                                              | 1.35000A                          | 1.345825 to 1.354175A                     |

- a. Measure range coupled to source range when simultaneously sourcing and measuring current.
- b. As measured by precision digital multimeter. Use closest possible value, and modify reading limits accordingly if necessary.



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## Error and Status Messages

In this appendix:

| Topic                                          | Page                |
|------------------------------------------------|---------------------|
| <a href="#">Introduction</a> .....             | <a href="#">A-2</a> |
| <a href="#">Error summary</a> .....            | <a href="#">A-2</a> |
| <a href="#">Error effects on scripts</a> ..... | <a href="#">A-2</a> |
| <a href="#">Reading errors</a> .....           | <a href="#">A-2</a> |

## Introduction

This appendix includes information on the Keithley Instruments Series 2600A System SourceMeter® instrument error levels, how to read errors, and a complete listing of error messages.

## Error summary

Error messages are listed in [Table A-2](#). Error levels are listed below:

- NO\_SEVERITY: Informational status message only.
- INFORMATIONAL: Informational status message only.
- RECOVERABLE: Error not serious, can be recovered.
- SERIOUS: Error serious, but unit still operational by correcting error.
- FATAL: Unit non-operational.

## Error effects on scripts

Most errors will not abort a running script. The only time a script is aborted is when a Lua run-time error (error number -286) is detected. Run-time errors are caused by actions such as trying to index into a variable that is not a table. Syntax errors (error number -285) in a script/command will not technically abort the script, but it will prevent the script/command from being executed in the first place.

## Reading errors

When errors occur, the error messages will be placed in the error queue (see [Queues](#)). [Table A-1](#) lists commands associated with the error queue (see [Section 19](#) for more information). For example, the following commands request the next complete error information from the error queue and return the message portion of the error:

```
errorcode, message, severity, node = errorqueue.next()
print(message)
```

Table A-1

### Error queue commands

| Error queue command             | Description                                  |
|---------------------------------|----------------------------------------------|
| <code>errorqueue.clear()</code> | Clear error queue of all errors.             |
| <code>errorqueue.count</code>   | Number of messages in the error/event queue. |
| <code>errorqueue.next()</code>  | Request error message.                       |

Table A-2  
Error summary

| Error number | Error level | Error Message                                |
|--------------|-------------|----------------------------------------------|
| -430         | RECOVERABLE | Query Deadlocked                             |
| -420         | RECOVERABLE | Query Unterminated                           |
| -410         | RECOVERABLE | Query Interrupted                            |
| -363         | RECOVERABLE | Input Buffer Over-run                        |
| -350         | RECOVERABLE | Queue Overflow                               |
| -315         | RECOVERABLE | Configuration Memory Lost                    |
| -314         | RECOVERABLE | Save/ Recall Memory Lost                     |
| -292         | RECOVERABLE | Referenced name does not exist               |
| -286         | RECOVERABLE | TSP Runtime error                            |
| -285         | RECOVERABLE | Program Syntax                               |
| -281         | RECOVERABLE | Cannot Create Program                        |
| -225         | RECOVERABLE | Out of Memory or TSP Memory allocation error |
| -224         | RECOVERABLE | Illegal Parameter Value                      |
| -223         | RECOVERABLE | Too Much Data                                |
| -222         | RECOVERABLE | Parameter Data Out of Range                  |
| -221         | RECOVERABLE | Settings Conflict                            |
| -220         | RECOVERABLE | Parameter                                    |
| -203         | RECOVERABLE | Command protected                            |
| -154         | RECOVERABLE | String Too Long                              |
| -151         | RECOVERABLE | Invalid String Data                          |
| -144         | RECOVERABLE | Character Data Too Long                      |
| -141         | RECOVERABLE | Invalid Character Data                       |
| -121         | RECOVERABLE | Invalid Character In Number                  |
| -120         | RECOVERABLE | Numeric Data                                 |
| -109         | RECOVERABLE | Missing Parameter                            |
| -108         | RECOVERABLE | Parameter Not Allowed                        |
| -105         | RECOVERABLE | Trigger Not Allowed                          |
| -104         | RECOVERABLE | Data Type                                    |
| -101         | RECOVERABLE | Invalid Character                            |
| 0            | NO_SEVERITY | Queue Is Empty                               |

Table A-2 (cont.)  
Error summary

| Error number | Error level | Error Message                                               |
|--------------|-------------|-------------------------------------------------------------|
| 603          | RECOVERABLE | Power On State Lost                                         |
| 702          | FATAL       | Unresponsive digital FPGA                                   |
| 802          | RECOVERABLE | Output Blocked By Interlock                                 |
| 820          | RECOVERABLE | Parsing Value                                               |
| 900          | FATAL       | Internal System                                             |
| 1100         | RECOVERABLE | Command Unavailable                                         |
| 1101         | RECOVERABLE | Parameter Too Big                                           |
| 1102         | RECOVERABLE | Parameter Too Small                                         |
| 1103         | RECOVERABLE | Max Greater Than Min                                        |
| 1104         | RECOVERABLE | Too many digits for param type                              |
| 1106         | RECOVERABLE | Battery Not Present                                         |
| 1107         | RECOVERABLE | Cannot modify factory menu                                  |
| 1108         | RECOVERABLE | Menu name does not exist                                    |
| 1109         | RECOVERABLE | Menu name already exists                                    |
| 1110         | FATAL       | Catastrophic analog supply failure                          |
| 1200         | RECOVERABLE | TSPLink initialization failed                               |
| 1201         | RECOVERABLE | TSPLink initialization failed                               |
| 1202         | RECOVERABLE | TSPLink initialization failed                               |
| 1203         | RECOVERABLE | TSPLink initialization failed (possible loop in node chain) |
| 1204         | RECOVERABLE | TSPLink initialization failed                               |
| 1205         | RECOVERABLE | TSPLink initialization failed (no remote nodes found)       |
| 1206         | RECOVERABLE | TSPLink initialization failed                               |
| 1207         | RECOVERABLE | TSPLink initialization failed                               |
| 1208         | RECOVERABLE | TSPLink initialization failed                               |
| 1209         | RECOVERABLE | TSPLink initialization failed                               |
| 1210         | RECOVERABLE | TSPLink initialization failed (node ID conflict)            |
| 1211         | RECOVERABLE | Node %u is inaccessible                                     |
| 1212         | RECOVERABLE | Invalid node ID                                             |
| 1400         | RECOVERABLE | Expected at least %d parameters                             |
| 1401         | RECOVERABLE | Parameter %d is invalid                                     |
| 1402         | RECOVERABLE | User scripts lost                                           |
| 1403         | RECOVERABLE | Factory scripts lost                                        |
| 1404         | RECOVERABLE | Invalid byte order                                          |
| 1405         | RECOVERABLE | Invalid ASCII precision                                     |
| 1406         | RECOVERABLE | Invalid data format                                         |
| 1500         | RECOVERABLE | Invalid baud rate setting                                   |
| 1501         | RECOVERABLE | Invalid parity setting                                      |
| 1502         | RECOVERABLE | Invalid terminator setting                                  |
| 1503         | RECOVERABLE | Invalid bits setting                                        |
| 1504         | RECOVERABLE | Invalid flow control setting                                |
| 1600         | RECOVERABLE | Maximum GPIB message length exceeded                        |
| 1800         | RECOVERABLE | Invalid Digital Trigger Mode                                |
| 1801         | RECOVERABLE | Invalid digital I/O Line                                    |
| 1803         | RECOVERABLE | Feature not supported in legacy digital I/O mode            |
| 2000         | RECOVERABLE | Flash download error                                        |
| 2001         | RECOVERABLE | Cannot flash with error in queue                            |
| 4900         | RECOVERABLE | Reading buffer index %s is invalid                          |
| 4901         | RECOVERABLE | The maximum index for this buffer is %d                     |

Table A-2 (cont.)  
**Error summary**

| Error number | Error level | Error Message                                                                  |
|--------------|-------------|--------------------------------------------------------------------------------|
| 4903         | RECOVERABLE | Reading buffer expired                                                         |
| 4904         | SERIOUS     | ICX parameter count mismatch, %s (Line #%d)                                    |
| 4905         | SERIOUS     | ICX parameter invalid value, %s (Line #%d)                                     |
| 4906         | SERIOUS     | ICX invalid function id, %s (Line #%d)                                         |
| 5001         | FATAL       | SMU is unresponsive                                                            |
| 5003         | SERIOUS     | Saved calibration constants corrupted                                          |
| 5004         | SERIOUS     | Operation conflicts with CALA sense mode                                       |
| 5005         | SERIOUS     | Value too big for range                                                        |
| 5007         | SERIOUS     | Operation would exceed safe operating area of the instrument                   |
| 5008         | SERIOUS     | Operation not permitted while output is on                                     |
| 5009         | SERIOUS     | Unknown sourcing function                                                      |
| 5010         | SERIOUS     | No such SMU function                                                           |
| 5011         | SERIOUS     | Operation not permitted while cal is locked                                    |
| 5012         | SERIOUS     | Cal data not saved - save or restore before lock                               |
| 5013         | SERIOUS     | Cannot save cal data - unlock before save                                      |
| 5014         | SERIOUS     | Cannot restore cal data - unlock before restore                                |
| 5015         | SERIOUS     | Save to cal set disallowed                                                     |
| 5016         | SERIOUS     | Cannot change cal date - unlock before operation                               |
| 5017         | SERIOUS     | Cannot change cal constants - unlock before operation                          |
| 5018         | SERIOUS     | Cal version inconsistency                                                      |
| 5019         | SERIOUS     | Cannot unlock - invalid password                                               |
| 5021         | SERIOUS     | Cannot restore default calset. Using previous calset                           |
| 5022         | SERIOUS     | Cannot restore previous calset. Using factory calset                           |
| 5023         | SERIOUS     | Cannot restore factory calset. Using nominal calset                            |
| 5024         | SERIOUS     | Cannot restore nominal calset. Using firmware defaults                         |
| 5025         | SERIOUS     | Cannot set filtercount > 1 when measure.count > 1                              |
| 5027         | SERIOUS     | Unlock cal data with factory password                                          |
| 5028         | SERIOUS     | Cannot perform requested operation while source auto-range is enabled          |
| 5029         | SERIOUS     | Cannot save without changing cal date and cal due values                       |
| 5032         | RECOVERABLE | Cannot change this setting unless buffer is cleared                            |
| 5033         | RECOVERABLE | Reading buffer not found within device                                         |
| 5038         | RECOVERABLE | Index exceeds maximum reading                                                  |
| 5040         | RECOVERABLE | Cannot use same reading buffer for multiple overlapped measurements            |
| 5041         | SERIOUS     | Output Enable not asserted                                                     |
| 5042         | SERIOUS     | Invalid while overlapped measure                                               |
| 5043         | SERIOUS     | Cannot perform requested operation while voltage measure auto-range is enabled |
| 5044         | SERIOUS     | Cannot perform requested operation while current measure auto-range is enabled |
| 5045         | SERIOUS     | Cannot perform requested operation while filter is enabled                     |
| 5046         | SERIOUS     | SMU too hot                                                                    |
| 5047         | RECOVERABLE | Minimum timestamp resolution is 1µs                                            |
| 5048         | SERIOUS     | Contact check not valid with HIGH-Z output off                                 |
| 5049         | SERIOUS     | Contact check not valid while an active current source                         |
| 5050         | SERIOUS     | I limit too low for contact check                                              |

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Table A-2 (cont.)  
**Error summary**

| <b>Error number</b> | <b>Error level</b> | <b>Error Message</b>                  |
|---------------------|--------------------|---------------------------------------|
| 5051                | FATAL              | Model Number/SMU Hardware mismatch    |
| 5052                | RECOVERABLE        | Interlock engaged; system stabilizing |
| 5052                | RECOVERABLE        | Cannot disable output enable action   |

---

# Common Commands

**In this appendix:**

| <u>Topic</u>                           | <u>Page</u> |
|----------------------------------------|-------------|
| <b>Appendix Common commands:</b> ..... | <b>B-1</b>  |
| Command summary.....                   | B-2         |
| Script command equivalents.....        | B-3         |
| Command reference .....                | B-3         |

## Common commands

### Command summary

Common commands supported by the Keithley Instruments Series 2600A System SourceMeter® instrument are summarized in [Table B-1](#). Although commands are shown in upper-case, common commands are not case sensitive, and either upper or lower case can be used. Note that although these commands are essentially the same as those defined by the IEEE-488.2 standard, the Series 2600A does not strictly adhere to that standard.

Table B-1  
Common commands

| Mnemonic    | Name                           | Description <sup>1</sup>                                                                                 |
|-------------|--------------------------------|----------------------------------------------------------------------------------------------------------|
| *CLS        | Clear status                   | Clears all event registers and Error Queue.                                                              |
| *ESE <mask> | Event enable command           | Program the Standard Event Enable Register.                                                              |
| *ESE?       | Event enable query             | Read the Standard Event Enable Register.                                                                 |
| *ESR?       | Event status register query    | Read/clear the Standard Event Enable Register.                                                           |
| *IDN?       | Identification query           | Returns the manufacturer, model number, serial number, and firmware revision levels of the unit.         |
| *OPC        | Operation complete command     | Set the Operation Complete bit in the Standard Event Register after all pending commands have completed. |
| *OPC?       | Operation complete query       | Places an ASCII "1" into the Output Queue when all selected device operations have completed.            |
| *RST        | Reset command                  | Returns the SourceMeter instrument to default conditions.                                                |
| *SRE <mask> | Service request enable command | Programs the Service Request Enable Register.                                                            |
| *SRE?       | Service request enable query   | Reads the Service Request Enable Register.                                                               |
| *STB?       | Status byte query              | Reads the Status Byte Register. <sup>1</sup>                                                             |
| *TRG        | Trigger command                | Sends a remote trigger to the SourceMeter.                                                               |
| *TST?       | Self-test query                | Returns a 0.                                                                                             |
| *WAI        | Wait-to-continue command       | Waits until all previous commands have completed.                                                        |

1. Status commands are covered in [Appendix C](#).



## Script command equivalents

Script command equivalents for the common commands in [Table B-1](#) are summarized in [Table B-2](#). See Section 12 for details on script commands.

Table B-2  
Script command equivalents

| Common command | Script command equivalent                                                                                          |
|----------------|--------------------------------------------------------------------------------------------------------------------|
| *CLS           | status.reset()                                                                                                     |
| *ESE?          | print(tostring(status.standard.enable))                                                                            |
| *ESE <mask>    | status.standard.enable = <mask>                                                                                    |
| *ESR?          | print(tostring(status.standard.event))                                                                             |
| *IDN?          | print([[Keithley Instruments Inc., Model]]..localnode.model..[[, ]].localnode.serialno..[[, ]].localnode.revision) |
| *OPC?          | waitcomplete() print([[1]])                                                                                        |
| *OPC           | opc()                                                                                                              |
| *RST           | reset()                                                                                                            |
| *SRE?          | print(tostring(status.request_enable))                                                                             |
| *SRE <mask>    | status.request_enable = <mask>                                                                                     |
| *STB?          | print(tostring(status.condition))                                                                                  |
| *TRG           | N/A                                                                                                                |
| *TST?          | print([[0]])                                                                                                       |
| *WAI           | waitcomplete()                                                                                                     |

## Command reference

Details on all common commands except those associated with the status model are covered below. See [Appendix C](#) for information on using status commands.

### \*IDN? — identification query

#### Reads ID information

The identification string includes the manufacturer, model number, serial number, and firmware revision levels and is sent in the following format:

Keithley Instruments Inc., Model nnnn, xxxxxxx, yyyy

Where:

nnnn is the model number (Model 2601A/2602A/2611A/2612A/2635A/2636A).

xxxxxxx is the serial number.

yyyyy is the firmware revision level.

### \*OPC — operation complete

Sets OPC bit

### \*OPC? — operation complete query

Places a “1” in output queue

When \*OPC is sent, the OPC bit in the Standard Event Register (see [Appendix C](#)) will set when all overlapped commands complete. An ASCII "1" is also placed in the Output Queue to be read by the \*OPC? query when overlapped commands complete.

**\*RST: reset****Return SourceMeter instrument to defaults**

When the \*RST command is sent, the Series 2600A returns to the default conditions.

**\*TRG: trigger****Send remote trigger to SourceMeter instrument**

Use the \*TRG command to issue a GPIB, LAN, or RS-232 trigger to the SourceMeter instrument. It has the same effect as a group execute trigger (GET).

**\*TST?: self-test query****Return 0**

This command always places a 0 in the Output Queue. It is included for common command compatibility, but the Series 2600A does not actually perform a self-test.

**\*WAI: wait-to-continue****Wait until commands are completed**

Two types of device commands exist:

- Sequential command: A command whose operations are allowed to finish before the next command is executed.
- Overlapped command: A command that allows the execution of subsequent commands while device operations of the overlapped command are still in progress.

The \*WAI command is used to suspend the execution of subsequent commands until the device operations of all previous overlapped commands are finished. The \*WAI command is not needed for sequential commands.

**In this appendix:**

| <b>Topic</b>                                       | <b>Page</b> |
|----------------------------------------------------|-------------|
| <b>Overview</b> .....                              | <b>C-1</b>  |
| Status byte and SRQ .....                          | C-2         |
| Status register sets .....                         | C-2         |
| Queues .....                                       | C-2         |
| Status function summary .....                      | C-11        |
| <b>Clearing registers and queues</b> .....         | <b>C-12</b> |
| <b>Programming and reading registers</b>           | <b>C-12</b> |
| Programming enable and transition registers .....  | C-12        |
| Reading registers .....                            | C-13        |
| <b>Status byte and service request (SRQ)</b> ..... | <b>C-13</b> |
| Status byte register .....                         | C-13        |
| Service request enable register .....              | C-15        |
| Serial polling and SRQ .....                       | C-15        |
| SPE, SPD (serial polling) .....                    | C-15        |
| Status byte and service request commands .....     | C-15        |
| Enable and transition registers .....              | C-16        |
| Controlling node and SRQ enable registers .....    | C-16        |
| <b>Status register sets</b> .....                  | <b>C-17</b> |
| System Summary Event Registers .....               | C-17        |
| Standard Event Register .....                      | C-18        |
| Operation Event Registers .....                    | C-19        |
| Measurement Event Registers .....                  | C-21        |
| Register programming example .....                 | C-22        |
| <b>Queues</b> .....                                | <b>C-22</b> |
| Output queue .....                                 | C-22        |
| Error queue .....                                  | C-22        |
| <b>TSP-Link system status</b> .....                | <b>C-23</b> |
| Status model configuration example .....           | C-23        |

## Overview

The Keithley Instruments Series 2600A System SourceMeter® instrument provides a number of status registers and queues, allowing the operator to monitor and manipulate the various instrument events. The status model is shown in [Figure C-1](#) through [Figure C-8](#). The heart of the status model is the Status Byte Register. This register can be read by the user's test program to determine if a service request (SRQ) has occurred, and what event caused it.

### Status byte and SRQ

The Status Byte Register receives the summary bits of five status register sets and two queues. The register sets and queues monitor the various instrument events. When an enabled event occurs, it sets a summary bit in the Status Byte Register. When a summary bit of the Status Byte is set and its corresponding enable bit is set (as programmed by the user), the RQS/MSS bit will set to indicate that an SRQ has occurred.

SRQs will affect both the GPIB and the VXI-11 connections. On the GPIB, the SRQ line will be asserted. On a VXI-11 connection, an SRQ event will be generated.

### Status register sets

A typical status register set is made up of a condition register, an event register, an event enable register, a negative transition register, and a positive transition register. A condition register is a read-only register that constantly updates to reflect the present operating conditions of the instrument.

When an event occurs, and the appropriate NTR or PTR bit is set, the matching event register bit is set to 1. The bit remains latched to 1 until the register is reset. When an event register bit is set and its corresponding enable bit is set (as programmed by the user), the output (summary) of the register will set to 1. This in turn sets the condition bit in a higher-level register, and can ultimately cascade to a summary bit of the Status Byte Register.

### Queues

The SourceMeter instrument uses an Output Queue and an Error Queue. The response messages, such as requested readings, are placed in the Output Queue. As various programming errors and status messages occur, they are placed in the Error Queue. When a queue contains data, it sets the appropriate summary bit of the Status Byte Register (EAV for the Error Queue; MAV for the Output Queue).

Figure C-1  
Status model overview

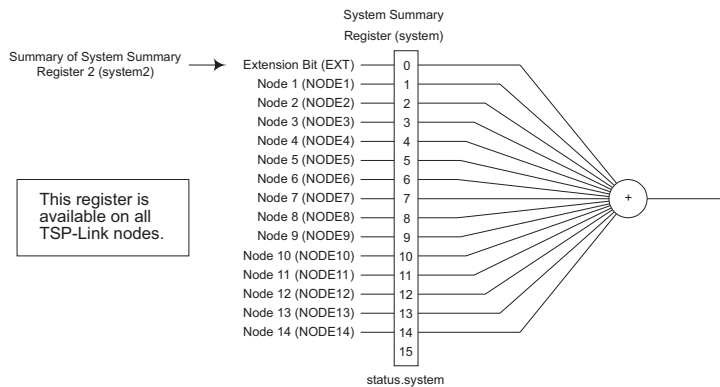
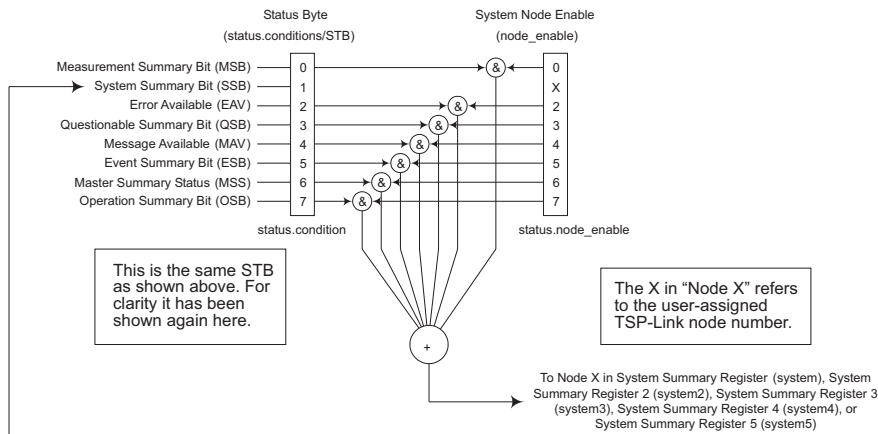
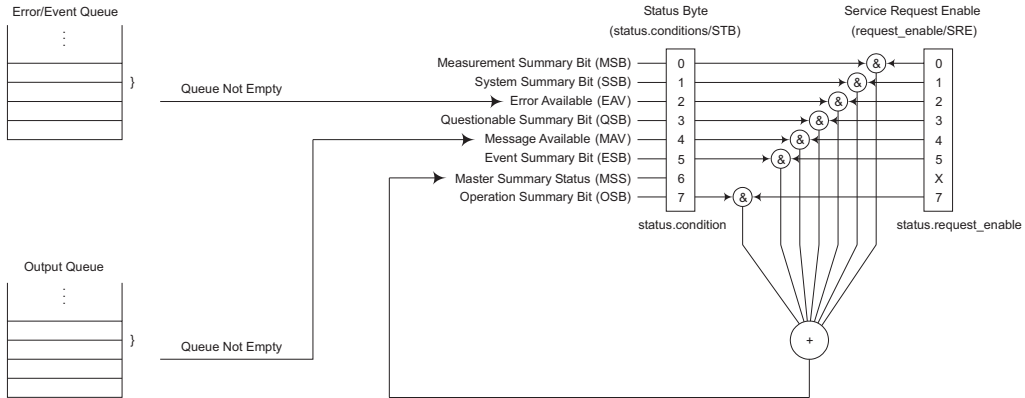


Figure C-2  
**Status model (system summary and standard event registers)**

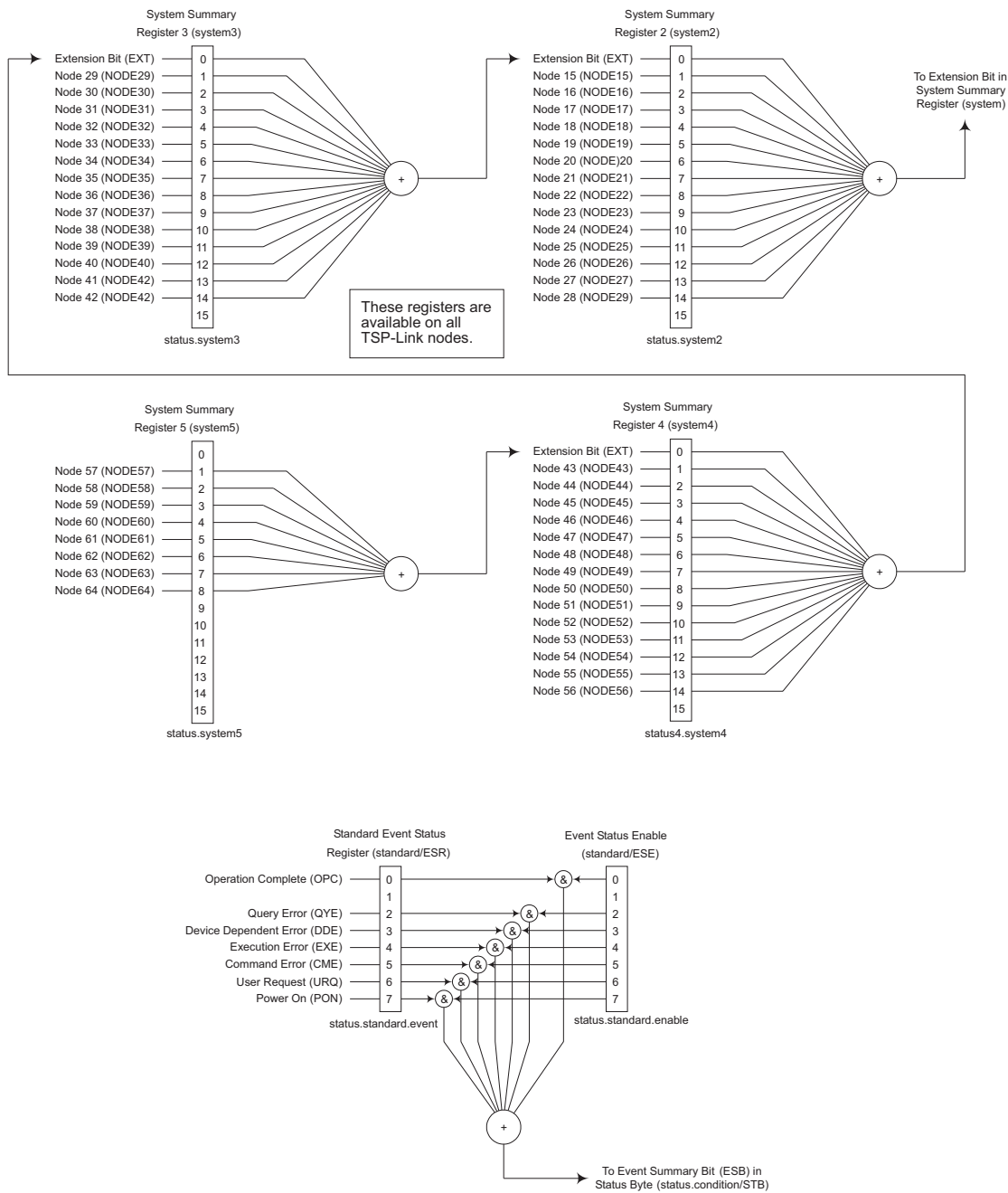


Figure C-3  
**Status model (operation event registers)**

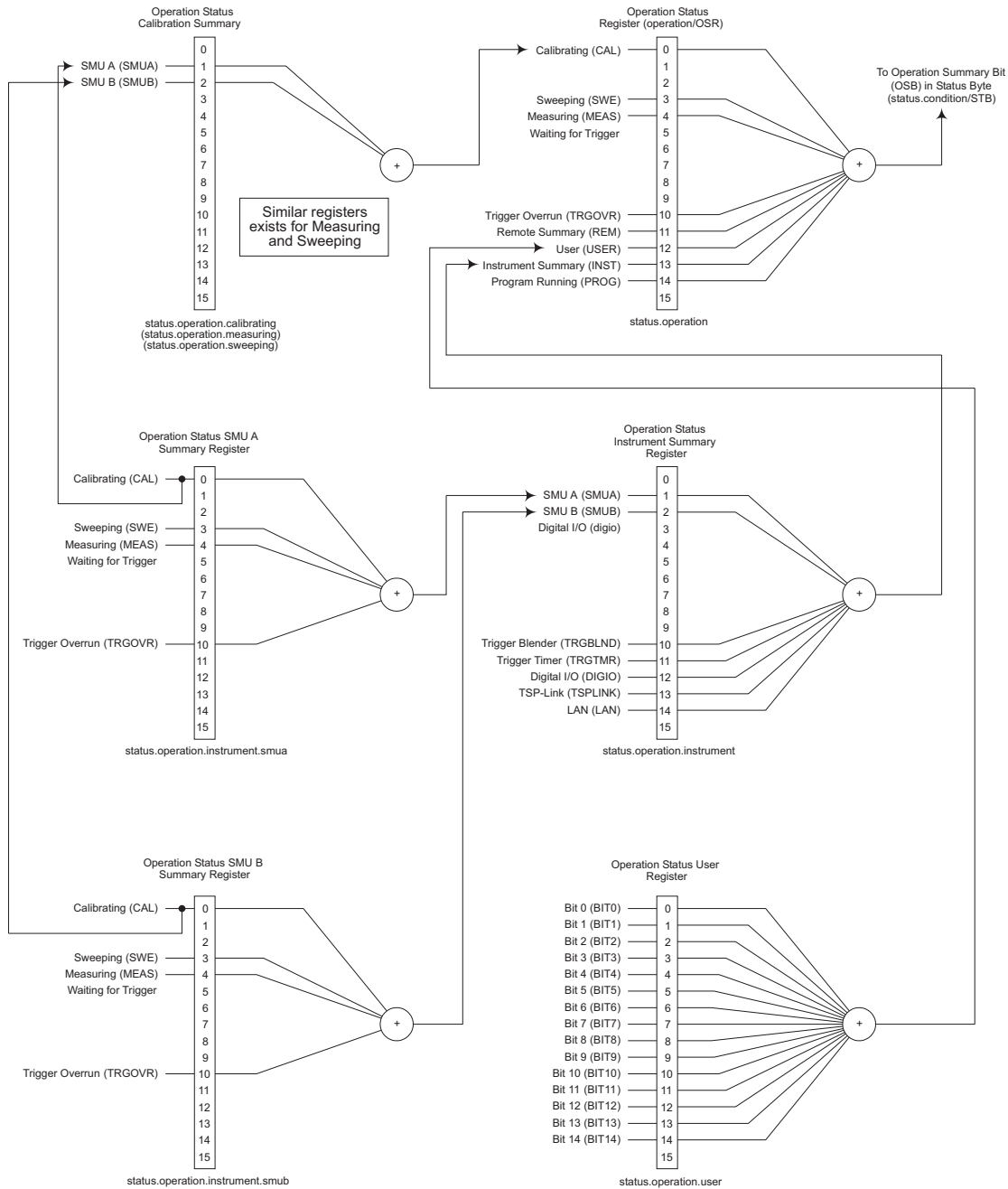


Figure C-4  
**Status model (operation event registers)**

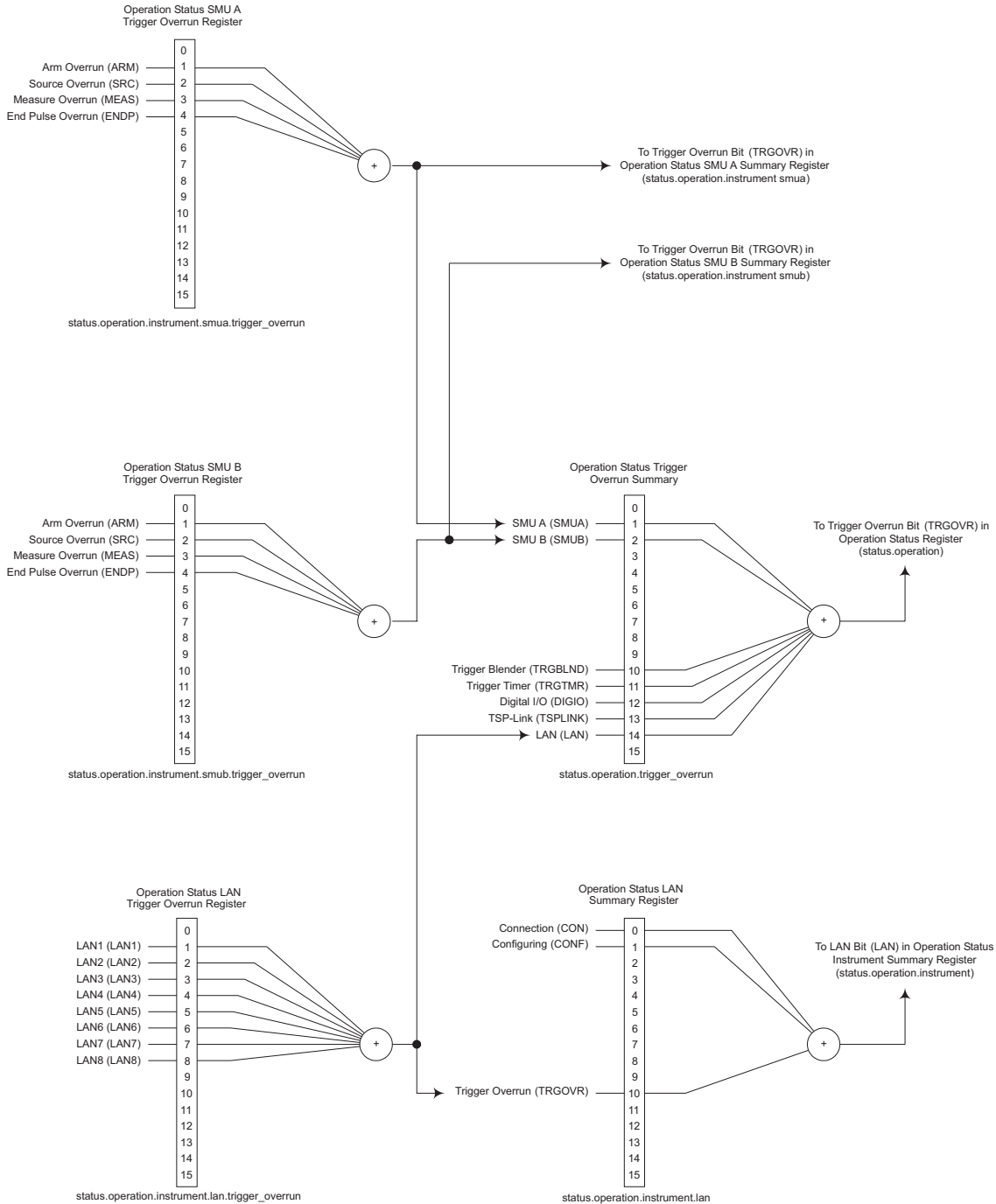
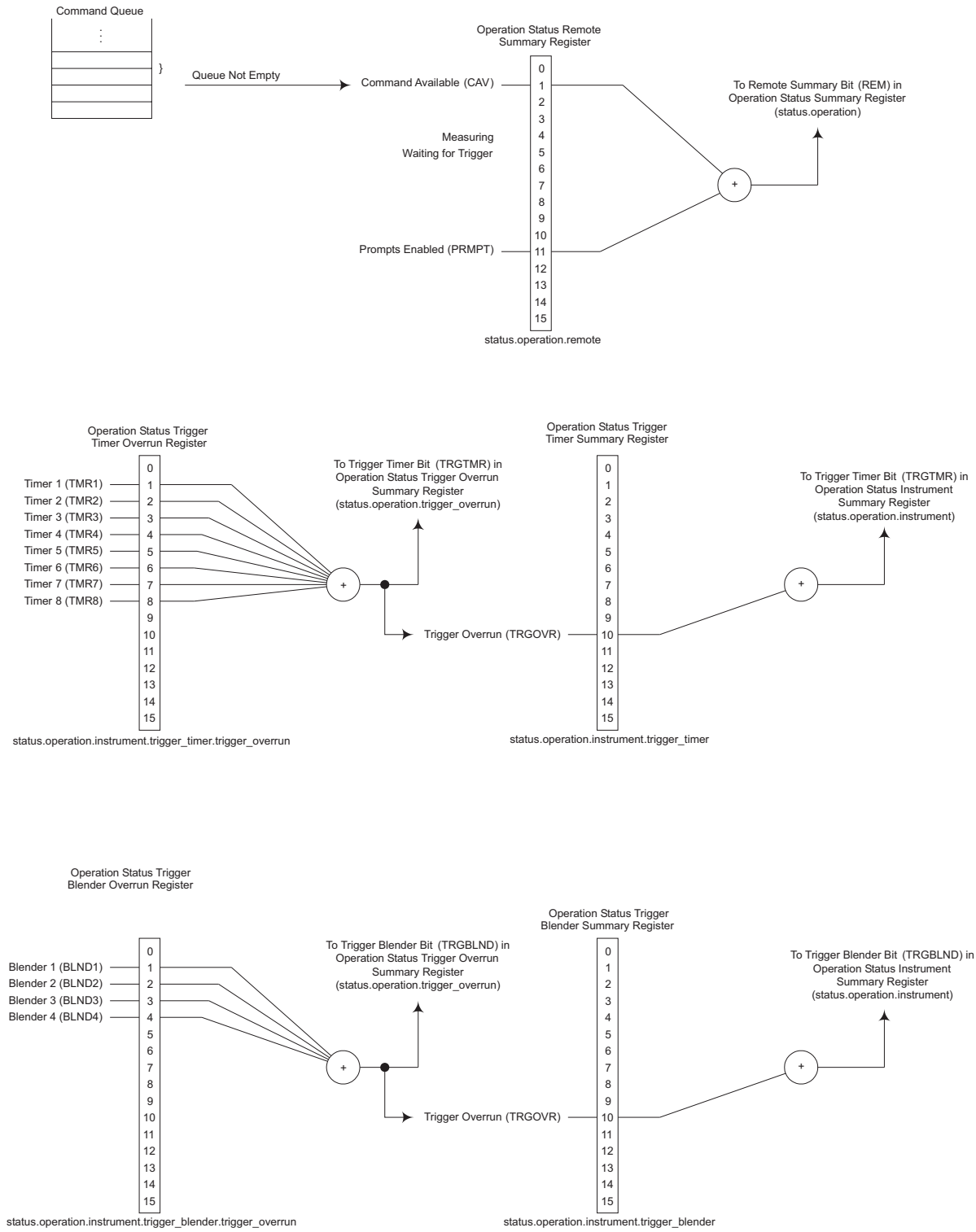




Figure C-5  
**Status model (operation event registers)**



**Figure C-6**  
**Status model (operation event registers)**

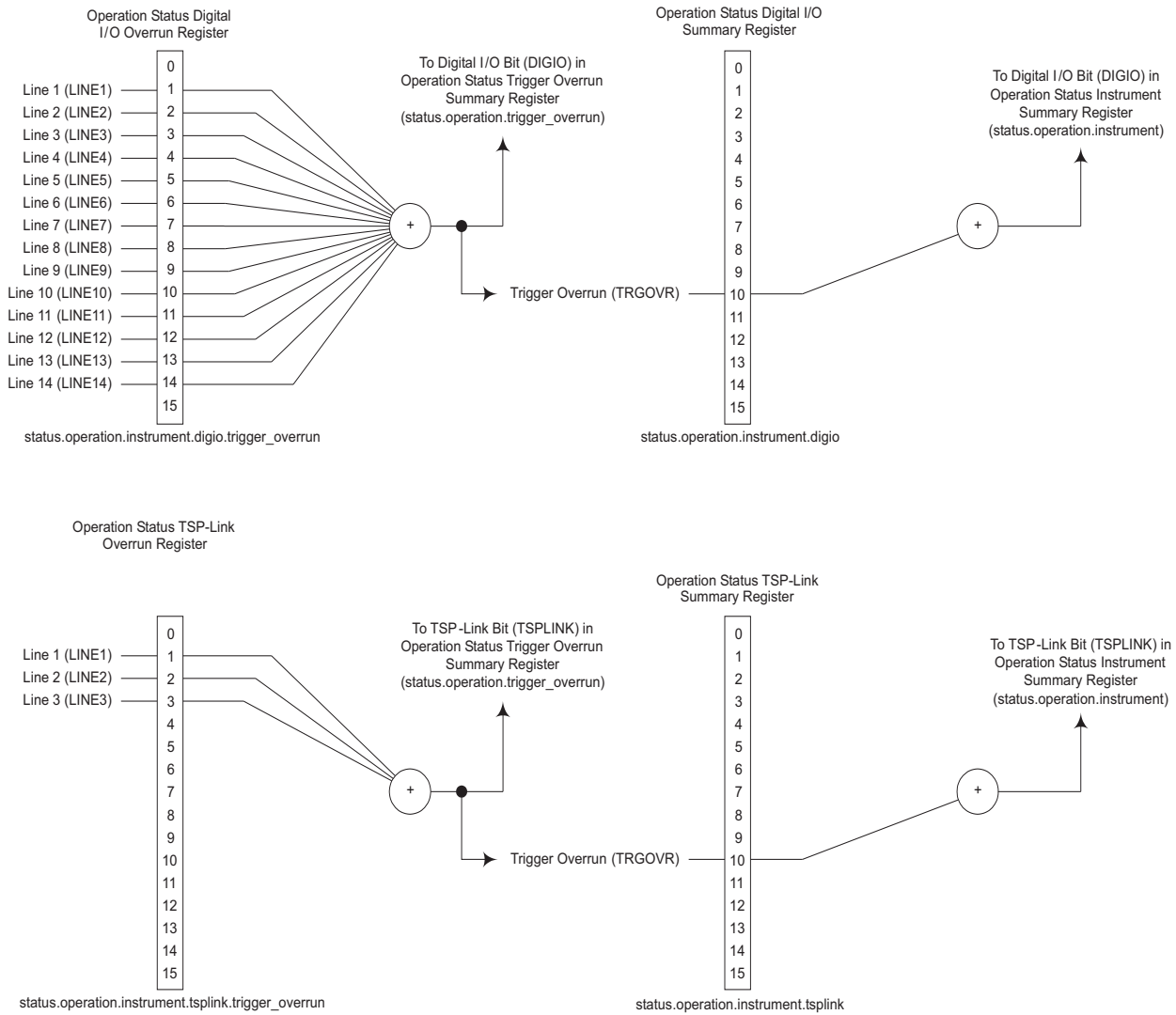


Figure C-7  
**Status model (questionable event registers)**

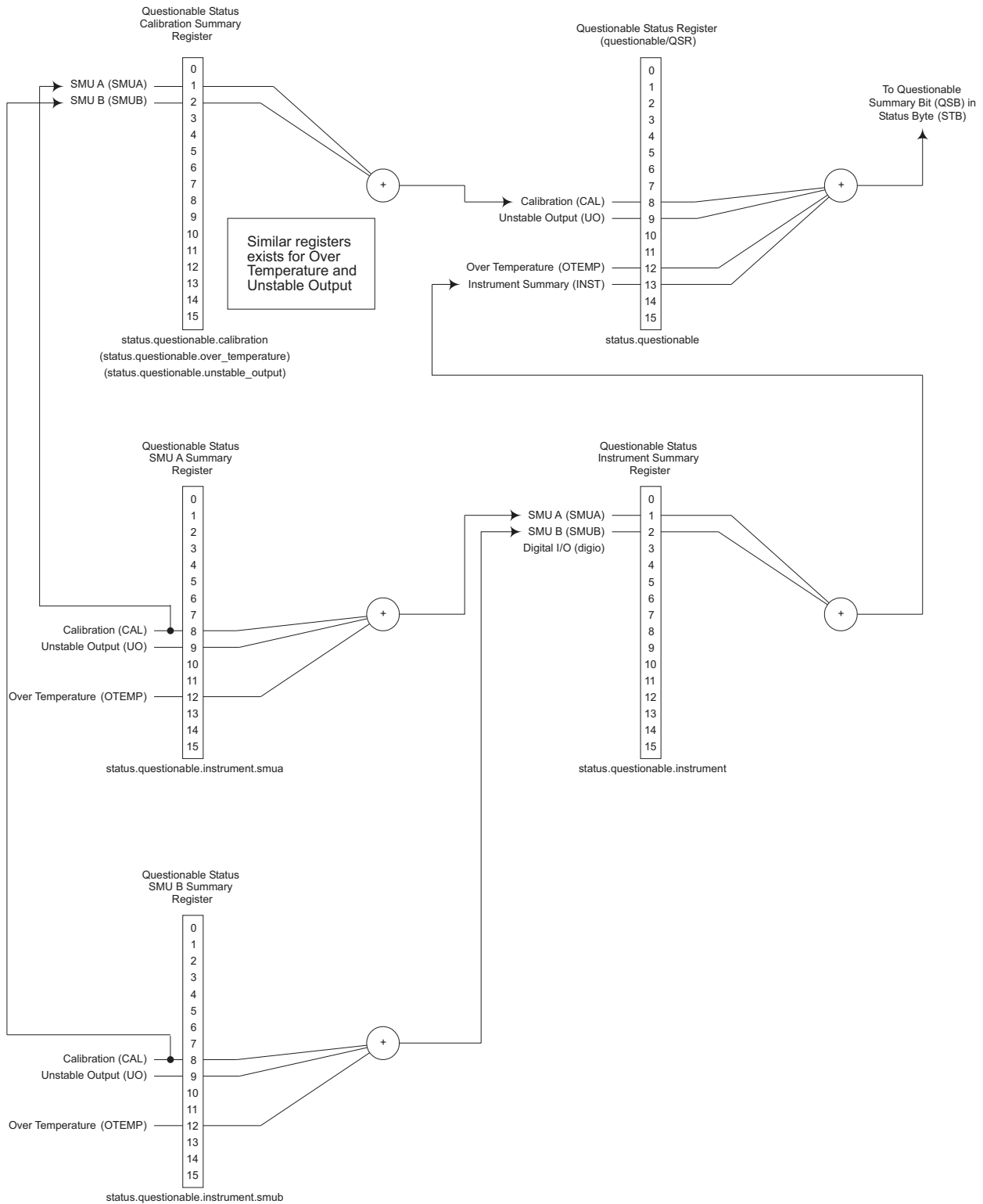
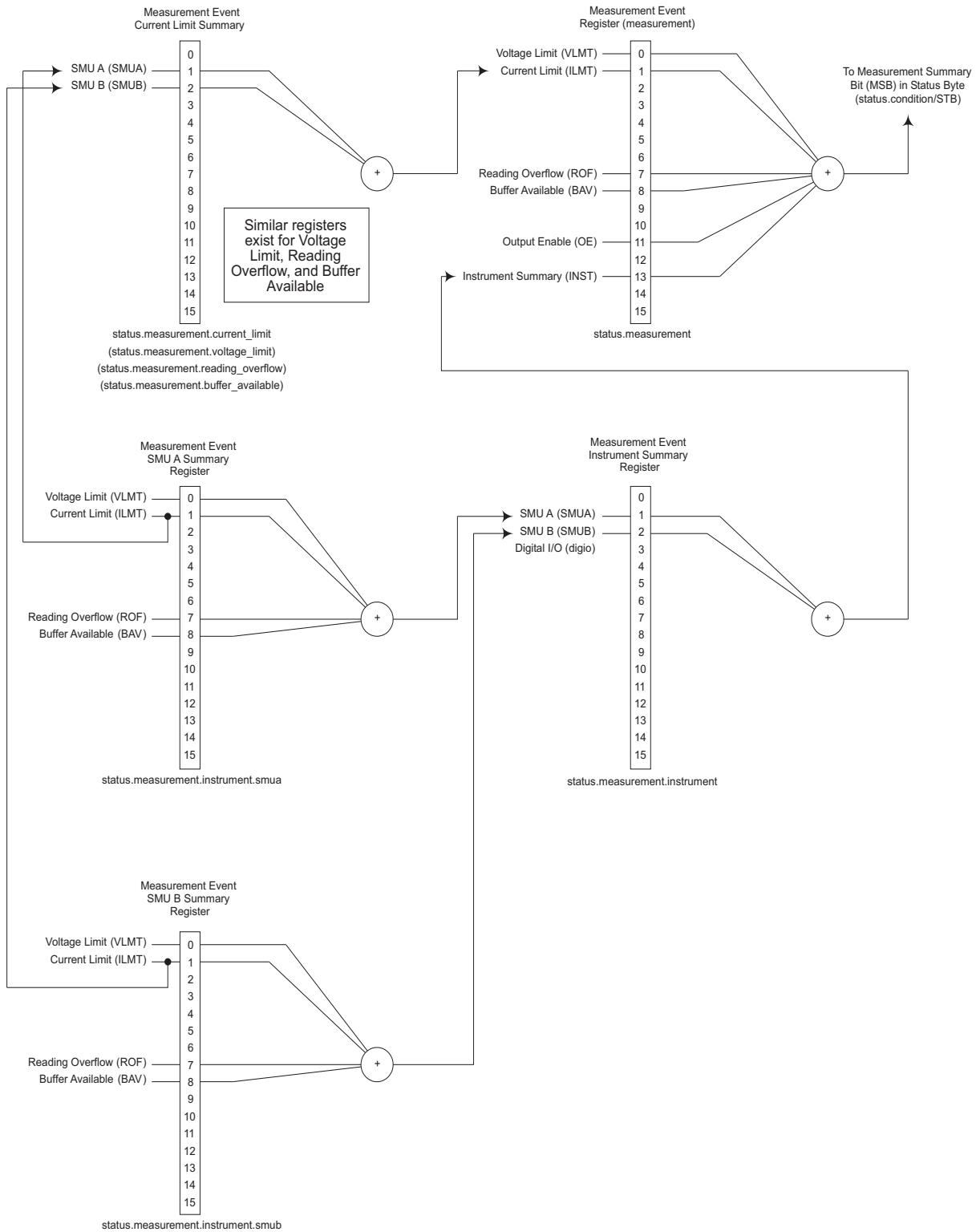


Figure C-8  
**Status model (measurement event registers)**



## Status function summary

The following functions and attributes control and read the various registers ([Table C-1](#)). Additional information is included later in the section in command listings for the various register sets.

Table C-1  
Status function summary

| Type               | Function or attribute <sup>1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| System summary     | status.condition<br>status.node_enable<br>status.node_event<br>status.request_enable<br>status.request_event<br>status.reset                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Measurement event  | status.measurement.*<br>status.measurement.buffer_available.*<br>status.measurement.current_limit.*<br>status.measurement.instrument.*<br>status.measurement.instrument.smuX.*<br>status.measurement.reading_overflow.*<br>status.measurement.voltage_limit.*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Operation event    | status.operation.*<br>status.operation.calibrating.*<br>status.operation.instrument.*<br>status.operation.instrument.digio.*<br>status.operation.instrument.digio.trigger_overrun.*<br>status.operation.instrument.lan.*<br>status.operation.instrument.lan.trigger_overrun.*<br>status.operation.instrument.smuX.*<br>status.operation.instrument.smuX.trigger_overrun.*<br>status.operation.instrument.trigger_blender.*<br>status.operation.instru-<br>ment.trigger_blender.trigger_overrun.*<br>status.operation.instrument.trigger_timer.*<br>status.operation.instru-<br>ment.trigger_timer.trigger_overrun.*<br>status.operation.instrument.tsplink.*<br>status.operation.instrument.tsplink.trigger_overrun.*<br>status.operation.measuring.*<br>status.operation.remote.*<br>status.operation.sweeping.*<br>status.operation.trigger_overrun.*<br>status.operation.user.* |
| Questionable event | status.questionable.*<br>status.questionable.calibration.*<br>status.questionable.instrument.*<br>status.questionable.instrument.smuX.*<br>status.questionable.over_temperature.*<br>status.questionable.unstable_output.*<br>status.questionable.over_temperature.*<br>status.questionable.unstable_output.*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Standard event     | status.standard.*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| System events      | status.system.*<br>status.system2.*<br>status.system3.*<br>status.system4.*<br>status.system5.*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

1. \* = '.condition', '.event', '.ntr', '.ptr' and '.enable'; smuX = smua or smub.

## Clearing registers and queues

When the SourceMeter instrument is turned on, various register status elements will be set as follows:

- The PON bit in the `status.condition` register will be set.
- Bits such as the output enable and over-temperature bits will be set appropriately.
- All enable registers will be set to 0.
- All NTR registers will be set to 0.
- All used PTR register bits will be set to 1.
- The two queues will be empty.

Commands to reset the status registers and the Error Queue are listed in [Table C-2](#). In addition to these commands, any programmable register can be reset by sending the 0 parameter value with the individual command to program the register.

Table C-2

### Commands to reset registers and clear queues

| Commands                     | Description                                                     |
|------------------------------|-----------------------------------------------------------------|
| <b>To Reset Registers:</b>   | Clears the output queue<br>Reset bits of status registers to 0. |
| <code>status.reset()</code>  | Reset bits of status registers to 0.                            |
| <b>To Clear Error Queue:</b> | Clear all messages from Error Queue.                            |

The instrument automatically clears the output queue when the instrument transitions from the local control state to the remote control state.

## Programming and reading registers

### Programming enable and transition registers

The only registers that can be programmed by the user are the enable and transition registers. All other registers in the status structure are read-only registers. The following explain how to determine the parameter values for the various commands used to program enable registers. The actual commands are summarized in [Appendix B](#) and [Table C-1](#).

A command to program an event enable or transition register is sent with a parameter value that determines the desired state (0 or 1) of each bit in the appropriate register. The bit positions of the register ([Figure C-9](#)) indicate the binary parameter value and decimal equivalent. To program one of the registers, send the decimal value for the bit(s) to be set. The registers are discussed further in [Enable and transition registers](#).

Figure C-9  
16-bit status register

|              |                   |                   |                   |                   |                   |                   |                   |                   |
|--------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Bit Position | B7                | B6                | B5                | B4                | B3                | B2                | B1                | B0                |
| Binary Value | 0/1               | 0/1               | 0/1               | 0/1               | 0/1               | 0/1               | 0/1               | 0/1               |
| Decimal      | 128               | 64                | 32                | 16                | 8                 | 4                 | 2                 | 1                 |
| Weights      | (2 <sup>7</sup> ) | (2 <sup>6</sup> ) | (2 <sup>5</sup> ) | (2 <sup>4</sup> ) | (2 <sup>3</sup> ) | (2 <sup>2</sup> ) | (2 <sup>1</sup> ) | (2 <sup>0</sup> ) |

#### A. Bits 0 through 7

|              |                    |                    |                    |                    |                    |                    |                   |                   |
|--------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-------------------|-------------------|
| Bit Position | B15                | B14                | B13                | B12                | B11                | B10                | B9                | B8                |
| Binary Value | 0/1                | 0/1                | 0/1                | 0/1                | 0/1                | 0/1                | 0/1               | 0/1               |
| Decimal      | 32768              | 16384              | 8192               | 4096               | 2048               | 1024               | 512               | 256               |
| Weights      | (2 <sup>15</sup> ) | (2 <sup>14</sup> ) | (2 <sup>13</sup> ) | (2 <sup>12</sup> ) | (2 <sup>11</sup> ) | (2 <sup>10</sup> ) | (2 <sup>9</sup> ) | (2 <sup>8</sup> ) |

#### B. Bits 8 through 15

When using a numeric parameter, registers are programmed by including the appropriate <mask> value, for example:

```
*ese <mask>
status.standard.enable = <mask>
```

To convert from decimal to binary, use the information shown in [Figure C-9](#). For example, to set bits B0, B4, B7, and B10, a decimal value of 1169 would be used for the mask parameter (1169 = 1 + 16 + 128 + 1024).

## Reading registers

Any register in the status structure can be read either by sending the common command query (where applicable), or by including the script command for that register in either the `print()` or `print(tostring())` command. The `print()` command returns a numeric value, while the `print(tostring())` command returns the string equivalent. For example, any of the following commands requests the Service Request Enable register value:

```
*SRE?
print(tostring(status.request_enable))
print(status.request_enable)
```

The response message will be a decimal value that indicates which bits in the register are set. That value can be converted to its binary equivalent using [Figure C-9](#). For example, for a decimal value of 37 (binary value of 100101), bits B5, B2, and B0 are set.

## Status byte and service request (SRQ)

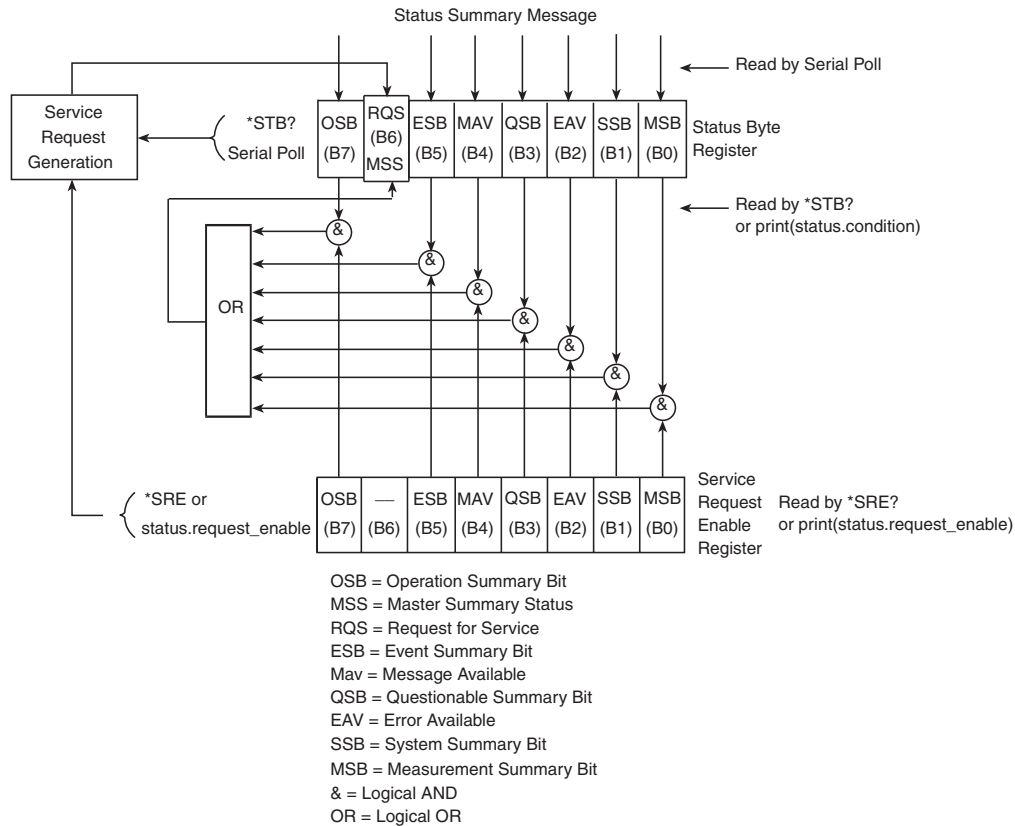
Service request is controlled by two 8-bit registers: the Status Byte Register and the Service Request Enable Register. [Figure C-10](#) shows the structure of these registers.

### Status byte register

The summary messages from the status registers and queues are used to set or clear the appropriate bits (B0, B1, B2, B3, B4, B5, and B7) of the Status Byte Register. These summary bits do not latch, and their states (0 or 1) are solely dependent on the summary messages (0 or 1). For

example, if the Standard Event Register is read, its register will clear. As a result, its summary message will reset to 0, which in turn will reset the ESB bit in the Status Byte Register.

Figure C-10  
**Status byte and service request (SRQ)**



The bits of the Status Byte Register are described as follows:

- **Bit B0, Measurement Summary Bit (MSB):** Set summary bit indicates that an enabled measurement event has occurred.
- **Bit B1, System Summary Bit (SSB):** Set summary bit indicates that an enabled system event has occurred.
- **Bit B2, Error Available (EAV):** Set bit indicates that an error or status message is present in the Error Queue.
- **Bit B3, Questionable Summary Bit (QSB):** Set summary bit indicates that an enabled questionable event has occurred.
- **Bit B4, Message Available (MAV):** Set bit indicates that a response message is present in the Output Queue.
- **Bit B5, Event Summary Bit (ESB):** Set summary bit indicates that an enabled standard event has occurred.
- **Bit B6, Request Service (RQS)/Master Summary Status (MSS):** Set bit indicates that an enabled summary bit of the Status Byte Register is set. Depending on how it is used, Bit B6 of the Status Byte Register is either the Request for Service (RQS) bit or the Master Summary Status (MSS) bit:
  - When using the GPIB serial poll sequence of the SourceMeter instrument to obtain the status byte (serial poll byte), B6 is the RQS bit. See [Serial polling and SRQ](#) for details on using the serial poll sequence.



- When using the `*STB?` common command or `status.condition` ([Table C-3](#)) to read the status byte, B6 is the MSS bit.
- **Bit B7, Operation Summary (OSB):** Set summary bit indicates that an enabled operation event has occurred.

## Service request enable register

The generation of a service request is controlled by the Service Request Enable Register. This register is programmed by the user and is used to enable or disable the setting of bit B6 (RQS/MSS) by the Status Summary Message bits (B0, B2, B3, B4, B5, and B7) of the Status Byte Register. As shown in [Figure C-10](#), the summary bits are logically ANDed (&) with the corresponding enable bits of the Service Request Enable Register. When a set (1) summary bit is ANDed with an enabled (1) bit of the enable register, the logic “1” output is applied to the input of the OR gate and, therefore, sets the MSS/RQS bit in the Status Byte Register.

The individual bits of the Service Request Enable Register can be set or cleared by using the `*SRE` common command or its script equivalent. To read the Service Request Enable Register, use the `*SRE?` query or script equivalent. The Service Request Enable Register clears when power is cycled or a parameter value of 0 is sent with the `*SRE` command (i.e. `*SRE 0`). The commands to program and read the SRQ Enable Register are listed in [Table C-3](#).

## Serial polling and SRQ

Any enabled event summary bit that goes from 0 to 1 will set bit B6 and generate an SRQ (service request). In your test program, you can periodically read the Status Byte to check if an SRQ has occurred and what caused it. If an SRQ occurs, the program can, for example, branch to an appropriate subroutine that will service the request.

SRQs can be managed by the serial poll sequence of the SourceMeter instrument. If an SRQ does not occur, bit B6 (RQS) of the Status Byte Register will remain cleared, and the program will simply proceed normally after the serial poll is performed. If an SRQ does occur, bit B6 of the Status Byte Register will set, and the program can branch to a service subroutine when the SRQ is detected by the serial poll.

The serial poll automatically resets RQS of the Status Byte Register. This allows subsequent serial polls to monitor bit B6 for an SRQ occurrence generated by other event types.

For common and script commands, B6 is the MSS (Message Summary Status) bit. The serial poll does not clear MSS. The MSS bit stays set until all Status Byte summary bits are reset.

## SPE, SPD (serial polling)

For the GPIB interface only, the SPE, SPD General Bus Command sequence is used to serial poll the SourceMeter instrument (see [General bus commands](#)). Serial polling obtains the serial poll byte (status byte). Typically, serial polling is used by the controller to determine which of several instruments has requested service with the SRQ line.

## Status byte and service request commands

The commands to program and read the Status Byte Register and Service Request Enable Register are listed in [Table C-3](#). Note that the table includes both common commands and their script command equivalents. For details on programming and reading registers, see [Programming enable and transition registers](#) and [Reading registers](#).

To reset the bits of the Service Request Enable Register to 0, use 0 as the parameter value for the command (for example, `*SRE 0`).

Table C-3  
**Status Byte and Service Request Enable Register commands**

| Command                                             | Description                                                           |
|-----------------------------------------------------|-----------------------------------------------------------------------|
| *STB?<br>or<br>print(status.condition)              | Read Status Byte Register.                                            |
| *SRE <mask><br>or<br>status.request_enable = <mask> | Program the Service Request Enable Register:<br><br><mask> = 0 to 255 |
| *SRE?<br>or<br>print(status.request_enable)         | Read the Service Request Enable Register.                             |

## Enable and transition registers

In general, there are three types of user-writable registers that are used to configure which bits feed the register summary and when it occurs. The registers are identified in the command table footnotes as follows:

- Enable register (identified as “enable” in the table footnotes): allows various associated events to be included in the summary bit for the register.
- Negative-transition register (NTR; identified as “ntr” in the table footnotes): a particular bit in the event register will be set when the corresponding bit in the NTR is set, and the corresponding bit in the condition register transitions from 1 to 0.
- Positive-transition register (PTR; identified as “ptr” in the table footnotes): a particular bit in the event register will be set when the corresponding bit in the PTR is set, and the corresponding bit in the condition register transitions from 0 to 1.

## Controlling node and SRQ enable registers

Attributes to control system node and SRQ enable bits and read associated registers are summarized in the [Status register sets](#). For example, either of the following will set the system node MSB enable bit:

```
status.node_enable = status.MSB
status.node_enable = 1
```

## Status register sets

As shown in [Figure C-1](#) through [Figure C-8](#), there are five status register sets in the status structure of the SourceMeter instrument; System Summary Event Status, Standard Event Status, Operation Event Status, Measurement Event Status, and Questionable Event Status.

### System Summary Event Registers

As shown in [Figure C-1](#) and [Figure C-2](#), there are five register sets associated with System Event Status. These registers summarize system status for various nodes connected to the TSP-Link (see Section 9). Note that all nodes on the TSP-Link share a copy of the system summary registers once the TSP-Link has been initialized. This feature allows all nodes to access the status models of other nodes, including SRQ.

In a TSP-Link system, the status model can be configured such that a status event in any node in the system can set the RQS (Request for Service) bit of the Master Node Status Byte. See [TSP-Link system status](#) in this appendix for details on using the status model in a TSP-Link system.

Commands for the system summary registers are summarized in [Table C-4](#).

For example, either of the following commands will set the EXT enable bit:

```
status.system.enable = status.system.EXT
status.system.enable = 1
```

When reading a register, a numeric value is returned. The binary equivalent of this value indicates which bits in the register are set. For details, see [Reading registers](#). For example, the following command will read the system enable register:

```
print(status.system.enable)
```

The used bits of the system event registers are described as follows:

- **Bit B0, Extension Bit (EXT):** Set bit indicates that an extension bit from a another system status register is set.
- **Bits B1-B14,<sup>1</sup> NODEn:** Indicates a bit on TSP-Link node n has been set (n = 1 to 64).

---

<sup>1</sup>.status.system5 does not use bits B9 through B15.

## Standard Event Register

The bits used in the Standard Event Register (shown in [Figure C-11](#)) are described as follows:

- **Bit B0, Operation Complete (OPC):** Set bit indicates that all pending selected device operations are completed and the SourceMeter instrument is ready to accept new commands. The bit is set in response to an \*OPC command. The ICL function `opc ( )` can be used in place of the \*OPC command. See [Appendix B](#) for details on \*OPC.
- **Bit B1:** Not used.
- **Bit B2, Query Error (QYE):** Set bit indicates that you attempted to read data from an empty Output Queue.
- **Bit B3, Device-Dependent Error (DDE):** Set bit indicates that an instrument operation did not execute properly due to some internal condition.
- **Bit B4, Execution Error (EXE):** Set bit indicates that the SourceMeter detected an error while trying to execute a command.
- **Bit B5, Command Error (CME):** Set bit indicates that a command error has occurred. Command errors include:
  - IEEE-488.2 syntax error: The SourceMeter instrument received a message that does not follow the defined syntax of the IEEE-488.2 standard.
  - Semantic error: SourceMeter instrument received a command that was misspelled or received an optional IEEE-488.2 command that is not implemented.
  - The instrument received a Group Execute Trigger (GET) inside a program message.
- **Bit B6, User Request (URQ):** Set bit indicates that the LOCAL key on the SourceMeter instrument front panel was pressed.
- **Bit B7, Power ON (PON):** Set bit indicates that the SourceMeter instrument has been turned off and turned back on since the last time this register has been read.

Commands to program and read the register are summarized in [Table C-4](#), and bits are summarized in [Status register sets](#).

Figure C-11  
Standard event register

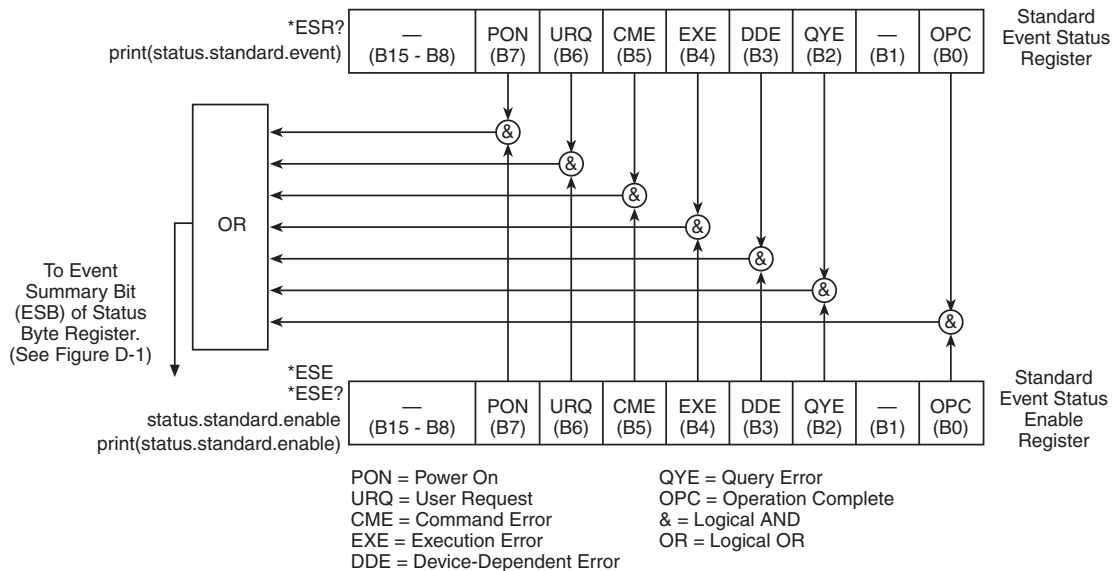


Table C-4  
Standard event commands

| Command                                              | Description                                                                                                      |
|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| *ESR?<br>or<br>print(status.standard.event)          | Read Standard Event Status Register.                                                                             |
| *ESE <mask><br>or<br>status.standard.enable = <mask> | Program the Event Status Enable Register:<br><br><mask> = 0 to 255<br>See <a href="#">Status register sets</a> . |
| *ESE?<br>or<br>print(status.standard.enable)         | Read Event Status Enable Register.                                                                               |

## Operation Event Registers

As shown in [Figure C-3](#), there are 22 register sets associated with Operation Event Status. Commands are summarized in the [Status register sets](#). Keep in mind that bits can also be set by using numeric parameter values. For details, see [Programming enable and transition registers](#).

For example, either of the following commands will set the CAL enable bit (B0):

```
status.operation.enable = status.operation.CAL
```

```
status.operation.enable = 1
```

When reading a register, a numeric value is returned. The binary equivalent of this value indicates which bits in the register are set. For details, see [Reading registers](#). For example, the following command will read the operation enable register:

```
print(status.operation.enable)
```

## Operation Status Register

This register set feeds to bit B7 (OSB) of the Status Byte. The bits used in the Operation Status Register set are described as follows:

- **Bit B0, Calibrating (CAL):** Set bit indicates that one or more channels are calibrating.
- **Bit B3, Sweeping (SWE):** Set bit indicates that one or more channels are sweeping.
- **Bit B4, Measuring (MEAS):** Bit will be set when taking an overlapped measurement, but it will not set when taking a normal synchronous measurement.
- **Bit B10, Trigger Overrun (TRGOVR):** Set bit indicates that an enabled bit in the Operation Status Trigger Overrun Summary register is set.
- **Bit B11, Remote Summary (REM):** Set bit indicates that an enabled in the Operation Status Remote Summary Register is set.
- **Bit B12, User (USER):** Set bit indicates that an enabled bit in the operation status user register is set.
- **Bit B13, Instrument Summary (INST):** Set bit indicates that an enabled bit in the operation status instrument summary register is set.
- **Bit B14, Program Running (PROG):** Set bit indicates that a program is running.

For more information on the Operation Status Registers, refer to [Status register sets](#) and the charts in this appendix.

## Questionable Event Registers

As shown in [Figure C-7](#), there are seven register sets associated with Questionable Event Status. Commands are summarized in the [Status register sets](#). Keep in mind that bits can also be set by using numeric parameter values. For details, see [Programming enable and transition registers](#) in this appendix.

For example, either of the following commands will set the CAL enable bit (B8):

```
status.questionable.enable = status.questionable.CAL
status.questionable.enable = 256
```

When reading a register, a numeric value is returned. The binary equivalent of this value indicates which bits in the register are set. For details, see [Reading registers](#). For example, the following command will read the questionable enable register:

```
print(status.questionable.enable)
```

For more information on the Questionable Event Registers, refer to [Status register sets](#) and the charts in this appendix.

## Questionable Status Register

This register set feeds to bit B3 (QSB) of the Status Byte. The bits used in the Questionable Status Register set are described as follows:

- **Bit B8, Calibration (CAL):** Set bit indicates that calibration is questionable.
- **Bit B9, Unstable Output (UO):** Set bit indicates that an unstable output condition was detected.
- **Bit B12, Over Temperature (OTEMP):** Set bit indicates that an over temperature condition was detected.
- **Bit B13, Instrument Summary (INST):** Set bit indicates that a bit in the questionable instrument summary register is set.

For more information on the Questionable Status Register, refer to [Status register sets](#) and the charts in this appendix.

## Measurement Event Registers

As shown in [Figure C-8](#), there are eight register sets associated with Measurement Event Status. Commands are summarized in the [Status register sets](#). Keep in mind that bits can also be set by using numeric parameter values. For details, see [Programming enable and transition registers](#).

For example, either of the following commands will set the VOLTAGE\_LIMIT enable bit:

```
status.measurement.enable = status.measurement.VOLTAGE_LIMIT
```

```
status.measurement.enable = 1
```

When reading a register, a numeric value is returned. The binary equivalent of this value indicates which bits in the register are set. For details, see [Reading registers](#). For example, the following command will read the measurement enable register:

```
print(status.measurement.enable)
```

This register set feeds to bit B0 (MSB) of the Status Byte. The bits used in the Measurement Event Registers are described as follows:

- **Bit B0, Voltage Limit (VLMT):** Set bit indicates that the voltage limit was exceeded. This bit will be updated only when (1) a measurement is taken or (2) the `smuX.source.compliance` command is invoked.
- **Bit B1, Current Limit (ILMT):** Set bit indicates that the current limit was exceeded. This bit will be updated only when (1) a measurement is taken or (2) the `smuX.source.compliance` command is invoked.
- **Bit B7, Reading Overflow (ROF):** Set bit indicates that an overflow reading has been detected.
- **Bit B8, Buffer Available (BAV):** Set bit indicates that there is at least one reading stored in either or both of the nonvolatile reading buffers.
- **Bit B11, Output Enable (OE):** Set bit indicates that output enable has been asserted.
- **Bit B13, Instrument Summary (INST):** Set bit indicates that a bit in the measurement instrument summary register is set.

For more information on the Measurement Event Registers, refer to [Status register sets](#) and the charts in this appendix.

## Register programming example

The command sequence below programs the instrument to generate an SRQ and set the system summary bit in all TSP-Link nodes when the current limit on Channel A is exceeded.

```
status.reset() -- Clear all registers.

status.measurement.current_limit.enable = -- Enable current limit bit in
status.measurement.current_limit.SMUA -- current limit register.

status.measurement.enable = -- Enable status measure
status.measurement.ILMT -- current limit bit.

status.system_enable = status.MSB -- Set system summary; enable MSB.

status.request_enable = status.MSB -- Enable status SRQ MSB.
```

## Queues

The SourceMeter instrument uses two queues, which are first-in, first-out (FIFO) queues:

- Output queue: Used to hold response messages.
- Error queue: Used to hold error and status messages (see [Table A-2](#)).

The SourceMeter instrument status model ([Figure C-1](#)) shows how the two queues are structured with the other registers.

### Output queue

The output queue holds data that pertains to the normal operation of the instrument. For example, when a `print` command is sent, the response message is placed in the Output Queue.

When data is placed in the Output Queue, the Message Available (MAV) bit in the Status Byte Register sets. A response message is cleared from the Output Queue when it is read. The Output Queue is considered cleared when it is empty. An empty Output Queue clears the MAV bit in the Status Byte Register.

A message is read from the Output Queue by addressing the SourceMeter instrument to talk.

### Error queue

The Error Queue holds error and status messages. When an error or status event occurs, a message that defines the error or status is placed in the Error Queue.

When a message is placed in the Error Queue, the Error Available (EAV) bit in the Status Byte Register is set. An error or status message is cleared from the Error Queue when it is read. The Error Queue is considered cleared when it is empty. An empty Error Queue clears the EAV bit in the Status Byte Register.

The commands to control the Error Queue are listed in [Table C-5](#). When you read a single message in the Error Queue, the oldest message is read and then removed from the queue. On power-up, the Error Queue is initially empty. If there are problems detected during power-on, entries will be placed in the queue. When empty, the error number 0 and “No Error” is placed in the queue.



Messages in the Error Queue include a code number, message text, severity, and TSP-Link node number. The messages are listed in [Table A-2](#).

Table C-5  
Error queue commands

| Error queue command                                                 | Description                                                           |
|---------------------------------------------------------------------|-----------------------------------------------------------------------|
| <code>errorqueue.clear()</code>                                     | Clear error queue of all errors.                                      |
| <code>errorqueue.count</code>                                       | Number of messages in the error/event queue.                          |
| <code>errorcode, message, severity, node = errorqueue.next()</code> | Request error code, text message, severity, and TSP-Link node number. |

## TSP-Link system status

The TSP-Link is an expansion interface that allows the instruments to communicate with each other. The test system can be expanded to include up to 64 TSP-Link-enabled instruments. In a TSP-Link system, one node (instrument) is the Master and the other nodes are the Slaves. The Master can control the other nodes (Slaves) in the system. See [Section 14](#) for details on the TSP-Link.

The system summary registers (shown in [Figure C-1](#) and [Figure C-2](#)) are shared by all nodes in the TSP-Link system. A status event that occurs at a Slave node can generate an SRQ (service request) in the Master node. After detecting the service request, your program can then branch to an appropriate subroutine that will service the request. See [Status byte and service request \(SRQ\)](#) for details.

### Status model configuration example

[Figure C-12](#) shows an example status model configuration for a TSP-Link system. In this example, a current limit (compliance) event in SMU A or SMU B of Node 15 will set the RQS bit of the Status Byte of the Master Node. The commands to configure the status model for this example are provided in [Status configuration \(enable\) commands](#) in this appendix.

When a current limit (compliance) condition occurs in SMU A or SMU B of Node 15, the following sequence of events will occur:

- **Node 15:** Bit B1 or B2 of the Measurement Event Current Limit Summary register sets when the current limit (compliance) event occurs.
- **Node 15:** Bit B1 (ILMT) of the Measurement Event Register sets.
- **Node 15:** Bit B0 (MSB) of the Status Byte sets.
- **System Summary Registers:** Bit B1 (Node 15) of the System2 Summary Register sets.

---

NOTE The System Summary Registers are shared by all nodes in the TSP-Link system. When a bit in a system register of Node 15 sets, the same bit in the Master Node system register also sets.

---

- **System Summary Registers:** Bit B0 (Extension) of the System Summary Register sets.
- **Master Node:** Bit B0 (MSB) of the Status Byte sets.
- **Master Node:** With service request enabled, bit B6 (RQS) of the Status Byte sets. When your program performs the next serial poll of the Master Node, it will detect the current limit event and can branch to a routine to service the request.

## Status configuration (enable) commands

The following commands (sent from the Master Node) enable the appropriate register bits for the above example:

**Node 15 status registers:** The following commands enable the current limit events for SMU A and SMU B of Node 15:

```
node[15].status.measurement.current_limit.enable = 6
node[15].status.measurement.enable = 2
node[15].status.node_enable = 1
```

The affected status registers for the above commands are indicated by labels A, B and C in [Figure C-12](#).

**System registers:** The following commands enable the required system summary bits for Node 15:

```
status.system2.enable = 2
status.system.enable = 1
```

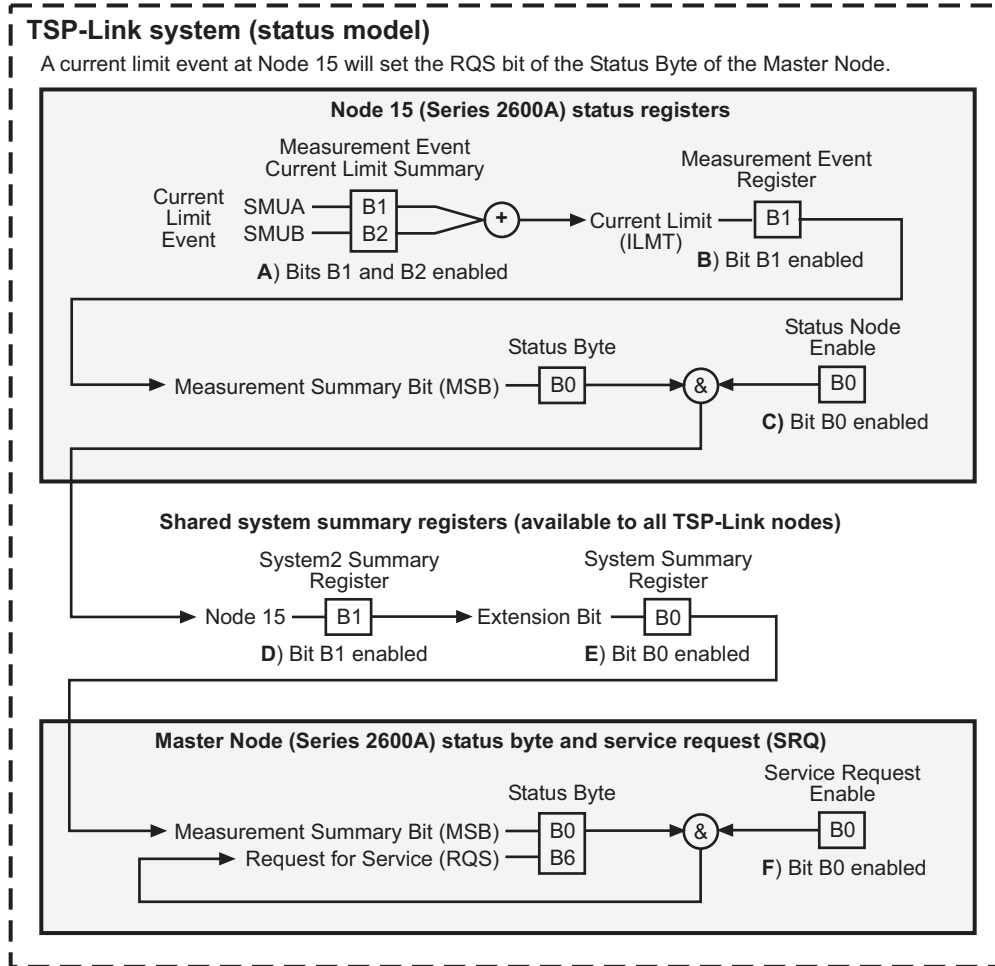
The affected system registers for the above commands are indicated by labels D and E in [Figure C-12](#).

**Master Node service request:** The following command enables the service request for the measurement event:

```
status.request_enable = 1
```

The affected status register for the above command is indicated by label E in [Figure C-12](#).

Figure C-12  
**TSP-Link status model configuration example**



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---

## Display Character Codes

**In this appendix:**

| Topic                                           | Page       |
|-------------------------------------------------|------------|
| <b>Display character codes</b> .....            | <b>D-2</b> |
| Display character codes (decimal 0-143) .....   | D-2        |
| Display character codes (decimal 144-255) ..... | D-4        |
| Display character dot patterns.....             | D-5        |

## Display character codes

This appendix provides a list of display character codes:

Table D-1

**Display character codes (decimal 0-143)**

| DECIMAL | DISPLAY                  | DECIMAL | DISPLAY | DECIMAL | DISPLAY        |
|---------|--------------------------|---------|---------|---------|----------------|
| 000     | reserved                 | 048     | 0       | 096     | ` (open quote) |
| 001     | reserved                 | 049     | 1       | 097     | a              |
| 002     | reserved                 | 050     | 2       | 098     | b              |
| 003     | reserved                 | 051     | 3       | 099     | c              |
| 004     | reserved                 | 052     | 4       | 100     | d              |
| 005     | reserved                 | 053     | 5       | 101     | e              |
| 006     | reserved                 | 054     | 6       | 102     | f              |
| 007     | reserved                 | 055     | 7       | 103     | g              |
| 008     | reserved                 | 056     | 8       | 104     | h              |
| 009     | reserved                 | 057     | 9       | 105     | i              |
| 010     | reserved                 | 058     | :       | 106     | j              |
| 011     | reserved                 | 059     | ;       | 107     | k              |
| 012     | reserved                 | 060     | <       | 108     | l              |
| 013     | reserved                 | 061     | =       | 109     | m              |
| 014     | reserved                 | 062     | >       | 110     | n              |
| 015     | reserved                 | 063     | ?       | 111     | o              |
| 016     | μ                        | 064     | @       | 112     | p              |
| 017     | ±                        | 065     | A       | 113     | q              |
| 018     | Ω                        | 066     | B       | 114     | r              |
| 019     | °                        | 067     | C       | 115     | s              |
| 020     | leftflagbar <sup>1</sup> | 068     | D       | 116     | t              |
| 021     | rightflagbar             | 069     | E       | 117     | u              |
| 022     | fullflagbar              | 070     | F       | 118     | v              |
| 023     | leftbar                  | 071     | G       | 119     | w              |
| 024     | rightbar                 | 072     | H       | 120     | x              |
| 025     | fullflagbar              | 073     | I       | 121     | y              |
| 026     | ▲                        | 074     | J       | 122     | z              |
| 027     | ▼                        | 075     | K       | 123     | {              |

<sup>1</sup> The dot patterns for leftflagbar, rightflagbar, fullflagbar, leftbar, rightbar, and fullflagbar characters found after [Table D-2](#).

Table D-1 (continued)

**Display character codes (decimal 0-143)**

| DECIMAL | DISPLAY                | DECIMAL | DISPLAY | DECIMAL | DISPLAY           |
|---------|------------------------|---------|---------|---------|-------------------|
| 028     | ◀                      | 076     | L       | 124     |                   |
| 029     | ▶                      | 077     | M       | 125     | }                 |
| 030     | selftest1 <sup>2</sup> | 078     | N       | 126     | ~                 |
| 031     | selftest2              | 079     | O       | 127     | ;                 |
| 032     | space                  | 080     | P       | 128     | space             |
| 033     | !                      | 080     | Q       | 129     | dot1 <sup>3</sup> |
| 034     | "                      | 082     | R       | 130     | dot2              |
| 035     | #                      | 083     | S       | 131     | dot12             |
| 036     | \$                     | 084     | T       | 132     | dot3              |
| 037     | %                      | 085     | U       | 133     | dot13             |
| 038     | &                      | 086     | V       | 134     | dot23             |
| 039     | ' (apostrophe)         | 087     | W       | 135     | dot123            |
| 040     | (                      | 088     | X       | 136     | dot4              |
| 041     | )                      | 089     | Y       | 137     | dot14             |
| 042     | *                      | 090     | Z       | 138     | dot24             |
| 043     | +                      | 091     | [       | 139     | dot124            |
| 044     | , (comma)              | 092     | \       | 140     | dot34             |
| 045     | -                      | 093     | ]       | 141     | dot134            |
| 046     | .                      | 094     | ^       | 141     | dot234            |
| 047     | /                      | 095     | _       | 143     | dot1234           |

<sup>2</sup> The dot patterns for the selftest1 and selftest2 can be found after [Table D-2](#).

<sup>3</sup> The dot patterns for the dot characters can be found after [Table D-2](#).

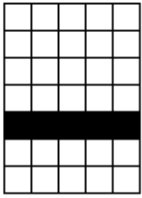
Table D-2  
Display character codes (decimal 144-255)

| DECIMAL | DISPLAY                | DECIMAL | DISPLAY        | DECIMAL | DISPLAY   |
|---------|------------------------|---------|----------------|---------|-----------|
| 144     | selftest3 <sup>1</sup> | 192     | ≥              | 240     | ÿ         |
| 145     | selftest4              | 193     | ≠              | 241     | lightning |
| 146     | selftest5              | 194     | ≡              | 242     | KI        |
| 147     | selftest6              | 195     | ≈              | 243     | box3      |
| 148     | selftest7              | 196     | ∞              | 244     | box4      |
| 149     | selftest8              | 197     | >>             | 245     | box5      |
| 150     | selftest9              | 198     | <<             | 246     | box6      |
| 151     | selftest10             | 199     | ı              | 247     | box7      |
| 152     | selftest11             | 200     | i              | 248     | box8      |
| 153     | selftest12             | 201     | ø              | 249     | box9      |
| 154     | selftest13             | 202     | £              | 250     | tombstone |
| 155     | selftest14             | 203     | ¥              | 251     | †         |
| 156     | box1 <sup>2</sup>      | 204     | P <sub>+</sub> | 252     | ↑         |
| 157     | box2                   | 205     | f              | 253     | ↓         |
| 158     | .5 <sup>3</sup>        | 206     | Ç              | 254     | →         |
| 159     | ¼                      | 207     | ç              | 255     | ←         |
| 160     | 0                      | 208     | æ              |         |           |
| 161     | 1                      | 209     | Æ              |         |           |
| 162     | 2                      | 210     | â              |         |           |
| 163     | 3                      | 211     | ä              |         |           |
| 164     | 4                      | 212     | å              |         |           |
| 165     | 5                      | 213     | á              |         |           |
| 166     | 6                      | 214     | à              |         |           |
| 167     | 7                      | 215     | á              |         |           |
| 168     | 8                      | 216     | Ä              |         |           |
| 169     | 9                      | 217     | Å              |         |           |
| 170     | ∞                      | 218     | ê              |         |           |
| 171     | β                      | 219     | ë              |         |           |
| 172     | γ                      | 220     | é              |         |           |
| 173     | δ                      | 221     | è              |         |           |
| 174     | ε                      | 222     | É              |         |           |
| 175     | η                      | 223     | î              |         |           |
| 176     | θ                      | 224     | ï              |         |           |
| 177     | λ                      | 225     | í              |         |           |
| 178     | π                      | 226     | ì              |         |           |
| 179     | ρ                      | 227     | ô              |         |           |
| 180     | σ                      | 228     | ö              |         |           |
| 181     | τ                      | 229     | ó              |         |           |
| 182     | φ                      | 230     | ò              |         |           |
| 183     | ω                      | 231     | ?              |         |           |
| 184     | Γ                      | 232     | Ö              |         |           |
| 185     | Δ                      | 233     | û              |         |           |
| 186     | Σ                      | 234     | ü              |         |           |
| 187     | Φ                      | 235     | ú              |         |           |
| 188     | ∩                      | 236     | ù              |         |           |
| 189     | ∪                      | 237     | Ü              |         |           |
| 190     | ÷                      | 238     | ñ              |         |           |
| 191     | ≤                      | 239     | Ñ              |         |           |

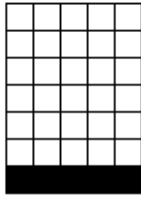
1 The dot patterns for the selftest characters can be found after this table.  
2 The dot patterns for the box characters can be found after this table.  
3 The dot patterns for this character can be found after this table.



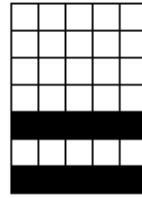
### Display character dot patterns



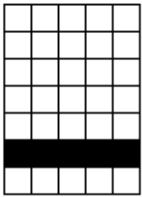
selftest7



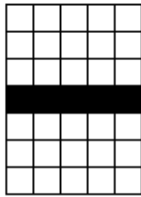
selftest9



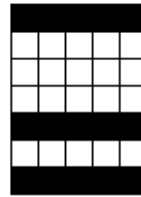
dot34



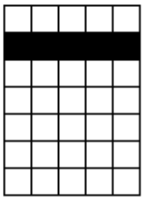
selftest8



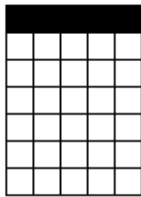
selftest6



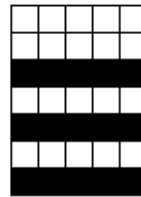
dot134



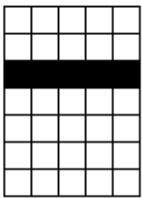
selftest4



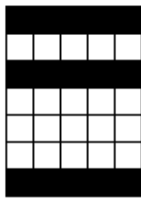
selftest3



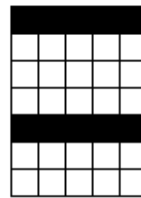
dot234



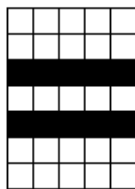
selftest5



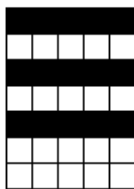
dot124



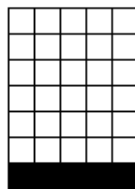
dot13



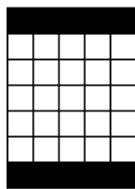
dot23



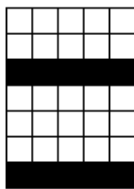
dot123



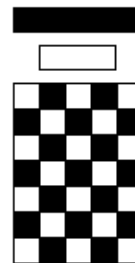
dot4



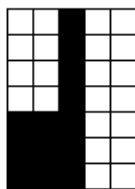
dot14



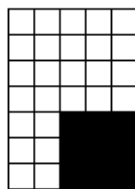
dot24



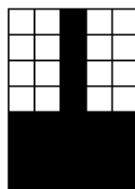
selftest2



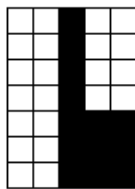
left flag bar



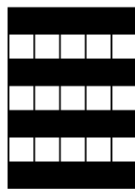
right bar



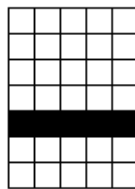
full flag bar



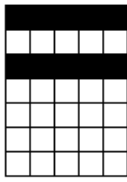
right flag bar



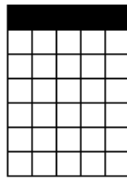
dot1234



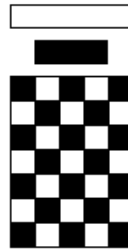
dot3



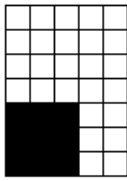
dot12



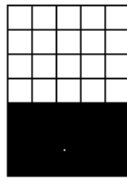
dot1



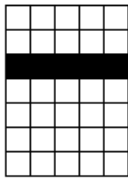
selftest1



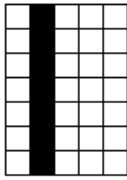
left bar



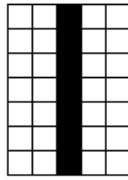
fullbar



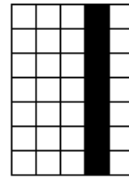
dot2



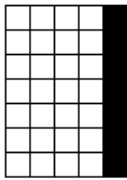
selftest11



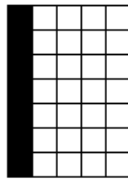
selftest12



selftest13



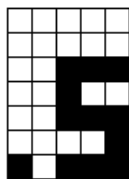
selftest14



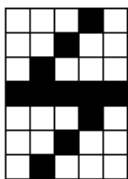
selftest10



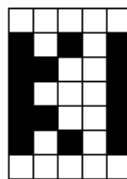
box1



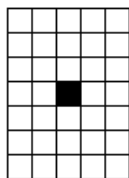
one-half



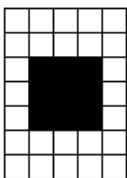
lightning bolt



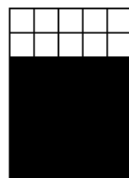
Keithley Instruments



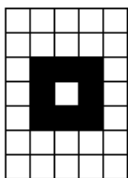
box3



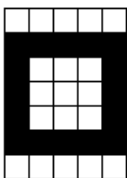
box4



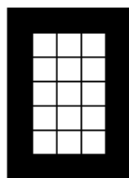
box2



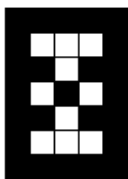
box5



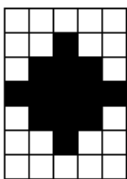
box6



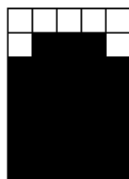
box7



box8



box9



tombstone

## A

|                              |       |
|------------------------------|-------|
| Accessories .....            | 1-4   |
| Action overruns .....        | 10-9  |
| Event blenders .....         | 10-18 |
| On hardware lines .....      | 10-11 |
| Timer .....                  | 10-17 |
| Annunciators. See Indicators |       |
| Arm count .....              | 10-8  |
| Arrays .....                 | 19-5  |
| assert() function .....      | 10-24 |
| Asymptote .....              | 9-5   |
| Attributes .....             | 19-11 |
| Auto ohms measurements ..... | 3-14  |
| Auto range .....             | 6-3   |
| Auto zero .....              | 3-7   |
| Front panel .....            | 3-7   |
| Front panel operation .....  | 3-7   |
| NPLC caching .....           | 3-7   |
| Remote command .....         | 3-7   |
| Remote operation .....       | 3-7   |

## B

|                 |      |
|-----------------|------|
| Baud rate ..... | 15-9 |
| Beeper .....    | 1-15 |
| Branching ..... | 19-7 |

## C

|                              |            |
|------------------------------|------------|
| Calibration                  |            |
| Commands .....               | 20-8       |
| Considerations .....         | 20-2       |
| Cycle .....                  | 20-3       |
| Errors .....                 | 20-5       |
| Procedure .....              | 20-9       |
| Recommended equipment .....  | 20-3       |
| Steps .....                  | 20-5       |
| Capabilities .....           | 1-2        |
| Source-measure .....         | 3-3        |
| Chassis ground .....         | 1-10, 1-12 |
| Chunk .....                  | 12-5       |
| Circuit configurations ..... | 3-6, 4-15  |
| Basic .....                  | 3-6        |
| Contact check .....          | 4-17       |
| Measure only (V or I) .....  | 4-16       |
| Source I .....               | 4-15       |
| Source V .....               | 4-15       |
| Command programming          |            |
| Attributes .....             | 19-11      |
| Conventions .....            | 19-9       |
| Functions .....              | 19-10      |
| Local state .....            | 19-14      |
| Logical instruments .....    | 19-12      |

|                                             |                 |
|---------------------------------------------|-----------------|
| Reading buffers .....                       | 19-13           |
| Remote state .....                          | 19-14           |
| Syntax rules .....                          | 19-11           |
| Time and date values .....                  | 19-14           |
| TSP-Link nodes .....                        | 19-12           |
| Common commands .....                       | B-1             |
| *IDN? .....                                 | B-3             |
| *OPC .....                                  | B-3             |
| *OPC? .....                                 | B-3             |
| *RST .....                                  | B-4             |
| *TRG .....                                  | B-4             |
| *TST? .....                                 | B-4             |
| *WAI .....                                  | B-4             |
| Summary .....                               | B-2             |
| Compliance                                  |                 |
| Limit .....                                 | 3-4, 4-2        |
| Maximum .....                               | 4-2             |
| Principles .....                            | 4-2             |
| Setting front panel compliance limit .....  | 3-5             |
| Setting remote compliance limit .....       | 3-5             |
| Concatenation .....                         | 19-7            |
| Connection                                  |                 |
| GPIB .....                                  | 15-3            |
| Connectors .....                            | 2-2             |
| Chassis ground .....                        | 2-4             |
| Digital I/O .....                           | 1-10, 1-12      |
| IEEE-488 .....                              | 1-10, 1-12      |
| Input .....                                 | 2-2             |
| Input/output LO .....                       | 2-4             |
| Output .....                                | 1-10, 1-12, 2-2 |
| Power module .....                          | 1-10, 1-12      |
| RS-232 .....                                | 1-10, 1-12      |
| TSP-Link .....                              | 1-10, 1-12      |
| Contact check                               |                 |
| Circuit configuration .....                 | 4-17            |
| Commands .....                              | 3-20            |
| Connections .....                           | 2-9             |
| Measurements .....                          | 3-19            |
| Overview .....                              | 3-19            |
| Programming example .....                   | 3-21            |
| Contact information .....                   | 1-3             |
| Continuous power operating boundaries ..... | 4-6             |
| Conventions .....                           | 19-9            |
| Cooling vents .....                         | 1-13            |
| Copying Test Scripts .....                  | 14-10           |
| Current accuracy .....                      | 22-9            |
| Output .....                                | 22-9            |
| Current measurement accuracy .....          | 22-10, 22-14    |
| Limits .....                                | 22-16           |
| Current measurement accuracy limits .....   | 22-15           |

**D**

|                          |                      |
|--------------------------|----------------------|
| Data queue               | 14-10                |
| Data store               |                      |
| Overview                 | 7-2                  |
| Programming examples     | 7-10                 |
| DCL (device clear)       | 15-6                 |
| Device identification    | 17-8                 |
| Digital I/O port         | 5-2, 8-5             |
| +5V output               | 8-2                  |
| Bit weighting            | 8-4, 8-10            |
| Commands                 | 8-5                  |
| Configuration            | 8-2, 8-3             |
| Controlling I/O lines    | 8-4                  |
| Front panel control      | 8-4                  |
| Interlock                | 8-8                  |
| Lines                    | 8-2                  |
| Output enable            | 8-3, 8-5             |
| Output enable control    | 8-6                  |
| Programming examples     | 8-5                  |
| Remote operation         | 8-5, 8-10, 10-19     |
| Triggering               | 10-9                 |
| Digits                   | 6-5, 6-6, 7-10, 7-12 |
| Remote programming       | 6-6                  |
| Display                  |                      |
| Indicators               | 1-8                  |
| Modes                    | 1-16                 |
| Resolution               | 6-6                  |
| Display operations       |                      |
| Adding menu entries      | 11-11                |
| Character codes          | 11-6, D-2            |
| Clearing                 | 11-4                 |
| Deleting menu entries    | 11-12                |
| Dot patterns             | D-2                  |
| Functions and attributes | 11-1                 |
| Indicators               | 11-9                 |
| Input prompting          | 11-7                 |
| Keycodes                 | 11-12                |
| Key-press codes          | 11-12                |
| Load test menu           | 11-10                |
| LOCAL lockout            | 11-10                |
| Measurement functions    | 11-3                 |
| Menu                     | 11-7                 |
| Messages                 | 11-4                 |
| Resolution               | 11-3                 |
| Running a test           | 11-12                |
| Text messages            | 11-5                 |
| Triggering               | 11-12                |
| User screen              | 11-2                 |
| DISPLAY PATTERNS test    | 21-3                 |
| Duty cycle               | 9-10                 |

**E**

|                                   |            |
|-----------------------------------|------------|
| Editing                           |            |
| Compliance                        | 1-17       |
| Source                            | 1-17       |
| Either edge trigger mode          | 10-31      |
| End pulse action                  | 10-8       |
| End pulse action event ID         | 10-8       |
| Environmental conditions          | 20-2, 22-2 |
| Line power                        | 20-2       |
| Temperature and relative humidity | 20-2       |
| Warm-up period                    | 20-2       |

|                          |            |
|--------------------------|------------|
| Error messages           | 15-7       |
| Effects on scripts       | A-2        |
| Reading                  | A-2        |
| Summary                  | A-2        |
| Ethernet communications  | 15-11      |
| Connections              | 15-11      |
| Ethernet connection      |            |
| Remote operation         | 15-12      |
| Event blenders           | 10-17      |
| Modes                    | 10-17      |
| Event ID                 | 10-8       |
| Event log                | 10-20      |
| Accessing                | 10-22      |
| Examples                 |            |
| Ohms programming example | 3-19, 3-21 |

**F**

|                                   |                   |
|-----------------------------------|-------------------|
| Factory default setups            |                   |
| Restoring                         | 3-22              |
| Factory defaults                  |                   |
| Restoring                         | 22-4              |
| Factory scripts                   | 12-18, 19-240     |
| KIHighC                           | 19-271            |
| KIParlib                          | 19-273            |
| KIPulse                           | 19-248            |
| KISavebuffer                      | 19-274            |
| KISweep                           | 19-240            |
| Modifying                         | 19-239            |
| Sweeping                          | 9-12              |
| Falling edge trigger mode         | 10-27             |
| Features                          | 1-2               |
| File I/O                          | 19-18             |
| File system                       |                   |
| Navigation                        | 1-22              |
| Filters                           | 6-9               |
| Commands                          | 6-12              |
| Configuration menu                | 6-10              |
| Configuring                       | 6-10              |
| Enabling                          | 6-10              |
| Front panel control               | 6-10              |
| Programming example               | 6-12              |
| Remote programming                | 6-12              |
| Response time                     | 6-10              |
| Types of                          | 6-9               |
| Firmware                          |                   |
| Upgrading                         | 21-4              |
| Using TSB for upgrade             | 21-4              |
| Floating an SMU                   | 2-20              |
| Flow control (signal handshaking) | 15-9              |
| Front panel                       |                   |
| Calibration                       | 20-5              |
| GPIB operation                    | 15-7              |
| Source-measure procedure          | 3-8               |
| Summaries                         | 1-6               |
| Tests                             | 21-3              |
| Functions                         | 12-4, 19-4, 19-10 |
| Fuse                              |                   |
| Line, replacement                 | 21-2              |
| Replacement                       | 1-15              |

**G**

|                             |      |
|-----------------------------|------|
| General bus commands        | 15-5 |
| GET (group execute trigger) | 15-6 |

- GPIB
  - Adapter .....1-4
  - Cables .....1-4
  - Connections .....15-3
  - Error and status messages .....15-7
  - Front panel operation .....15-7
  - Operation .....15-3
  - Primary address .....15-4
  - Standards .....15-3
  - Status indicators .....15-7
  - Terminator .....15-5
- GTL (go to local) .....15-6
- Guard .....4-17
  - Connections .....4-19
  - Overview .....4-18
- Guarding .....2-13
- H**
- Hardware trigger modes .....10-27
- High-capacitance mode .....5-1
  - Enabling .....5-4
  - Overview .....5-2
- I**
- IFC (interface clear) .....15-6
- Indicators .....11-9
  - Front panel .....1-8
- Input/output connections .....1-10, 1-12
- Input/output terminal blocks .....2-2
- Inspection .....1-3
- Instrument Control Library (ICL) .....19-18
- Interactive script .....12-10
- Interface selection .....15-2
  - GPIB .....1-21
  - RS-232 .....1-21
- Interlock .....8-8
  - Operation .....8-8
  - Overview .....8-8
- IP address .....17-3
- K**
- Key-press codes .....11-12
- Keys
  - Function .....1-7
  - Output control .....1-8
  - Range .....1-8
  - Special .....1-7
- KEYS test .....21-3
- L**
- LAN
  - Assigning the Method .....16-9
  - CONFIG/FAULT IP .....16-11
  - Configuring speed .....16-10
  - Connecting to .....16-8
  - Domain name system .....16-9
  - Duplex mode .....16-11
  - Logging trigger events .....10-20
  - Network settings .....16-11
  - Overview .....16-2
  - Point-to-point connection .....16-2
  - Remote operations .....15-12
  - Setting the IP address .....16-9
  - Setting the method .....16-8
  - Setting the subnet mask .....16-9
  - Status messages .....16-11
  - Triggering .....10-18
  - Troubleshooting .....16-7
- legacy mode .....8-7
- Line
  - Frequency .....1-14
  - Fuse replacement .....21-2
  - Power .....22-3
- LLO (local lockout) .....15-6
- Load test menu .....11-10
- LOCAL key .....15-8
- Logical instruments .....19-12
- Logical operators .....19-6
- Loop control .....19-8
- Low range limits .....6-3
- LSTN .....15-7
- M**
- Maintenance .....21-2
  - Fuse replacement .....21-2
- Manuals .....1-5
- Math library functions .....19-17, 19-238
- Measure
  - V or I .....4-16
  - Voltage or current .....3-13
- Menus
  - Configuration .....1-20
  - Configuration menus .....1-20
  - Main .....1-19
  - Main menu .....1-19
  - Menu types .....1-19
  - Navigation .....1-18
- N**
- Naming scripts .....12-3
- Noise shield .....2-14
- Nonvolatile memory .....12-6
- NPLC caching .....3-8
- O**
- Ohms
  - Calculations .....3-14
  - Measurement procedure .....3-14
  - Measurements .....3-14
  - Programming example .....3-17
  - Remote programming .....3-17
  - Sense selection .....3-16
  - Sensing .....3-15
- Operating boundaries .....4-6
  - Continuous power .....4-6
  - I-Source .....4-7
  - Source or sink .....4-6
  - V-Source .....4-11
- Operation
  - Considerations .....3-6
  - Overview .....3-3
- Operators .....19-4
- Options .....1-4
- Output current accuracy .....22-9
  - Limits .....22-10
- Output enable .....8-5

- Control .....8-6, 8-7
  - Operation .....8-6, 8-8
  - Output voltage accuracy .....22-6
    - Limits .....22-8
  - Output-off states .....2-23
    - High-impedance .....2-23
    - Menu .....2-23
    - Normal .....2-23
    - Remote programming .....2-24
    - zero .....2-23
  - Overheating protection .....4-3
    - equations .....4-3
  - Overlapped operations .....14-9
- P**
- Password .....17-6
    - Reset .....17-7
    - Setting .....17-6
  - Phone number .....1-3
  - Power
    - Calculations .....3-18, 4-4
    - Equations .....4-3
    - Measurement procedure .....3-18, 3-19
    - Measurements .....3-18
    - Programming example .....3-19
    - Remote programming .....3-18, 3-20
  - Power module .....1-10, 1-12
  - Power switch .....1-7
  - Power-on setup .....3-22, 3-23
  - Power-up .....1-14
    - Line frequency .....1-14
    - Line power connection .....1-14
    - Sequence .....1-15
  - Precedence .....19-6
  - Primary address .....15-4
  - Pulse
    - Concepts .....9-9
    - Duty cycle .....9-10
    - Rise and fall times .....9-9
  - Pulse energy limitations .....4-20
  - Pulse mode sweeps .....9-9, 10-13
    - Using timers .....10-13
  - Pulse train .....10-14
  - Pulse-mode sweeps .....10-6
- Q**
- Queries .....12-3
  - Queues ..... C-2, C-22
    - Error .....C-22
    - Output .....15-2, C-22
- R**
- Range .....6-2
    - Auto .....6-3
    - Auto range limits .....6-3
    - Available ranges .....6-2
    - Commands .....6-4
    - Considerations .....6-4
    - Limitations .....6-3
    - Low limits .....6-3
    - Manual .....6-3
    - Output value .....22-5
    - Programming .....6-4
    - Programming example .....6-5
  - Reading buffers .....7-2, 19-13
    - Attributes .....7-8
    - Commands .....7-7
    - Defined buffer example .....7-10
    - Designations .....7-6
    - Displaying readings .....7-5
    - Dual buffer example .....7-11
    - Dynamically allocated .....7-10
    - Dynamically allocated buffer example 7-12
    - Location number .....7-5
    - Overview .....7-2
    - Remote state .....7-5
    - Removing stale buffers .....14-10
    - Saving .....7-4
    - Status .....7-9
    - Storage .....7-4
    - Storage control attributes .....7-6
    - Timestamp .....7-5
  - Readings
    - Maximum .....6-3
    - Recalling .....7-5
  - Rear panel summaries .....1-9
  - Recommended test equipment .....22-3
  - Recommended verification equipment ...22-3
  - Registers
    - Enable and transition .....C-16
    - Measurement event .....C-21
    - Operation event .....C-19
    - Programming example .....C-22
    - Questionable event .....C-20
    - Reading .....C-13
    - Serial polling and SRQ .....C-15
    - Service request enable .....C-15
    - Standard event .....C-18
    - Status sets .....C-17
    - System summary event .....C-17
  - Rel .....6-8
    - Defining a value .....6-8
    - Enabling and disabling .....6-8
    - Front panel .....6-8
    - Remote programming .....6-9
  - REM .....15-7
  - Remote calibration .....20-5
  - Remote command interface
    - Selecting .....16-13
  - Remote operation
    - Source-measure procedure .....3-10
  - Remote programming
    - Ohms .....3-17
    - Power .....3-18, 3-20
    - rel .....6-9
  - Remote vs. local operation .....19-240
  - REN (remote enable) .....15-6
  - Reserved words .....19-3
  - Restoring factory defaults .....22-4
  - Rising edge acceptor trigger mode .....10-30
  - Rising edge master trigger mode .....10-29
  - Rotary knob .....1-8
  - RS-232 cable .....1-4, 1-5
  - RS-232 interface
    - Baud rate .....15-9



- Connections ..... 15-10
- Data bits ..... 15-9
- Flow control ..... 15-9
- Operation ..... 15-8
- Parity ..... 15-9
- Sending and receiving data ..... 15-9
- Terminator ..... 15-9
- Run-time environment ..... 12-2, 12-6, 12-18
- Memory considerations ..... 12-18

**S**

- Safety shield ..... 2-16
- Script management ..... 12-16
- Scripting ..... 12-2
- Scripts ..... 12-3, 12-5
  - Creating ..... 13-6
  - Creating functions ..... 12-4
  - Examples ..... 12-9
  - Factory scripts ..... 12-18
  - Importing ..... 13-16
  - Launch configuration ..... 13-10
  - Launching ..... 13-14
  - Loading from the USB flash drive ..... 12-13
  - Memory considerations ..... 12-18
  - Modifying ..... 13-6
  - Naming ..... 12-3
  - Programming model ..... 12-7
  - Renaming ..... 12-4
  - Retrieving ..... 13-15
  - Retrieving from Model 260x ..... 13-15
  - Saving ..... 13-7
  - Types ..... 12-7
  - User ..... 12-8
    - Creating ..... 12-8
- SDC (selective device clear) ..... 15-6
- Selecting an interface ..... 15-2
- Sending commands and statements ..... 4-22
- Sensing ..... 2-6
  - 2-wire local ..... 2-6
  - 4-wire remote ..... 2-8
  - Mode selection ..... 2-9
  - Ohms ..... 3-15
- Serial polling ..... C-15
- Settling time considerations ..... 4-20
- Setups
  - Power-on ..... 3-22
- Shielding
  - Noise ..... 2-14
  - Safety ..... 2-16
- Sink ..... 4-6
  - Operation ..... 3-14
- SMU
  - Connections ..... 2-10
  - Event detectors ..... 10-6
    - Clearing ..... 10-7
- Source ..... 4-6
- Source I measure I ..... 4-14
- Source V measure V ..... 4-14
- Source-measure
  - Capabilities ..... 3-3
  - Front panel operation ..... 3-8
  - Programming example ..... 3-11
  - Remote operation ..... 3-10
- SPE, SPD (serial polling) ..... 15-7

- Speed ..... 6-6
  - Command ..... 6-7
  - Configuration menu ..... 6-7
  - Programming example ..... 6-7
  - Remote programming ..... 6-7
  - Setting ..... 6-7
- SRQ (Service Request) ..... 15-7, C-13
- Standard libraries ..... 19-15, 19-236
- Status byte and service request (SRQ) ..... C-13
  - Commands ..... C-15
- Status function summary ..... C-11
- Status model ..... C-2
  - Clearing registers and queues ..... C-12
  - Commands ..... C-11
  - Function summary ..... C-11
  - Programming registers and queues ..... C-12
  - Queues ..... C-2
  - Status byte and SRQ ..... C-2, C-13
  - Status register sets ..... C-2
    - TSP-Link system ..... C-23
- Status register sets ..... C-2, C-17
- Stimulus input
  - Action overruns ..... 10-9
  - Event log ..... 10-21
  - Hardware trigger modes ..... 10-27
  - Hardware value ..... 10-18
  - Interactive triggering ..... 10-23
  - LAN triggers ..... 10-18
  - LXI triggers ..... 10-19
  - Pseudo line state ..... 10-18
  - Stateless event flag ..... 10-18
  - Trigger events ..... 10-8
- String library functions ..... 19-16, 19-237
- Sweep
  - Characteristics ..... 9-3
  - Configuring and running sweeps ..... 9-10
  - Configuring measurements ..... 9-11
  - Factory scripts ..... 9-12
  - Functions ..... 9-12
  - Initiating and running sweeps ..... 9-11
  - Linear staircase ..... 9-3
  - Linear staircase sweeps ..... 9-3
  - List sweeps ..... 9-8
  - Logarithmic staircase ..... 9-5
  - Logarithmic staircase sweeps ..... 9-5
  - Measurement storage ..... 9-10
  - Operation ..... 9-2
  - Overview ..... 9-2
  - Programming examples ..... 9-12
  - Source and measurement delays ..... 9-11
  - Waveforms ..... 4-3
- Synchronous triggering modes ..... 10-32
  - Synchronous ..... 10-35
  - SynchronousA ..... 10-34
  - synchronousM ..... 10-32
- Syntax rules ..... 19-11
- System
  - Connections ..... 13-2
  - Identification ..... 1-15

**T**

- Tables ..... 19-5
- TALK ..... 15-7
- Telnet ..... 16-13

- Configuring ..... 16-13
  - Terminator ..... 15-5, 15-9
  - Test considerations ..... 22-5
  - Test fixture ..... 2-20
  - Test Script Builder ..... 13-2
    - Console ..... 13-16
    - Editor ..... 13-2
    - File management ..... 13-22
    - Instrument Console ..... 13-16
    - Opening communications ..... 13-4
    - Project navigator ..... 13-2
    - Starting ..... 13-3
  - Test Script Processor ..... 12-2
  - Tests
    - Front panel ..... 21-3
  - Timers ..... 10-11
    - Action overruns ..... 10-17
    - Attributes ..... 10-11
    - Performing pulsed mode sweeps ..... 10-13
    - Pulse train ..... 10-14
    - Triggering ..... 10-12
  - Timestamp ..... 7-5
  - Trigger count ..... 10-8
  - Trigger events ..... 10-8
    - Arm count ..... 10-6
    - Event IDs ..... 10-4
    - Trigger count ..... 10-8
    - Trigger model ..... 10-3, 10-4
  - Trigger model ..... 10-8
  - Trigger objects ..... 10-3
    - Event blenders ..... 10-17
    - Manual (TRIG key) ..... 10-7
    - SMU event detectors ..... 10-6
    - Timers ..... 10-11
  - Triggering ..... 10-1
    - Action overruns ..... 10-9
    - Action overruns on hardware lines ..... 10-11
    - Bypassing SMU event detectors ..... 10-24
    - Clearing SMU event detectors ..... 10-7
    - Command interface ..... 10-22
    - Common attributes ..... 10-9
    - Configuring attributes ..... 3-12
    - Configuring hardware lines ..... 10-10
    - Configuring source and measure actions ..... 10-6
    - Detecting trigger events ..... 10-23
    - Either edge trigger mode ..... 10-31
    - Enabling pulse-mode sweeps ..... 10-6
    - Falling edge trigger mode ..... 10-27
    - Generating trigger events ..... 10-24
    - Interactive ..... 10-23
    - LAN overview ..... 10-18
    - Local mode ..... 3-11
    - Manual ..... 10-23
    - Overview ..... 10-3
    - release() function ..... 10-24
    - Remote trigger model ..... 10-4
    - Rising edge acceptor trigger mode ..... 10-30
    - Rising edge master trigger mode ..... 10-29
    - set() function ..... 10-24
    - SMU event detectors ..... 10-6
    - Synchronous ..... 10-35
    - Synchronous triggering modes ..... 10-32
    - Trigger events ..... 10-8
    - TSP-Link ..... 14-5
    - wait() function ..... 10-23
  - Triggering events
    - End pulse action ..... 10-6
  - TSB Embedded ..... 17-9
  - TSP advanced features ..... 14-5
  - TSP-Link ..... 14-2
    - Abort ..... 14-5
    - Accessing nodes ..... 14-4
    - Connections ..... 14-2
    - Initialization ..... 14-3
    - Master ..... 14-2
    - Node numbers ..... 14-3
    - PC-based system ..... 14-2, 19-15
    - Reset ..... 14-3
    - reset() command ..... 14-5
    - Slaves ..... 14-2
    - Stand-alone system ..... 14-2, 19-15
    - Triggering ..... 14-5
  - TSP-Link synchronization lines ..... 8-9
    - Connecting to ..... 8-9
    - Digital I/O ..... 8-9
    - Remote commands ..... 8-10
    - Triggering ..... 10-9
  - TSP-Net ..... 18-2
- ## U
- Unpacking ..... 1-3
  - USB ..... 1-21
    - Connecting the USB flash drive ..... 1-21
    - Loading scripts from ..... 12-13
    - Saving a script to ..... 12-11
    - Saving the reading buffer to ..... 7-4
  - User script ..... 12-8, 13-25
    - Creating ..... 12-8
    - Modifying ..... 12-15
    - Running ..... 12-14
    - Saving ..... 12-11
  - User setups
    - Recalling ..... 3-22
    - Saving ..... 3-21
    - Saving from a command interface ..... 3-22
- ## V
- Variables ..... 19-3
  - Vents
    - Cooling ..... 1-10, 1-12, 1-13
  - Verification ..... 22-2
    - Limits ..... 22-3
    - Test considerations ..... 22-5
    - Test equipment ..... 22-3
    - Test procedures ..... 22-5
    - Test requirements ..... 22-2
    - Test summary ..... 22-5
  - Verify menu ..... 16-10
  - Virtual front panel ..... 17-7
  - Voltage
    - Accuracy ..... 22-6
    - Accuracy limit ..... 22-9
    - Measure ..... 3-13
    - Measurement accuracy ..... 22-8

Measurement accuracy limits .....22-9

**W**

Warm-up .....3-6  
Warm-up period .....22-2  
Warranty information .....1-3  
Web interface .....17-2  
    Accessing .....17-2  
    Browser requirements .....17-2  
    Configuring IP address .....17-3

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