Operating and Programming Guide

This guide describes how to use and program the Agilent 53147A, 53148A, and 53149A. The information in this guide applies to instruments having the number prefix listed below, unless accompanied by a "Manual Updating Changes" package indicating otherwise.

SERIAL PREFIX NUMBER:	**US4047 (53147A)**
	US4048 (53148A)
	US4049 (53149A)

Agilent 53147A/148A/149A Microwave Frequency Counter/ Power Meter/DVM

Printed: May 2002

Printed in U.S.A.

Manual part number 53147-90009

Certification and Warranty

Certification

Agilent Technologies, Inc. certifies that this product met its published specification at the time of shipment from the factory. Agilent further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (formerly National Bureau of Standards), to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

Warranty

Agilent warrants Agilent hardware, accessories and supplies against defects in materials and workmanship for a period of one year from date of shipment. If Agilent receives notice of such defects during the warranty period, Agilent will, at its option, either repair or replace products which prove to be defective. Replacement products may be either new or like-new.

Agilent warrants that Agilent software will not fail to execute its programming instructions, for the period specified above, due to defects in material and workmanship when properly installed and used. If Agilent receives notice of such defects during the warranty period, Agilent will replace software media which does not execute its programming instructions due to such defects.

For detailed warranty information, see back matter.

Safety Considerations

General

This product and related documentation must be reviewed for familiarization with this safety markings and instructions before operation.

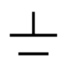
Before Cleaning

Disconnect the product from operating power before cleaning.

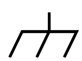
Warning Symbols That May Be Used In This Book

Instruction manual symbol; the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual.

Indicates hazardous voltages.



Indicates earth (ground) terminal.



or

Indicates terminal is connected to chassis when such connection is not apparent.

Indicates Alternating current.

Indicates Direct current.

Safety Considerations (cont'd)

WARNING

BODILY INJURY OR DEATH MAY RESULT FROM FAILURE TO HEED A WARNING. DO NOT PROCEED BEYOND A WARNING UNTIL THE INDICATED CONDITIONS ARE FULLY UNDERSTOOD AND MET.

CAUTION

Damage to equipment, or incorrect measurement data, may result from failure to heed a caution. Do not proceed beyond a *CAUTION* until the indicated conditions are fully understood and met.

Safety Earth Ground

An uninterruptible safety earth ground must be maintained from the mains power source to the product's ground circuitry.

WARNING

WHEN MEASURING POWER LINE SIGNALS, BE EXTREMELY CAREFUL AND ALWAYS USE A STEP-DOWN ISOLATION TRANSFORMER WHICH OUTPUT IS COMPATIBLE WITH THE INPUT MEASUREMENT CAPABILITIES OF THIS PRODUCT. THIS PRODUCT'S FRONT AND REAR PANELS ARE TYPICALLY AT EARTH GROUND. *THUS, NEVER TRY TO MEASURE AC POWER LINE SIGNALS WITHOUT AN ISOLATION TRANSFORMER.*

For additional safety and acoustic noise information, see back matter.

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7.C.NL.10.31.00.R1.M.CW6FC

Contents

In This Guide

This book is the Operating and Programming Guide for the Agilent 53147A, 53148A, and 53149A. It consists of a table of contents, this preface, a quick-reference guide, four chapters, three appendices, and an index.

This preface contains the following information:

Contents and Organization

The **Quick Reference Guide** consists of a Menu Tree (tear-out sheet) that serves as a tool to trigger your memory or get you quickly reacquainted with the instrument.

Chapter 1 Getting Started is a quick-start guide that gives you a brief overview of the instrument’s keys, indicators, menus, display, and connectors. A graphical procedure for performing a measurement is also provided.

Chapter 2 Operating Your Instrument is an operator’s reference. You are given an overview of each group of front-panel keys, operating functions, and menus followed by a series of exercises that guide you through the operation of the instrument.

Chapter 3 Programming provides information that you can use to remotely operate the instrument.

Chapter 4 Specifications lists the specifications and characteristics of the instrument.

Appendix A Rack Mounting the Instrument provides rack-mounting procedures for the instrument.

Appendix B Messages lists and explains all of the messages that are displayed on the instrument’s front panel and/or sent over the RS-232 serial interface.

Appendix C Using the Battery Option explains how to use the instrument with the Battery option.

Index

Related Documents

For more information on frequency counters, refer to the following Series 200 Application Notes:

- *Fundamentals of Electronic Frequency Counters*, Application Note 200, Agilent part number 02-5952-7506.
- *Understanding Frequency Counter Specifications*, Application Note 200-4, Agilent part number 02-5952-7522.
- *Fundamentals of Time and Frequency Standards*, Application Note 52-1, Agilent part number 02-5952-7870.

Types of Service Available if Instrument Fails

If your instrument fails within one year of original purchase, Agilent will repair it free of charge. If your instrument fails after your one-year warranty expires, Agilent will repair it, or you can repair it yourself.

There are three types of repair services:

- Standard repair service—if downtime is not critical.
- Express Repair/Performance Calibration Service—if downtime is critical.
- Owner repair—repair the unit yourself using the *Assembly-Level Service Guide*.

Standard Repair Services (Worldwide)

Contact your nearest Agilent Service Center to arrange to have your instrument repaired.

Express Repair/Performance Calibration Service (USA Only)

If downtime is critical, you can receive your repaired instrument via overnight shipment. Just call **1-800-403-0801** and ask for Express Repair/Performance Calibration Service. When your instrument is repaired, it will be returned via overnight shipment.

Repair Instrument Yourself

If you choose to repair the instrument yourself or would like more details on self test and calibration, use the procedures in the *Assembly-Level Service Guide*.

Repackaging for Shipment

For the Express Repair/Performance Calibration Service described above, return your failed instrument to the designated Agilent Service Center, using the instrument's original shipping carton (if available). Agilent notifies you when your failed instrument is received.

If the instrument is to be shipped to Agilent for service or repair, be sure you do the following:

- Attach a tag to the instrument identifying the owner and indicating the required service or repair. Include the instrument model number and full serial number.
- Place the instrument in its original container (if available) with appropriate packaging material.
- Secure the container with strong tape or shipping bands.

If the original shipping container is not available, place your unit in a container with at least 4 inches of compressible packaging material around all sides of the unit. Use static free packaging materials to avoid additional damage to your unit.

Agilent suggests that you always insure shipments.

Description of the Microwave Frequency Counter/Power Meter/DVM

The Agilent 53147A, 53148A, and 53149A are capable of measuring frequencies from 10 Hz to 125 MHz on Channel 1 and from 50 MHz to 20 GHz (53147A), 26.5 GHz (53148A), and 46 GHz (53149A) on Channel 2. These instruments are also capable of measuring power (the power and frequency ranges for power measurement are dependent on the power-sensor model used) and DC voltages up to ±50 VDC. All three instruments have a maximum frequency resolution of 1 Hz.

The Agilent 53147A/148A/149A provide GPIB and RS-232 serial interfaces and are suitable for field, bench-top, and ATE operation.

The basic measurement functions of the Agilent 53147A/148A/149A includes Frequency, Relative Frequency, Frequency Offset, Power, Power Offset, Relative Power, and DC voltages. All of these features are accessible from the front panel and over the GPIB and RS-232 interfaces.

The Agilent 53147A/148A/149A includes the following additional measurement functions and features that are designed specifically for manufacturing and service applications:

- 1, 2, 5, and 10 MHz external reference capability
- Optional high-stability oven oscillator for high-accuracy needs and lengthened calibration cycles
- Frequency and power offset capabilities for relative measurements
- SCPI programming capability
- Battery and dc input option for operation in locations where AC power is unavailable
- Optional soft carrying case for safe transportation and mobile use

Programmable control is performed via a GPIB or an RS-232 serial interface. The GPIB and RS-232 ports are standard for the Agilent 53147A, 53148A, and 53149A.

Options

The options available for the Agilent 53147A/148A/149A are listed below. Specifications for the options are listed in Chapter 3, "Programming." Options ordered with the instrument are installed at the factory and are ready for operation on delivery. Refer to the "Retrofitting Options" chapter in the *Agilent 53147A/148A/149A Assembly-Level Service Guide* for information on installing options in the field.

Hardware

- High Stability Oven Timebase, Option 001
- Battery/DC Power Input, Option 002
- Rack Mount Kit, Option 1CM
- Soft Carrying Case, Option 007

Retrofit

Options 001 and 002 can be installed only by authorized Agilent Technologies Repair Centers.

Accessories Supplied and Available

Accessories Supplied

- Power cord, 2.3 meters (Part number dependent upon destination country)
- Power sensor cable (Agilent 11730A)
- DVM test leads (Agilent 34132B)

Accessories Available

- Soft Carrying Case (Agilent P/N 53147-80016)
- Automotive Power Adapter (Agilent P/N 53150-60214)
- Battery (Agilent P/N 53150-80010)
- GPIB Cables (Agilent 10833A/B/C/D)
- RS-232 Cable (Agilent P/N 53150-60215)
- Power Sensors (Agilent 8480 series)

Manuals Supplied

Agilent 53147A/148A/149A Operating and Programming Guide
(Agilent P/N 53147-90009)

Agilent 53147A/148A/149A Assembly-Level Service Guide
(Agilent P/N 53147-90010)

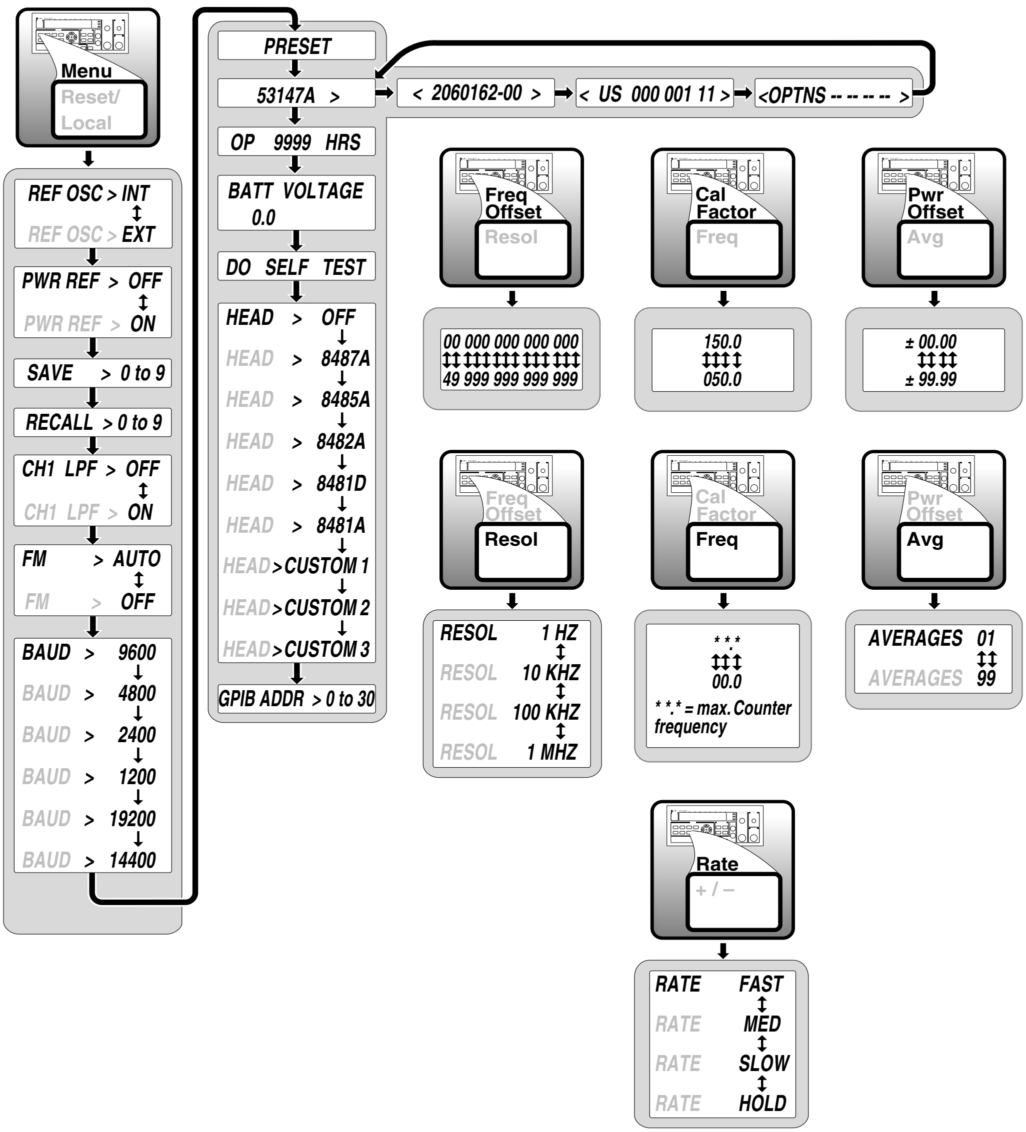
Agilent 53147A/148A/149A Quick Reference Guide

The Quick Reference Guide is designed for experienced users of the Agilent 53147A, 53148A, and 53149A. It is intended to be used as a tool to trigger your memory. If you are using the instrument for the first time, it is recommended that you at least read Chapter 1, “Getting Started,” first.

The Quick Reference Guide, which follows this page, consists of a menu tree that may be torn out of the guide for external use.

Quick Reference

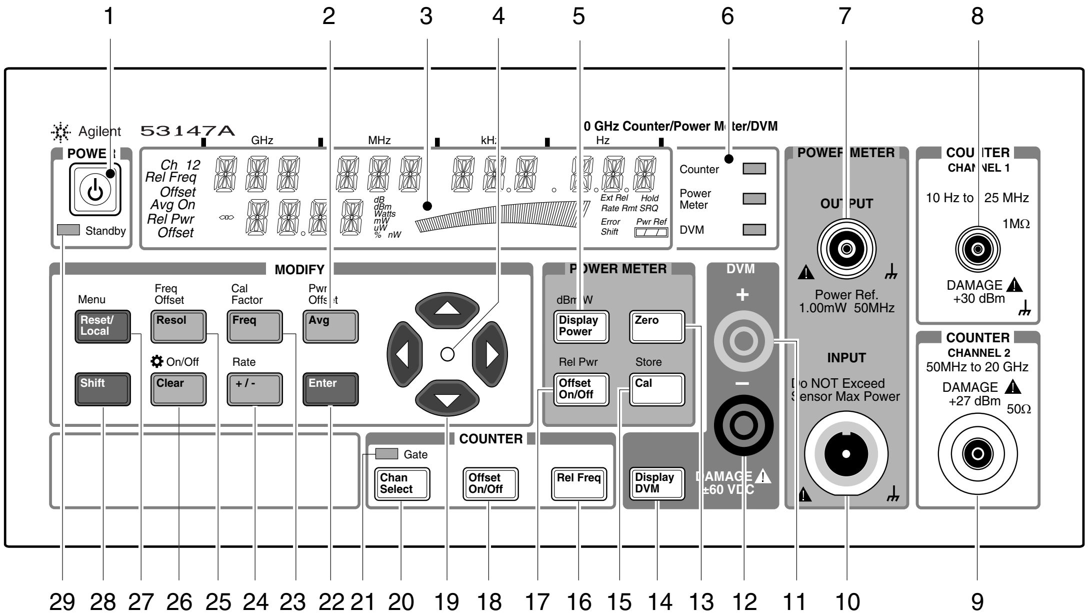
Agilent 53147A/148A/149A
Frequency Counter/Power Meter/DVM



1

Getting Started

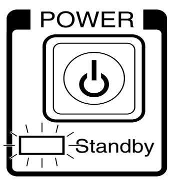
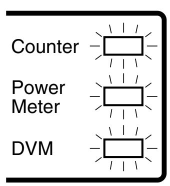
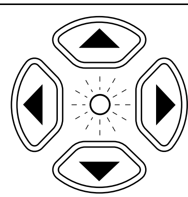
The Front Panel at a Glance

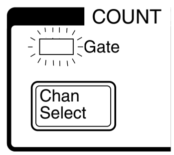


1 Power / Standby switch
2 Average / Power Offset key
3 LCD display
4 Selection-keys-active indicator
5 Display Power / dBm/W key
6 Instrument-function indicators (Counter / Power Meter / DVM)
7 Power Reference Output connector
8 Channel 1 input connector
9 Channel 2 input connector
10 Power Meter Input connector
11 DVM + connector
12 DVM – connector
13 Zero key
14 Display DVM key
15 Calibrate / Store key
16 Relative Frequency key
17 Power Offset On/Off / Relative Power key
18 Frequency Offset On/Off key
19 Selection (arrow) keys
20 Counter Channel Selection key
21 Gate indicator
22 Enter key
23 Frequency / Calibration Factor key
24 Sign change (+/–) / Rate key
25 Resolution / Frequency Offset key
26 Clear / Display Backlight On/Off key
27 Reset/Local / Menu key
28 Shift key
29 Standby indicator

The Front Panel Indicators at a Glance

There are five front-panel LED indicators. These are listed and described in the following table.

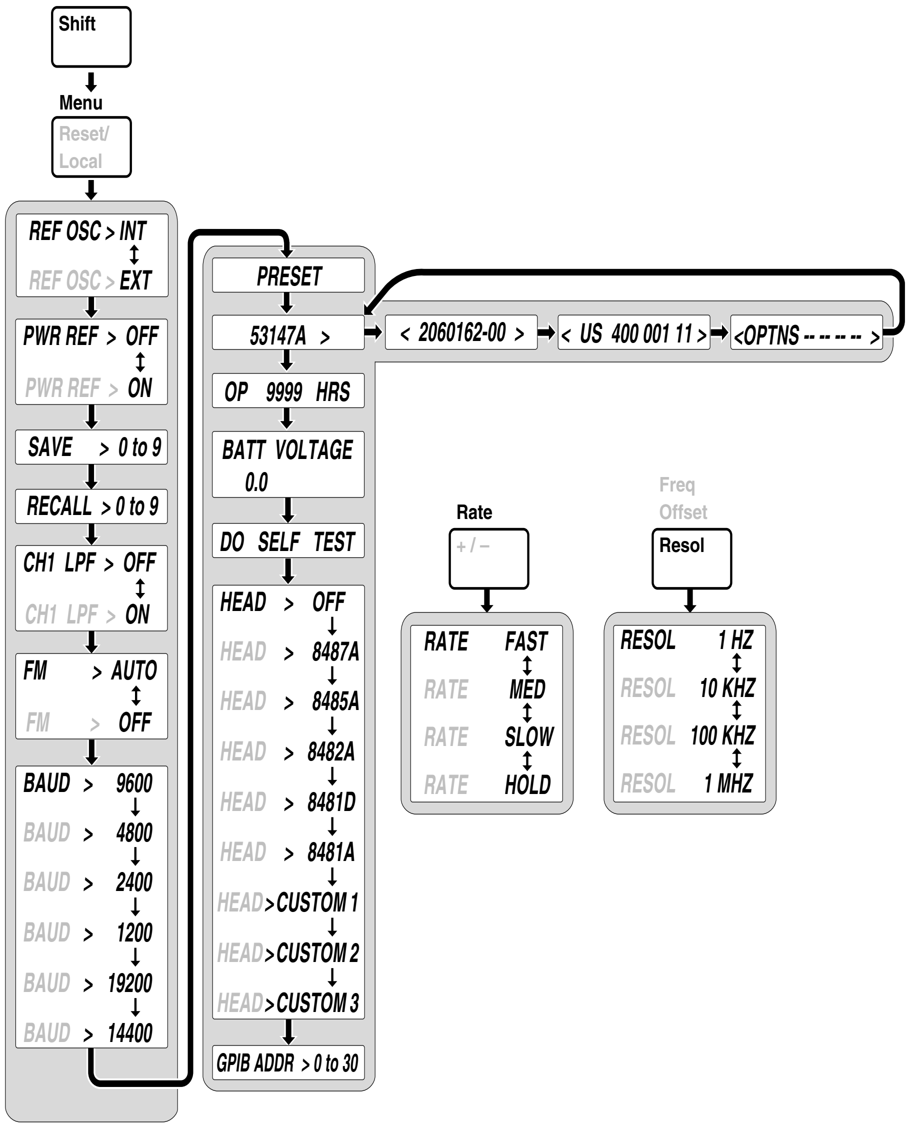
Indicator	Description
	The Standby indicator is lit whenever the power cord is connected (or the battery option is supplying power), and the POWER switch on the front panel is OFF (out). During Standby, most of the instrument's circuits do not receive power. The cooling fan and the timebase *are* powered to maintain temperature stability in the timebase components, and if the Battery option is installed, the battery-charging circuits *are* powered. When you press the POWER switch on the front panel, the Standby indicator goes off, and *all* of the instrument's circuits receive power.
	The function LEDs light to indicate which of the instrument's functions are displayed. If frequency is the only measurement displayed (the Power Meter and the DVM are disabled), only the Counter LED is lit. If both frequency and power measurements are displayed (the Counter and the Power Meter are enabled), the Counter and Power Meter LEDs are lit. If a voltage reading and a power reading are displayed (the DVM and the Power Meter are enabled), the Power Meter and DVM LEDs are lit. If only a voltage reading is displayed (the DVM is the only function enabled), the DVM LED is lit, and the Counter and Power Meter LEDs are not lit.
	When the LED indicator between the arrow keys flashes, the arrow keys can be used to navigate and change values in menus. When you make a change in a menu, always press the **Enter** key to save the setting and exit the menu.

Indicator	Description
	The Gate LED indicator flashes to indicate the rate at which Counter measurements are triggered. The flash rate of the LED varies with the settings of the measurement rate (**Rate** key) and the Counter measurement resolution (**Resol** key). The flash rate of the LED provides a rough indication of the number of Counter measurements that are being taken in a given period of time.

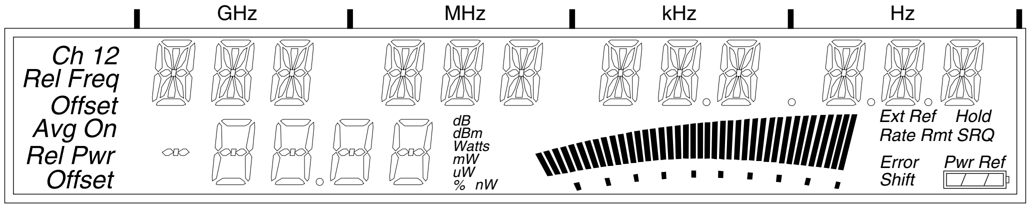
NOTE

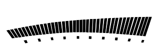
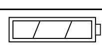
It is normal for the fan to run when the instrument is in Standby mode. Power is supplied to the timebase whenever the instrument is connected to a power source, and the fan runs to cool the power supply.

The Front Panel Menus at a Glance



The Display Annunciators at a Glance



Annunciator	Description
Ch 1 or Ch 2	Indicates which channel is selected to measure an input signal.
Freq	Indicates that the value displayed is a frequency reading.
Rel Freq	The displayed frequency value is relative to a previously stored value.
Freq Offset	The displayed frequency value is offset by a previously entered frequency value.
Avg On	The displayed measurement value is the result of a number of individual measurements that have been averaged.
Pwr	The instrument is set to measure Power (Power Meter is on).
Rel Pwr	The displayed power measurement is relative to a previously stored power value.
Pwr Offset	The displayed power value is offset by a previously entered power value.
dB, dBm, Watts, mW, μW, nW, %	Indicates the unit of measurement for the currently displayed power value.
	Provides a real-time analog representation of the Power measurement (intended for peaking and similar procedures).
Ext Ref	The Counter is using an external reference Timebase for frequency measurements.
Hold	Indicates the instrument is in Hold (single-measurement) mode.
Rmt, SRQ	Shows the current state of the GPIB interface (Rmt = Remote operation via GPIB; SRQ = Service ReQuest).
Error	Indicates that a front-panel key command is unacceptable in the current context.
Shift	Indicates that all front-panel keys are redefined to the function printed above the key.
Pwr Ref	Indicates that the 1 mW power reference output is turned on.
	Shows the amount of charge in the batteries (if the Battery option is installed).

The Display Special Characters at a Glance

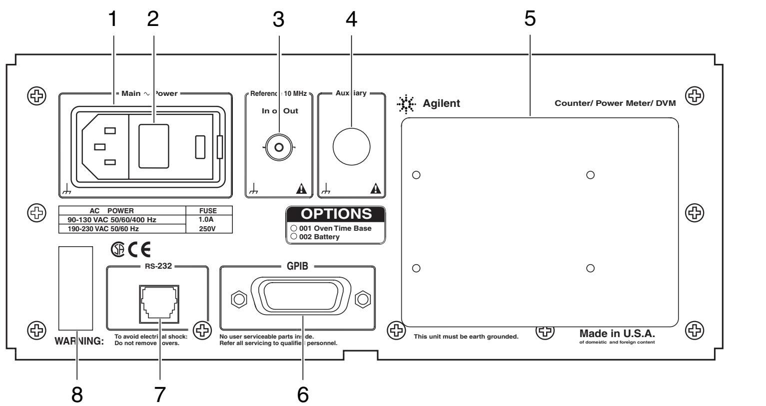
Special Characters	Description
>	Points to the current value for a Menu setting.
<	Indicates that the value for the current Menu setting can be changed using the selection (arrow) keys.

NOTE

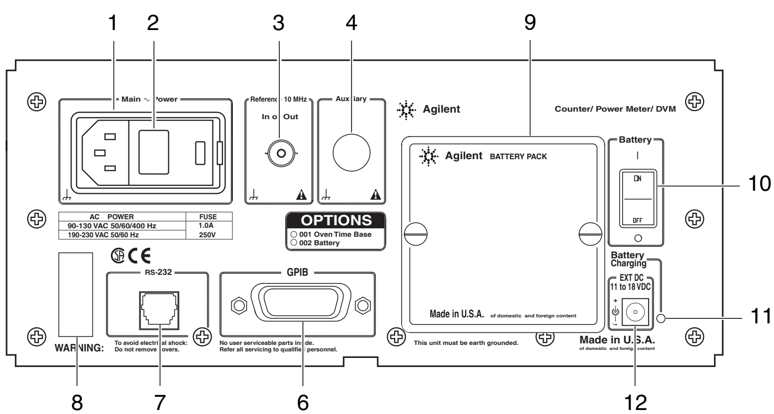
The special characters shown above are intended to help you navigate within the Menu. When the right pointer (>) is flashing, it indicates the current setting for the selected Menu option. When the left pointer (<) is flashing, it indicates that you can use the selection (arrow) keys to change the setting for the current Menu option. To switch between the two, press the right arrow key when the right pointer (>) is flashing, or press the left arrow key when the left pointer (<) is flashing.

The Rear Panel at a Glance

Standard



With Battery Option



1 AC Input/Power module (Senses incoming voltage and adjusts automatically)

2 Fuse Holder (behind door)

3 External Reference connector (BNC) 1, 2, 5, 10 MHz Input, 10 MHz Output

4 Auxiliary connector (reserved) *

5 Battery option cover plate

6 GPIB Interface connector (IEEE-488.2)

7 RS-232 Interface connector (RJ12)

8 Serial number plate

9 Battery sled (Battery option only)

10 Battery power switch (Battery option only)

11 Battery Charging LED (Battery option only)

12 EXT DC power-input connector (Battery option only)

* *The Auxiliary connector is not installed on standard production units.*

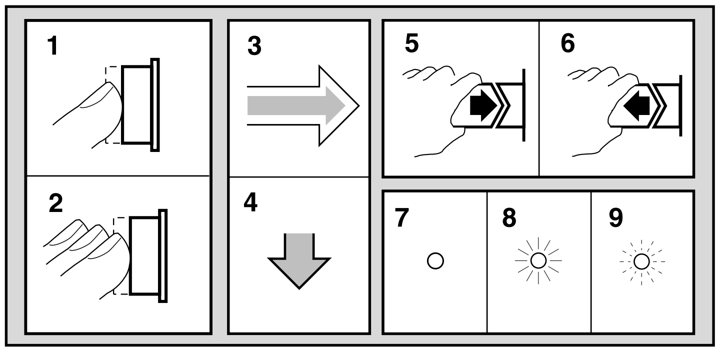
Operating the Instrument

The procedures in this section are designed to familiarize you with the instrument's features and controls. Agilent suggests that you follow the steps for each of these procedures, even if you do not presently need to make any measurements or to adjust any of the instrument's settings. The following procedures are provided:

- Turning the Instrument On
- Turning the Display Backlight Off or On
- Selecting an Input Channel
- Using the Menu
- Setting the Serial Port Baud Rate
- Measuring Frequency
- Measuring Relative Frequency
- Offsetting a Frequency Measurement
- Setting the Power Head Model Number
- Measuring Power
- Measuring Relative Power
- Offsetting a Power Measurement
- Setting the Measurement Rate
- Setting the Number of Averages
- Setting the Resolution
- Measuring Voltage

The following legend defines the meanings of the icons used throughout this chapter.

Legend



1 Press key one time and release

2 Multiple key presses

3 Result

4 Auto operation

5 Connect signal

6 Disconnect signal

7 Indicator off

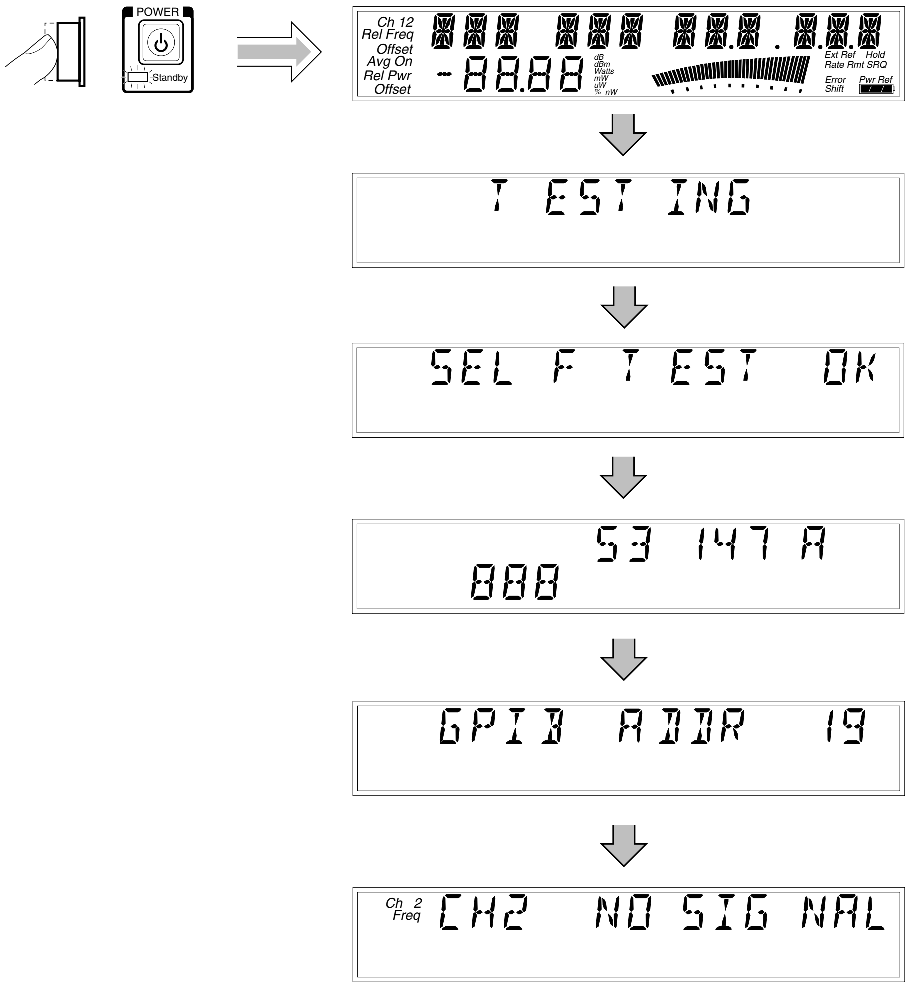
8 Indicator on

9 Indicator flashing

1

Turning the Instrument On

To turn on the instrument, press and release the POWER button on the front panel.



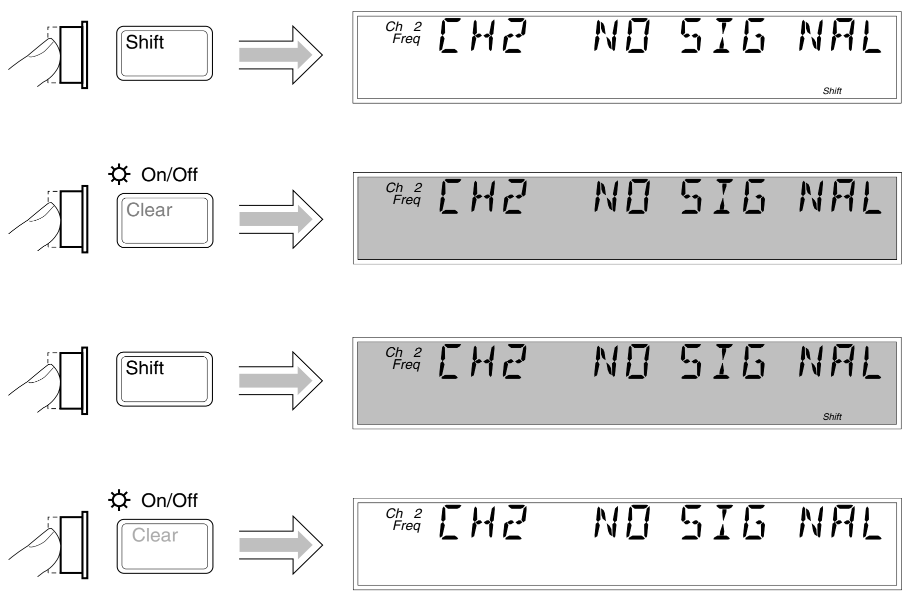
NOTE

If a signal was applied to the Counter’s Channel 2 input connector prior to turning on the instrument, CH2 NO SIGNAL is displayed momentarily. As soon as the Counter acquires the input signal, it displays the signal’s value.

NOTE The internal Reference Oscillator requires 15 minutes to reach a stable operating temperature. Since the Reference Oscillator receives power only when the instrument is on or in Standby mode, no measurements should be taken unless the instrument has been receiving power for at least that amount of time.

Turning the Display Backlight Off or On

When you first turn the instrument on, the backlight for the LCD display is always lit. You can toggle the backlight off and on by pressing the **Shift** key and then the ☼ **On/Off** (**Clear**) key, as shown below.



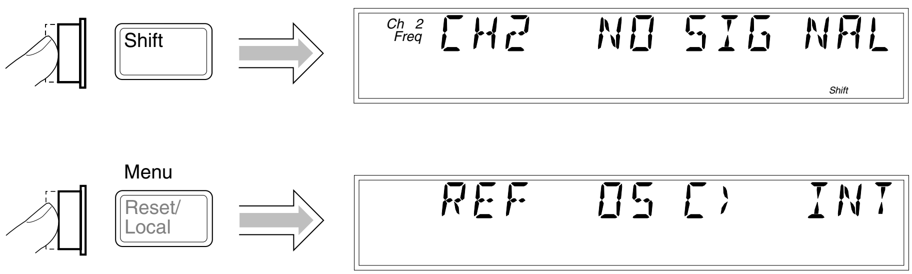
NOTE If your instrument has the Battery option, you can extend the length of time the instrument can operate from the batteries by turning off the display backlight.

Using the Menu

The Agilent 53147A/148A/149A has one menu that you use to control a number of the instrument's features and functions.

Displaying the Menu

To display the Menu, press the **Shift** key and then the **Menu** (**Reset/Local**) key, as shown below.

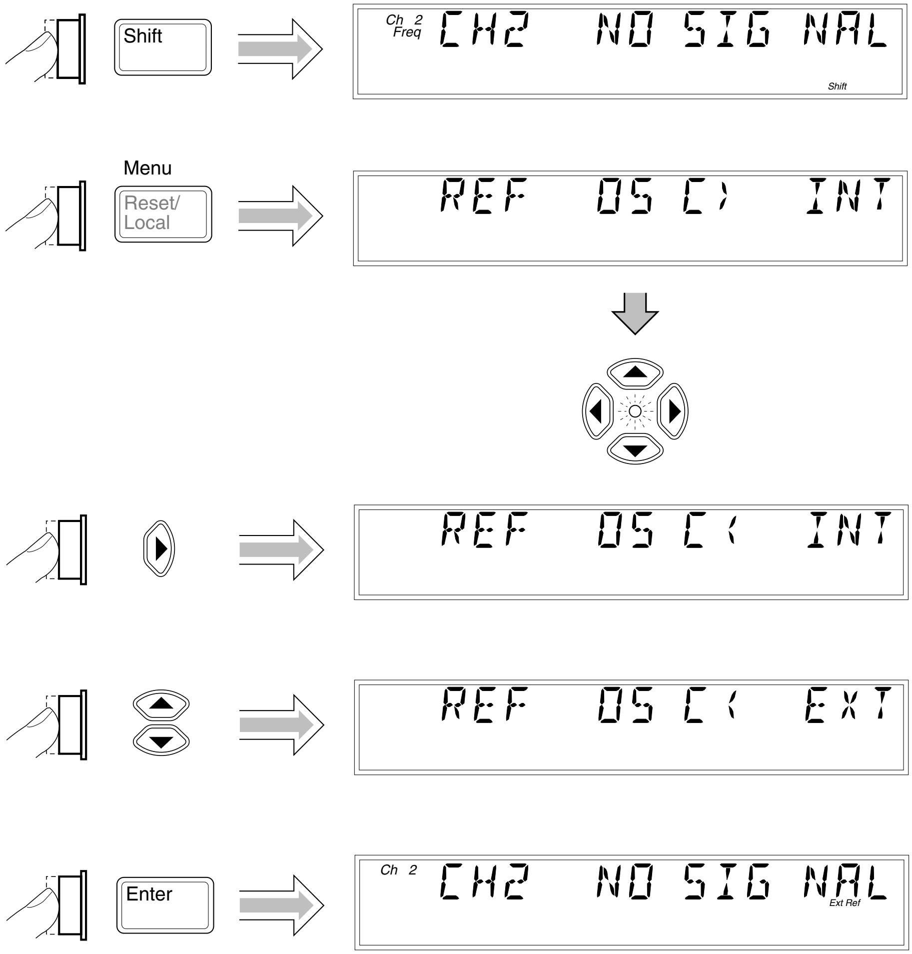


Navigating in the Menu and Changing Settings

Use the Selection (arrow) keys to navigate to the setting you want to change and then to actually make the changes. For example, the diagram on the next page shows how to change the setting of the Reference Oscillator from INTernal to EXTernal. (In this example, a reference signal is applied to the External Reference connector, but no signal is applied to the Channel 2 input.)

NOTE

The instrument does not switch to EXTernal unless a suitable reference signal is available at the External Reference connector.



When you select the Menu, the indicator between the arrow keys flashes to indicate that the arrow keys are now active. Since the Reference Oscillator setting is the first one displayed when you invoke the Menu (unless you've used the Menu to change another setting since you turned the instrument on), you don't have to use the (up-arrow) key or the (down-arrow) key to get to it.

When you press the ▶ (right-arrow) key, the flashing annunciator ( ) changes direction, and the current setting for the Reference Oscillator (INT [internal] or EXT [external]) flashes. This indicates that you can now change this setting. Use either the up-arrow key or the down-arrow key to change the setting.

If there are more than two settings available for the currently selected function, you can cycle through the available settings by repeatedly pressing either the up-arrow key or the down-arrow key. For example, to change the setting for the Baud rate for the serial port, use the sequence on the next page.

Press either the **Enter** key or the left arrow key to accept the currently displayed setting. The **Enter** key accepts the setting and exits the Menu; the left arrow key accepts the setting but does not exit the Menu. Use the left arrow key to accept a setting if you want to change additional menu settings. The **Clear** key reverses an unaccepted setting change.

1

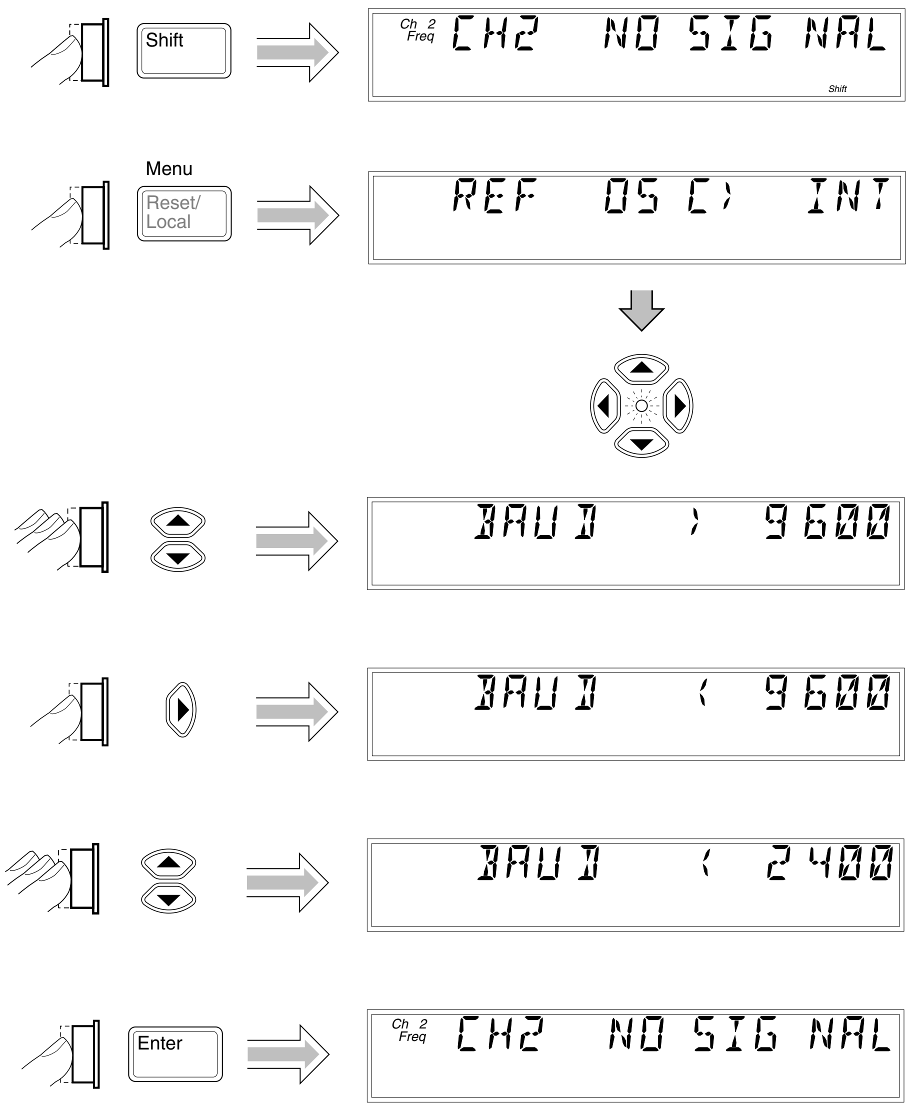
You navigate to and adjust the remaining settings available in the Menu in the manner described above. The Menu also contains some items that provide information only (no settings are required [or possible] for these), such as Battery Voltage, Operation Hours, and information that identifies the instrument (Agilent model number, firmware version number, serial number, and installed option codes). These menu options and the ones described below are shown in “The Front Panel Menus at a Glance” on page 1-5.

There is also a menu item called Preset and one called Do Self Test. If you press the **Enter** key while PRESET is displayed, all of the instrument’s settings are returned to the factory-default settings. If you press **Enter** while DO SELF TEST is displayed, the instrument repeats the tests that are normally performed when the instrument is first turned on.

NOTE

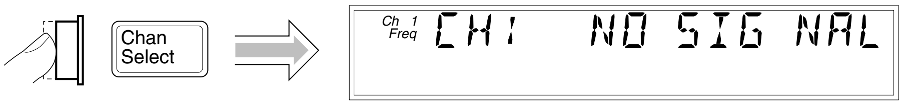
Remember to terminate each value you change in any of the menu options by pressing the **Enter** key or the left arrow key. You can abort a change to any menu option while the Menu is displayed by pressing the **Reset/Local** key or the **Clear** key. Both keys nullify any changes you made to the current menu option, but they do not affect any changes to other menu options. The **Clear** key terminates the current menu session, but the **Reset/Local** key does not.

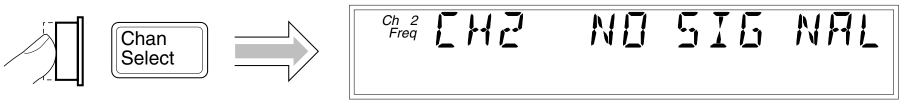
Setting the Serial Port Baud Rate (Menu Example)



Selecting the Counter Input Channel

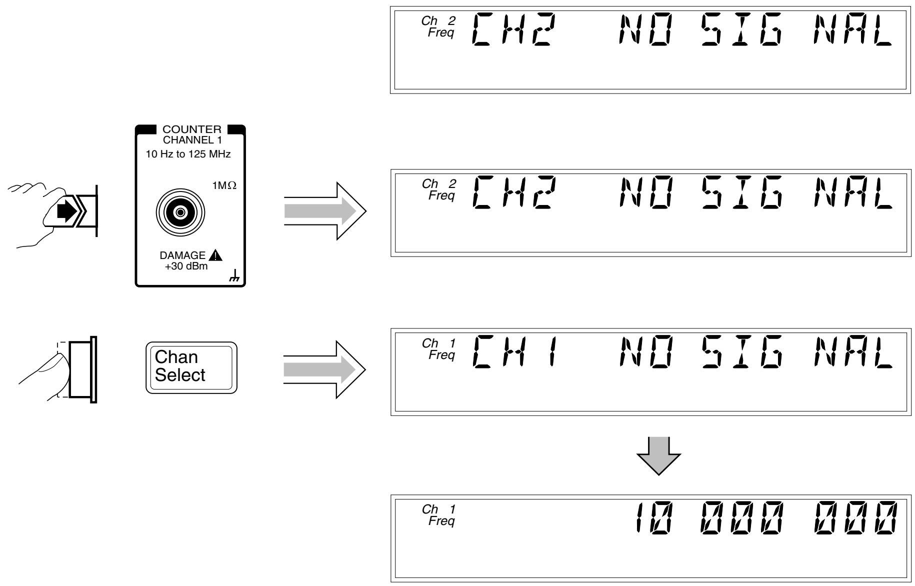
You can toggle between Counter Channels 1 and 2 by pressing the **Chan Select** key.





Measuring Frequency

The following diagram shows the basic sequence to use to make a frequency measurement using Channel 1. This example assumes that the instrument is on and has completed the Self Test. For the purposes of this example, use the 10 MHz reference output on the instrument's rear panel as a signal source for input to Counter Channel 1.



The same procedure applies to making a basic frequency measurement on Channel 2. However, since Channel 2 is automatically selected when you turn on the instrument, the channel-selection step is unnecessary (unless you previously selected Channel 1).

CAUTION

The Channel 2 input path circuits contain sensitive GaAs semiconductors. To prevent damage to these components, always adhere to standard ESD (Electro-Static Discharge) prevention procedures, and ensure that the maximum power specification for this channel (+27 dBm) is not exceeded.

NOTES

- The Counter displays CH2 NO SIGNAL or CH1 NO SIGNAL and shuts down all unnecessary circuits when a signal of insufficient amplitude (or no signal) is applied to the corresponding input. This lowers the power consumption, and if the Battery option is installed, it extends the length of time the instrument can operate from the batteries.

- When the frequency of a signal applied to the Channel 2 input exceeds the maximum rated frequency for the Counter, it displays CH2 TOO HIGH.

- The DVM uses the same portion of the display to display voltage measurements that the instrument uses to display frequency measurements. Therefore, the DVM and the Counter cannot display measurements simultaneously. Pressing the **Display DVM** key toggles the upper portion of the display between the DVM and the Counter.

CAUTION

The 2.9 mm Planar Crown* connector used for the Channel 2 input on the Agilent 53149A must be handled with care to prevent damage and/or contamination, especially since it acts as a wave guide as well as an electrical connection. Observe the following precautions when handling this connector:

1. If you remove the outer portion of the connector, do not touch the exposed surfaces of either part of the connector with your bare skin or any material that is not intended for cleaning this type of connector.

2. Avoid dropping or striking either portion of the connector.

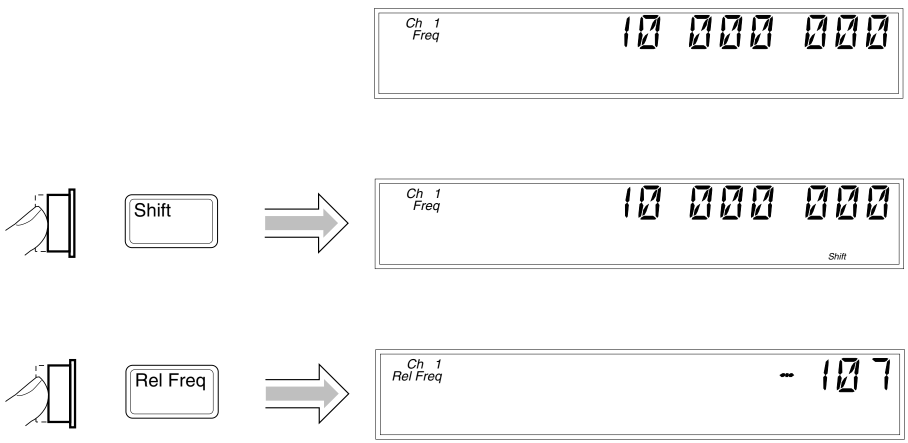
If the connector becomes contaminated, it can be cleaned with isopropyl alcohol and a lint-free cloth or other suitable cleaning implement.

* *Planar Crown® is a registered trademark of Weinschel Corp.*

Measuring Relative Frequency

You can measure the difference in frequency from one measurement to another (drift) using the Relative Frequency function. You do this by pressing the **Shift** and **Rel Freq** (**Offset On/Off**) keys as shown in the diagram below (this example assumes that a signal is currently applied to Channel 1).

The Counter stores the current frequency reading when you press the **Rel Freq** key. It then subtracts this value from all subsequent readings and displays the difference until you press the **Rel Freq** key again.



NOTE If the input signal fluctuates, the value displayed varies as the Counter continues to take measurements. You can vary the speed at which measurements are taken by varying the settings for Rate and Resolution (see “Setting the Measurement Rate” and “Setting the Resolution for Frequency Measurements” on pages 1-29 and 1-31).

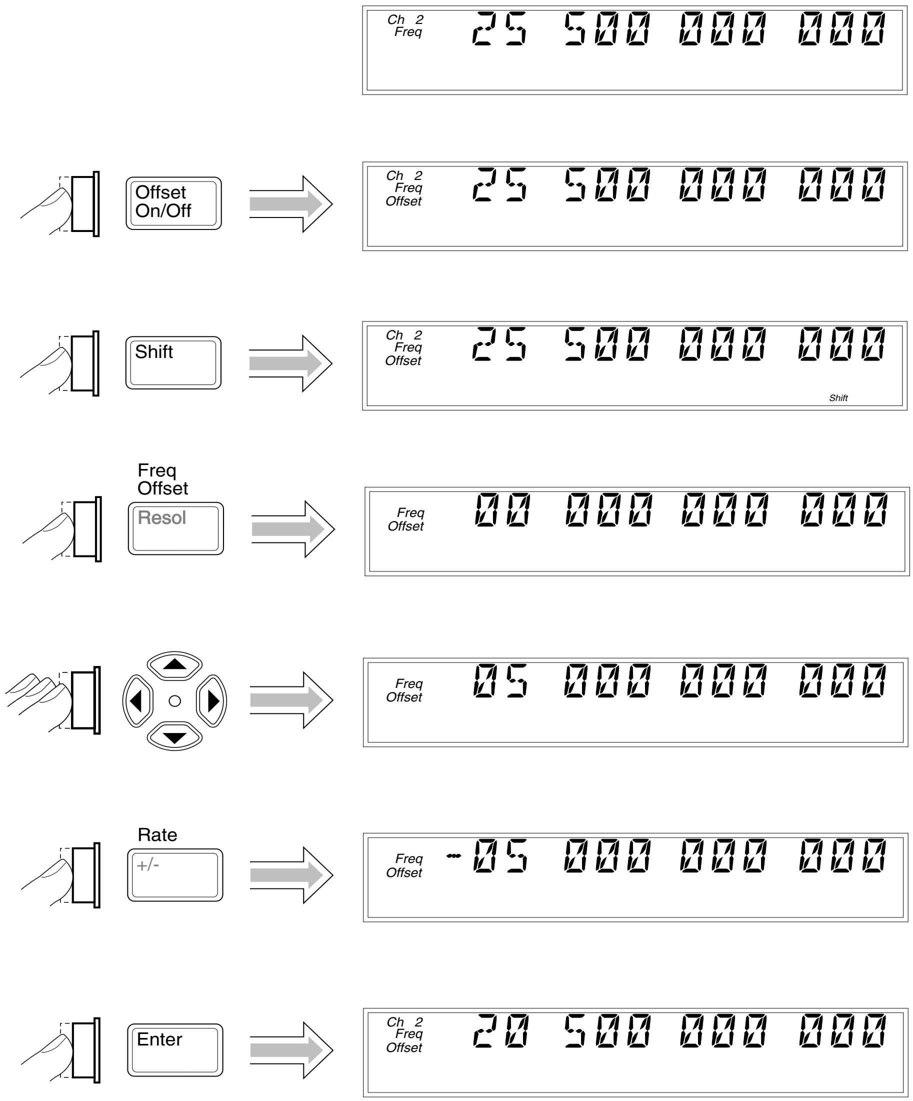
Offsetting a Frequency Measurement

You can use the Frequency Offset (Freq Offset) function to add or subtract a constant value to/from a frequency measurement. For example, you can use an offset to compensate for a systematic error or to display the difference in frequency between two signals.

NOTE The Frequency Offset and Relative Frequency functions can be used simultaneously.

To display an offset frequency measurement, you need to set the value and sign (**+/–**) of the offset and to turn the Frequency Offset function on. In the diagram on the next page, the Frequency Offset function is enabled first, and the offset value is then entered. However, the order doesn't matter, so you can also enter the offset value first, and then turn the offset function on.

NOTE When you are entering a value for Frequency Offset (or Power Offset), you can use the **Reset** key to restore all of the displayed digits to zero. These are the only two functions in which the **Reset** key has this effect.


Ch 2 Freq
25 500 000 000
Offset On/Off
Ch 2 Freq Offset
25 500 000 000
Shift
Ch 2 Freq Offset
25 500 000 000
Shift
Freq Offset
Resol
Freq Offset
00 000 000 000
Freq Offset
05 000 000 000
Rate
+/-
Freq Offset
-05 000 000 000
Enter
Ch 2 Freq Offset
20 500 000 000

Measuring Power

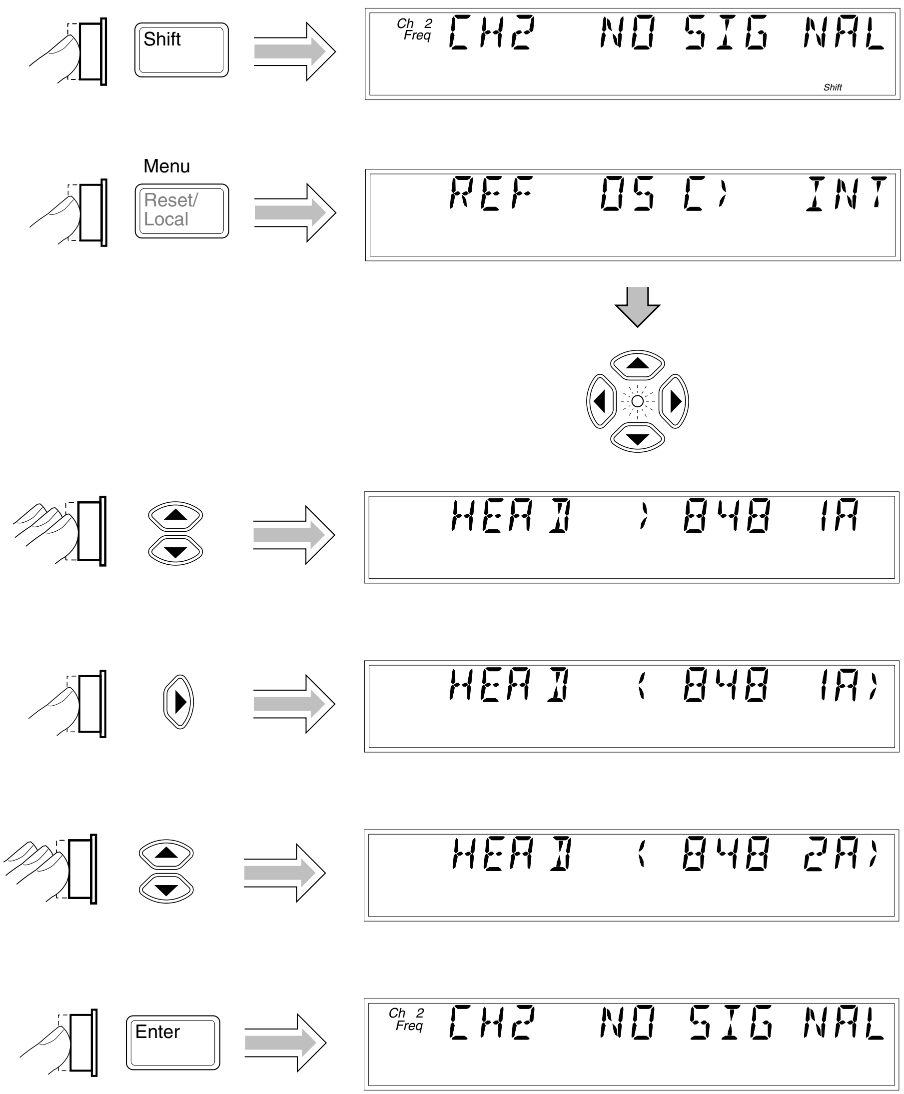
The Agilent 53147A/148A/149A can measure signal power (the power and frequency ranges for power measurement are dependent on the power-sensor model used). To measure power, you must first set the Power Meter for the power-meter sensor (head) that you intend to use.

Selecting a Power Meter Head (Sensor) Model

The example procedure in the following diagram shows how to select the model number of the power-meter head (sensor). This procedure assumes that the Power Meter is currently set to use a model 8481A power sensor and that you intend to use a model 8482A power sensor.

NOTE

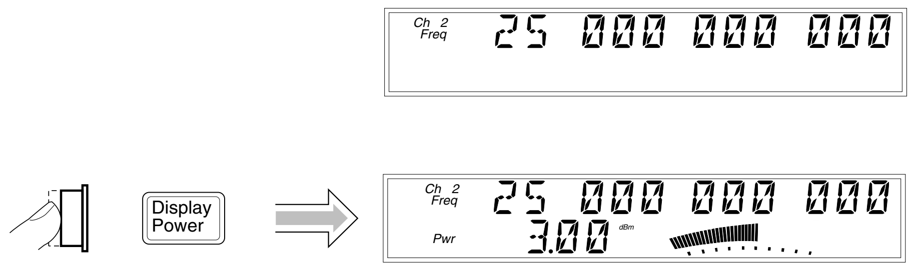
When you select a power head (sensor), you are implementing a preconfigured calibration table for that head. There are five preconfigured tables (for head models 8481A, 8481D, 8482A, 8485A, and 8487A) and three custom calibration tables (CUST 1, CUST 2, and CUST 3). You can modify the frequency/calibration-factor values in any of the data points for any power head, add data points to any configuration table (up to a maximum of 100 data points per table), and input data to build new calibration tables by selecting CUST 1, CUST 2, and/or CUST 3. Complete instructions for modifying and adding calibration tables are provided in “Modifying and Adding Calibration Factor Tables” on page 2-27.


Shift
Ch 2 Freq
CH2 NO SIGNAL
Shift
Menu
Reset/ Local
REF OSC) INT
HEAD) 848 1A
HEAD (848 1A)
HEAD (848 2A)
Enter
Ch 2 Freq
CH2 NO SIGNAL

Measuring Power

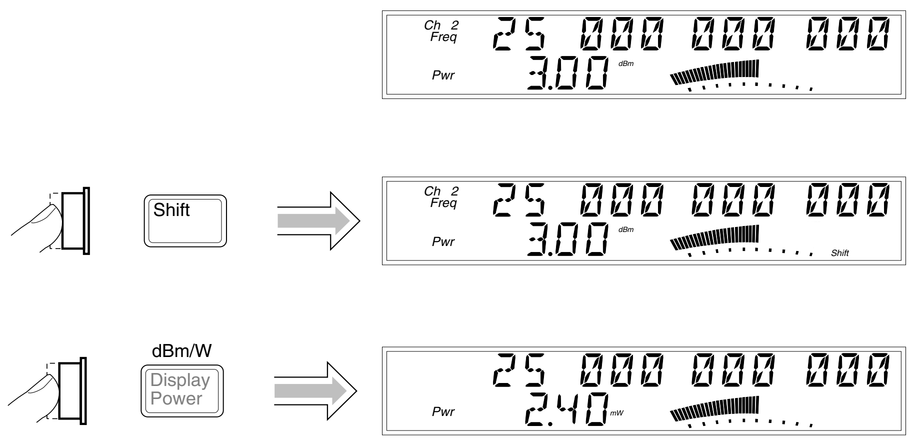
The procedure for measuring power that is illustrated in the following diagram assumes that the power-sensor head being used has been selected in the instrument’s menu and that the signal to be measured is connected to the head.

NOTE When the power of a signal applied to the Power Meter Input connector exceeds the maximum rated power for the Power Meter head, the Power Meter displays HI.



Selecting the Unit of Measurement for Power

The instrument's power meter can display values in either of two sets of units of measurement—dB and dBm or Watts, mW, µW, and nW (the power meter automatically selects the most appropriate unit of measurement when Watts is selected). Use the procedure in the following diagram to select the unit of measurement for power (this procedure assumes that a signal is currently applied to the power meter and that power is being displayed):



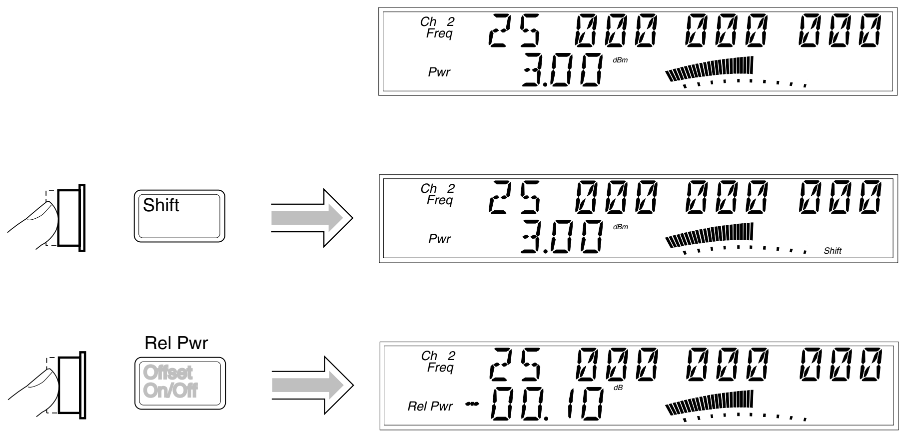
NOTE

If a signal having an amplitude that exceeds the Power Meter specifications is applied, and power measurement is enabled, the annunciators for the power reading display "HI" to indicate that the signal's amplitude exceeds the specification. If a signal having an amplitude below the minimum specification is applied, the power annunciators display "LO" to indicate that the signal level is too low to be measured by this Power Meter.

Measuring Relative Power

You can measure the difference in power from one measurement to another (drift) using the Relative Power function. You do this by pressing the **Shift** and **Rel Pwr** (**Offset On/Off**) keys, as shown in the diagram below (this example assumes that a signal is currently applied to the Power Meter input connector).

The Power Meter stores the current power reading when you press the **Rel Pwr** key. It then subtracts this value from all subsequent readings and displays the difference until you press the **Rel Pwr** key again.

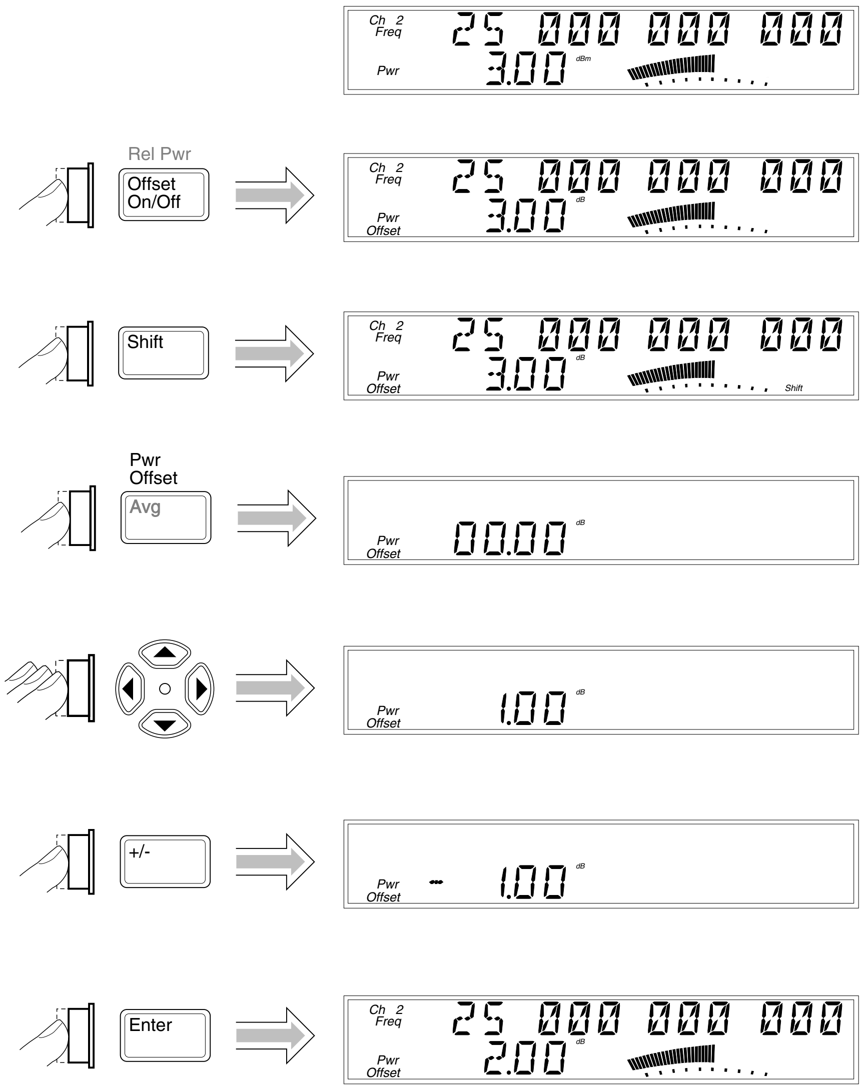


Offsetting a Power Measurement

You can use the Power Offset (Pwr Offset) function to add or subtract a constant value to/from a power measurement. For example, you can use an offset to compensate for a systematic error or to display the difference in power between two signals.

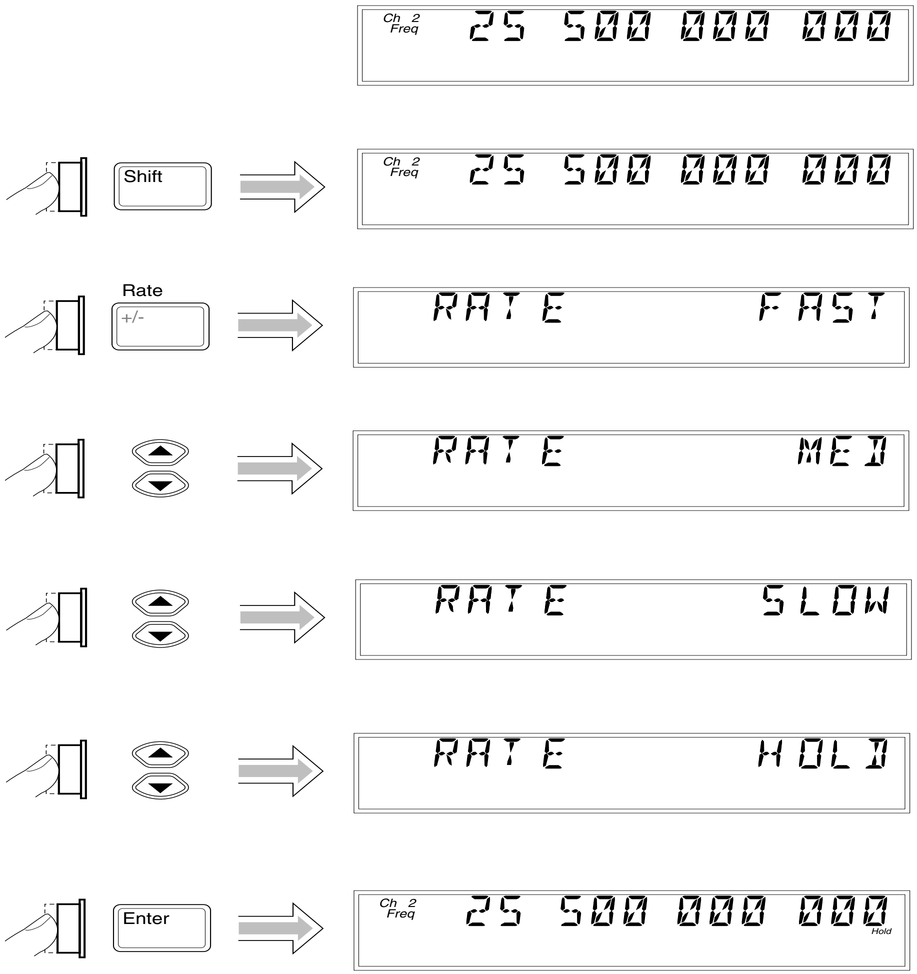
NOTE The Power Offset and Relative Power functions can be used simultaneously.

To display an offset power measurement, you need to set the value and sign (**+/–**) of the offset and to turn the Power Offset function on. In the following diagram, the Power Offset function is enabled first, and the offset value is then entered. However, the order doesn't matter, so you can also enter the offset value first, and then turn the offset function on.



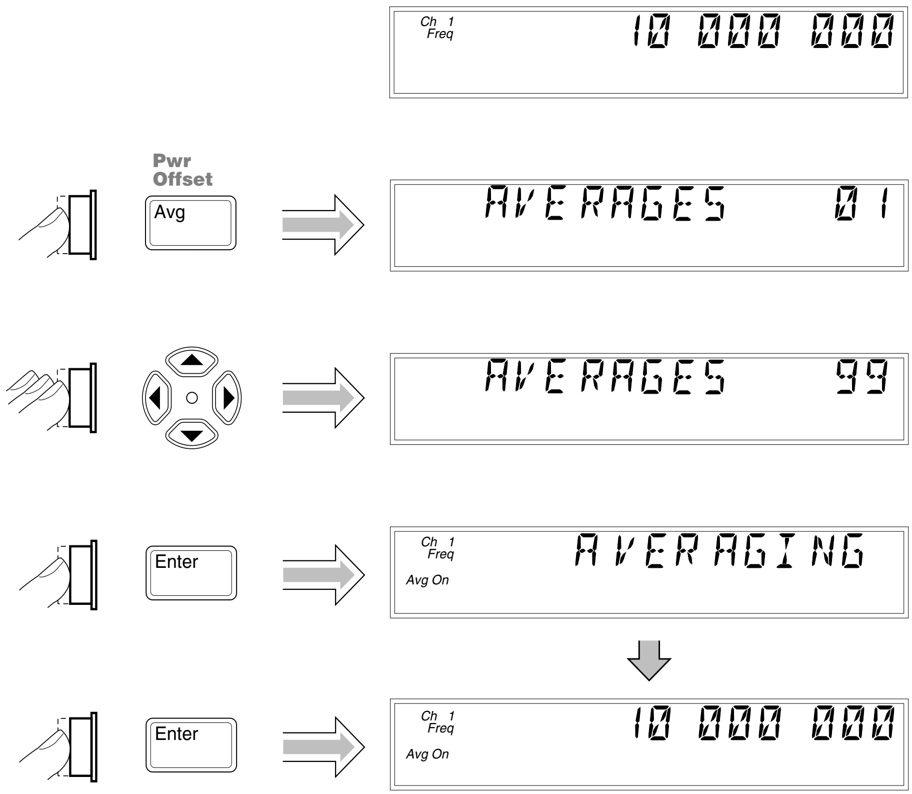
Setting the Measurement Rate

The measurement rate determines how frequently the instrument takes measurements (frequency, power, and/or voltage). You can set the measurement rate to FAST, MED (medium), SLOW, or HOLD (single measurement taken each time you press the **Reset/Local** key).



Setting the Number of Averages

You can set the number of frequency, power, and/or voltage measurements the instrument takes and averages before displaying the result. The default setting is one (no averages are performed), and the maximum setting is 99. Note that the tens position (10 through 90) and the units position (0 through 9) are adjusted separately, and that you cannot set the number of averages to zero.



NOTE

For most of the instrument's settings, when you continue to press either the up-arrow or the down-arrow key when you reach the end of the available settings, the value for the setting "rolls over" to the value at the opposite end of the range. For example, if the GPIB address is set to 31, and you press the up-arrow key, the value changes to one.

However, when you adjust the value in the units position for the number of measurements to be averaged, rollover does not occur. If you press the up-arrow when the value in the tens position is zero and the value in the units position is nine, or if you press the down-arrow when the value in the tens position is zero and the value in the units position is one, there is no change. If the value in the units position could roll over (in either direction), it would allow you to set a value of zero for the number of averages. Since at least one measurement must be taken, zero is an illegal value.

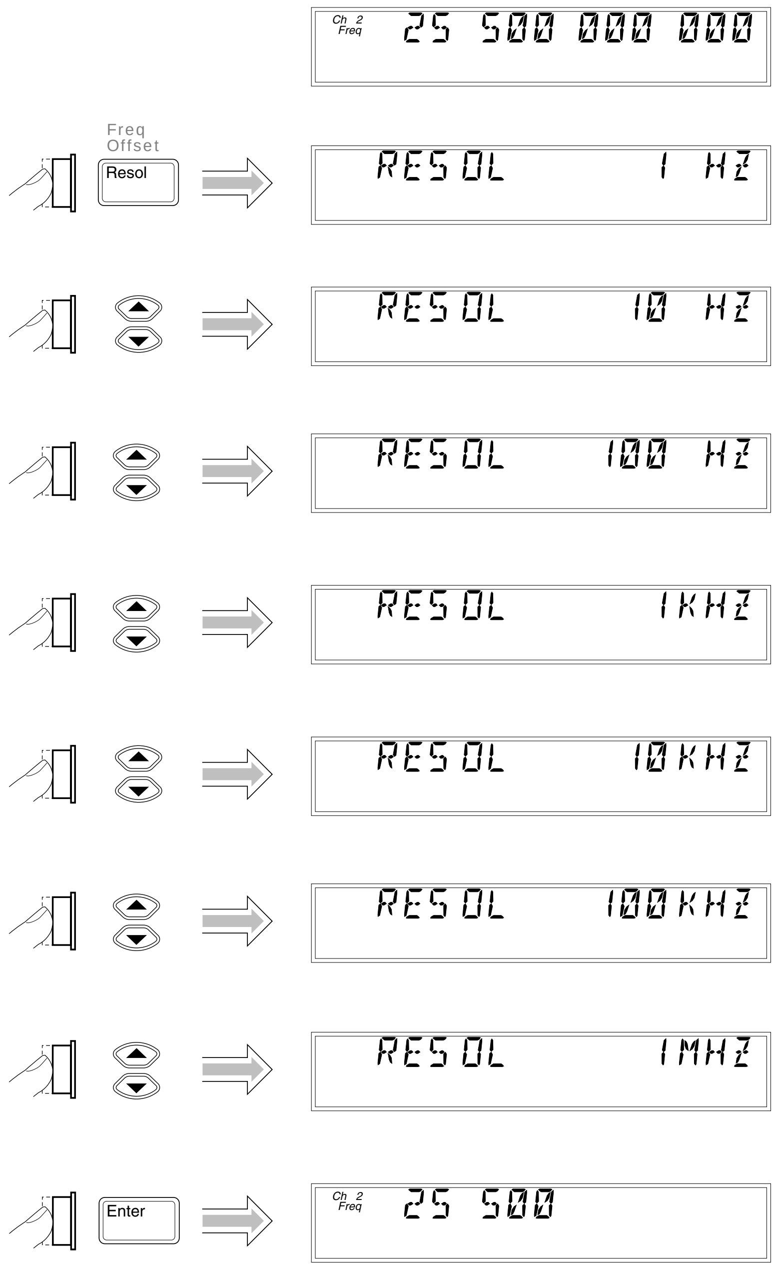
NOTE

When the resolution setting is high (e.g., 1 Hz), and a large number of averages is selected, it takes a considerable amount of time for the instrument to take the measurements, compute the averages, and display a reading. As a result, the rate at which the display is updated is considerably slower than at small numbers of averages and lower resolution settings. For example, when the resolution is set to 1 Hz, and the number of averages is set to 60, a new reading is displayed every 60 seconds (approximately).

Setting the Resolution for Frequency Measurements

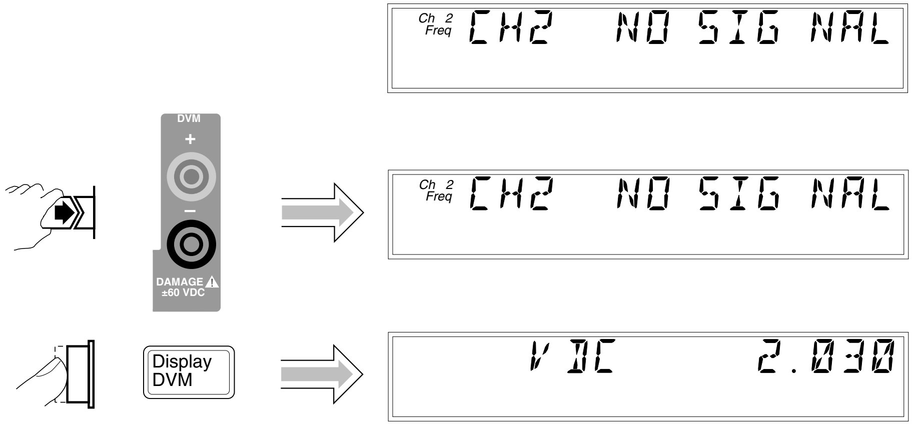
Since less time is required to complete each measurement as the resolution of the measurements is reduced, the resolution setting affects the rate at which measurements are taken and displayed, as well as the number of digits displayed for the measurements. As a result, the rate at which the Gate indicator flashes changes when you change the resolution.

As shown in the procedure in the diagram on the next page, the available resolution settings are 1 Hz (the default setting), 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, and 1 MHz.


Ch 2
Freq
25 500 000 000
Freq
Offset
Resol
RESOL 1 HZ
RESOL 10 HZ
RESOL 100 HZ
RESOL 1KHZ
RESOL 10KHZ
RESOL 100KHZ
RESOL 1MHZ
Enter
Ch 2
Freq
25 500

Measuring Voltage

To measure voltage, press the **Display DVM** key, connect the red DVM test lead to the red + DVM connector, connect the black DVM test lead to the black – DVM connector, and touch the red and black test prods to the source of the voltage you want to measure.



If the positive test lead is applied to a positive voltage source, and the negative lead is applied to a return for that source, the meter indicates the positive value (+) of the voltage. If the positive test lead is applied to a negative voltage source, and the negative lead is applied to a return for that source, the meter indicates the negative value (–) of the voltage.

NOTE

The DVM automatically selects the appropriate voltage range to display the measurement with maximum accuracy, and it automatically determines and displays the polarity of the voltage measured.

CAUTION

The 53147A/148A/149A DVM can measure voltages up to ± 50VDC. Applying voltages outside of the ± 60VDC range to the DVM inputs can damage the DVM.

2

Operating Your Instrument

Introduction

This chapter contains information and usage procedures for the front-panel keys, operating functions, and menus of the Agilent 53147A, 53148A, and 53149A.

Chapter Summary

How this Instrument Works for You

The following is a list of some of the key things the instrument does for you.

- Presets the menus to default states and values at power-up.
- The instrument's **Menu** key and other front-panel keys allow you to select such things as the timebase source, the GPIB address, and the RS-232 serial-port baud rate. The instrument also allows you to store your selections in non-volatile memory; thus, these settings are not lost when power has been off or after a remote-interface reset.
- Automatically displays measurement(s) when you have selected a measurement function.
- Accepts your entry for a menu item when you press the **Enter** key. You *must* press the **Enter** key to complete each setting and/or selection.
- Saves user configuration settings.

Summary of the Measurement Sequence

1. Connect the power cord to the instrument and to an appropriate power source (or, if the instrument has the Battery option, turn on the Battery Power switch), and then press and release the POWER button on the front panel.

NOTE

The internal Reference Oscillator receives power whenever the power cord is connected to a power source. Therefore, if the instrument has just been connected to a power source, the frequency of the reference signal may drift until the oscillator stabilizes. Specifications for the stability of the standard internal timebase and the optional Oven Timebase are provided in Chapter 3.

2. Connect the input signal to the appropriate input connector (Counter Channel 1, Counter Channel 2, Power Meter input, or DVM input).
3. Connect an external reference signal to the External Reference connector on the back panel (if desired).
4. Press the **Chan Select** key, the **Display Power** key, and/or the **Display DVM** key to select the measurement function (if necessary).
5. Press the **Freq Offset** key and/or the Power Meter **Offset On/Off** key(s) to enable offset measurements (if desired), and then use the **Freq Offset** (**Shift** + **Resol**) and/or **Pwr Offset** (**Shift** + **Avg**) keys to enter the offset values.
6. Use the **Resol**, **Rate** (**Shift** + **+/–**), and **Avg** keys to configure the display.
7. Use the **Menu** (**Shift** + **Reset/Local**) key to set the reference-oscillator source, to select the Channel 1 low-pass filter, to configure the Counter's response to frequency modulation, to select a Power Meter head, and/or to select a previously saved set of user settings.
8. If you intend to operate the instrument remotely using the GPIB, use the **Menu** (**Shift** + **Reset/Local**) key to set the GPIB address.
9. If you intend to operate the instrument remotely using the serial interface, use the **Menu** (**Shift** + **Reset/Local**) key to adjust the serial port Baud rate.

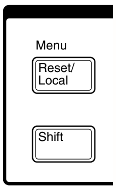
2

Using the Selection Keys

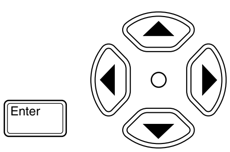
There are six Selection keys—four “arrow” keys, the **Enter** key, and the sign (**+/–**) key. The functions of the arrow keys depend on the instrument’s operating mode (i.e., sequencing through choices in the Menu, numeric entry, state change, etc.). This section describes how the Selection keys function in these different operating modes.

Sequencing Through the Menu

To access the Menu, press the **Shift** key, and then press the **Menu** (**Reset/Local**) key.



- Press the up- or down-arrow key to go forward to the next menu function or back to the previous menu function. Pressing either of these keys repeatedly cycles through the list of menu functions.
- Press the right-arrow key to select a function. When you do this, the flashing annunciator ( ) changes direction and the current setting flashes to indicate that you can now use the up- and down-arrow keys to cycle through the available settings.



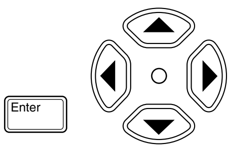
- Press the up- or down-arrow key to move through the list of available settings for a function. Pressing either of these keys repeatedly cycles through the list of settings.
- Press the Sign (**+/–**) key to change the sign of numeric values.
- Press the **Enter** key to accept the currently displayed setting and exit the Menu.

NOTE

In most cases, when you reach the top or bottom of a list of settings, or the left or right end of a numerical field, the focus rolls over to the opposite end of the list of settings, or wraps around to the opposite end of the numeric field. In some situations, however, this does not occur, because if it did, you could choose an illegal setting. For these settings, you have to use the opposite button to cycle back through the values or settings.

Numeric Entry

Several menu functions, and several functions that have dedicated keys on the front panel, require you to enter numeric values.



- Press the (left-arrow) and (right-arrow) keys to move left and right to select adjustable digits (the selected digit flashes).
- Press the (up-arrow) and/or (down-arrow) key to increment and decrement the selected (flashing) digit of the displayed value (see note on previous page).
- Press the Sign (**+/–**) key to change the sign of the numeric value.
- Press the **Enter** key to complete a numeric entry. (If you change the value of a numeric entry, but you forget to press the **Enter** key, the value of the entry is *not* changed.)

Changing States

Several menu functions, and several functions that have dedicated keys on the front panel, require you to choose from a list of available states. These functions and the states you can choose for each of them are:

- Reference Oscillator (REF OSC)
  - Internal (INT)
  - External (EXT)
- Serial Port Baud Rate (BAUD)
  - 1200
  - 2400
  - 4800
  - 9600
  - 14400
  - 19200
- Frequency Modulation (FM)
  - Automatic (AUTO)
  - Off (OFF)

- Channel 1 Low-Pass Filter (CH1 LPF)
  - On (ON)
  - Off (OFF)
- Measurement Rate (**Rate** key)
  - Fast (FAST)
  - Medium (MED)
  - Slow (SLOW)
  - Hold (HOLD)
- Resolution (**Resol** key)
  - 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz

Use the Selection keys as described below to change the state of these functions:

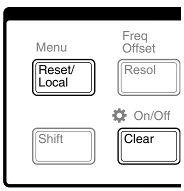
- When the annunciator ( ) in the display flashes, press the right-arrow key to move the focus from the displayed menu function (or front-panel-key function) to the setting for that function.
- Press the up- or down-arrow key to cycle through the available choices.

Press the **Enter** key to complete the setting. (If you change the setting of a function, but you forget to press the **Enter** key, the setting of the function is *not* changed.)

NOTE

The Sign key has no function and is ignored in menu selections and front-panel functions that have state-change selections only.

Using the **Clear** and **Reset/Local** Keys



The **Clear** and **Reset/Local** keys have similar functions in the Menu and in other front-panel-key function settings, but their effects vary with the instrument's state and condition. In general, the **Reset/Local** key restores the setting that was in effect when you entered the Menu or front-panel-key function, but it does not close the Menu or the function-setting display. The **Clear** key also restores the previous setting, but it closes the Menu or the front-panel-key function-setting display at the same time.

If you press the **Reset/Local** key while the instrument is taking measurements, it resets the current operation and forces the instrument to reacquire and re-measure the signal.

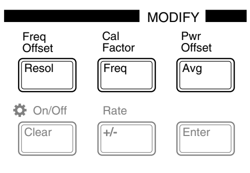
Pressing the **Reset/Local** key while the instrument is in Remote Mode forces the instrument into Local Mode and enables all of the front-panel controls.

Acknowledging Messages

When a message is displayed, press the **Reset/Local** key, the **Clear** key, or the **Enter** key (after reading the message) to acknowledge it and erase it from the display.

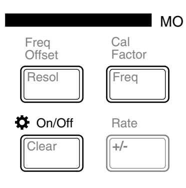
Other Function Selection Keys

There are several functions that you access directly from front-panel keys (not from within the Menu). These functions, which are all in the MODIFY section of the front panel, are:

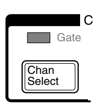


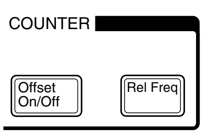
- Display Resolution (**Resol** key)
- Frequency Offset (**Freq Offset** — **Shift** + **Resol** key)
- Frequency (**Freq** key)
- Calibration Factor (**Cal Factor** — **Shift** + **Freq** key)
- Measurement Rate (**Rate** — **Shift** + **+/–** key)
- Number of Averages (**Avg** key)
- Power Offset (**Pwr Offset** — **Shift** + **Avg** key)

Use the Selection keys in the manner described earlier in this chapter (see “Numeric Entry” and “Changing States”) to adjust the settings for these functions. Detailed procedures for using the **Resol**, **Freq Offset**, **Freq**, **Cal Factor**, **Rate**, and **Avg** keys are provided later in this chapter.



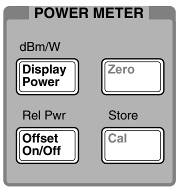
There are also a number of functions that are toggled between states (no selections or numerical-entry fields are displayed) using named front-panel keys. These are:



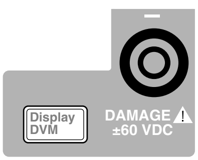


- Display backlight on or off (MODIFY: ✲ **On/Off**). Press **Shift**, and then press ✲ **On/Off** (the **Clear** key in the MODIFY section of the front panel).
- Frequency channel selection (COUNTER: **Chan Select**). Press the **Chan Select** key in the COUNTER section of the front panel to toggle between the two Counter input channels.
- Frequency offset measurement (COUNTER: **Offset On/Off**). Press the **Offset On/Off** key in the COUNTER section of the front panel to turn the frequency offset function on or off.
- Relative frequency measurement (COUNTER: **Rel Freq**). Press the **Rel Freq** key in the COUNTER section of the front panel to measure the difference in frequency between the current measurement and the measurement taken at the time you pressed the **Rel Freq** key (drift).

- Display power measurement (POWER METER: **Display Power**). Press the **Display Power** key in the POWER METER section of the front panel to turn the power measurement function on and off.



- Power offset (POWER METER: **Offset On/Off**). To turn the power offset function on or off, press the **Offset On/Off** key in the POWER METER section of the front panel (**Display Power** must be selected).
- Relative power measurement (POWER METER: **Rel Pwr — Shift** + **Offset On/Off**). Press **Shift**, and then press the **Rel Pwr** key (the **Offset On/Off** key in the POWER METER section of the front panel) to measure the difference in power between the current measurement and the measurement taken at the time you pressed the **Rel Pwr** key.
- Unit of measurement for power (POWER METER: **dBm/W — Shift** + **Display Power**). To toggle between measuring power in dBm and in Watts, press the Shift key, and then press the **dBm/W** key (the **Display Power** key in the POWER METER section of the front panel).



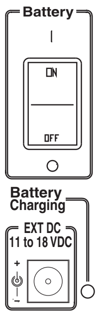
- Display voltage measurement (DVM: **Display DVM**). Press the **Display DVM** key in the DVM section of the front panel to turn the voltage measurement function on and off.

2

NOTE

The Counter is active by default, so the **Display DVM** key toggles the upper portion of the display between voltage measurement and frequency measurement. Frequency and power measurements can be displayed simultaneously, as can voltage and power measurements. Frequency measurements and voltage measurements can be displayed alone, but power measurements are always accompanied by either the frequency display or the voltage display.

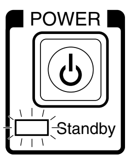
Measuring Frequency



1 **Connect the instrument to a power source.**

When the instrument is connected to an AC power source, the Standby indicator on the front panel lights. The Standby indicator also lights if the instrument is connected to an external DC power source or is operated from internal batteries and the battery power switch is on (with the Battery option only).

2 **Press the POWER button on the front panel.**

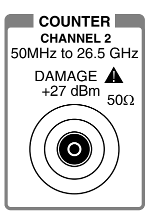


The Standby indicator goes off, and all segments of the front-panel display are temporarily activated. TESTING is displayed while the instrument performs its power-on self-test. If the instrument passes all of the tests, SELF TEST OK is displayed, and the instrument then displays its model number, firmware version number, GPIB address, and CH2 NO SIGNAL. The Counter is now ready to measure the frequency of a signal applied to the Channel 2 input. Note that the Ch 2 and Freq annunciators are activated.

3 **Connect an input signal to Channel 2**.

CAUTION

The Channel 2 input path circuits contain sensitive GaAs semiconductors. To prevent damage to these components, always adhere to standard ESD (ElectroStatic Discharge) prevention procedures, and ensure that the maximum power specification for this channel (+27 dBm) is not exceeded.

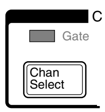


The Counter automatically displays the measured frequency of the input signal. To set the resolution, measurement rate, and/or the number of averages, see the appropriate procedure in the section titled “Operating the Instrument,” or refer to “Setting the Resolution,” “Setting the Measurement Rate,” and “Setting the Number of Averages,” later in this chapter.

NOTE

When the frequency of a signal applied to the Channel 2 input exceeds the maximum rated frequency for the Counter, the Counter displays CH2 TOO HIGH.

4 To measure the frequency of a signal applied to the Channel 1 input, press the Chan Select key.



CHANNEL 1 is displayed momentarily, and the Ch 1 and Freq annunciators are activated. If a signal is presently applied to the Channel 1 input, the measured frequency is then displayed. If no signal is applied, CH1 NO SIGNAL is displayed until an input signal is connected to the Channel 1 input connector.

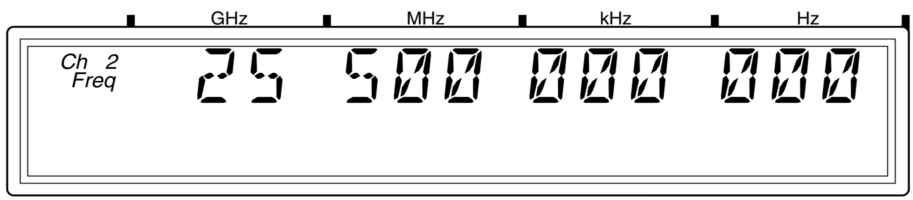
Setting the Resolution and Measurement Rate

The number of measurements the Counter makes in a given amount of time is affected by the Rate setting, the Resolution setting, and the quality of the input signal (signal quality affects the amount of time the Counter requires to determine an accurate measurement). By adjusting the Resolution and Rate settings, you can affect how often the Counter takes measurements.

Setting the Resolution

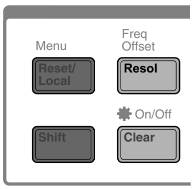
The Counter's resolution setting determines the number of digits displayed for measurements and the precision of the measurements. Since less time is required to compute each measurement as the resolution of the measurements is reduced, the resolution setting also affects the rate at which measurements are taken and displayed. As a result, the flash rate of the Gate indicator changes when you change the resolution.

The numerals shown for the value of the measurement are displayed in four groups of three digits, as shown below (the leading zero is suppressed):



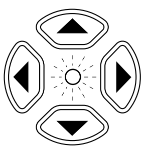
Resolution Setting Example

For the following example, use the 10 MHz output from the reference timebase as the input to Channel 1.



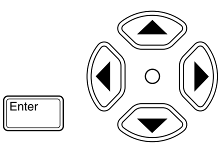
1 Press the Resol key to enter the resolution-setting mode.

The current resolution setting is displayed (the current value and the indicator between the arrow keys are flashing to indicate that you can use the up- and down-arrow keys to change the setting).



2 Press the up-arrow or down-arrow key to decrease or increase the resolution.

You can press these keys as many times as necessary to locate the setting you want to use. The available resolution settings are 1 Hz (the default), 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, and 1 MHz.



3 Press the Enter key to activate your setting and exit the resolution-setting mode.

The setting you chose is now in effect. The number of digits displayed for the measurement is adjusted accordingly; you can observe the affect on measurement speed by monitoring the flash rate of the Gate indicator.

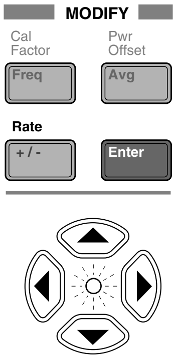
NOTE

The measurement resolution has a direct effect on the amount of time the Counter requires to complete a measurement. Measurements made at the Counter's maximum resolution setting (1 Hz) are noticeably slower than at lower resolutions. This is especially noticeable when the Counter is set to average a number of measurements.

Setting the Measurement Rate

The measurement Rate setting determines how frequently the instrument initiates measurements (frequency, power, and/or voltage). Since the actual measurement rate is also affected by the Counter's resolution setting and the signal quality, as mentioned earlier, the available rate settings (FAST, MED, and SLOW) do not equate to a fixed number of measurements in a given amount of time. The HOLD setting turns off automatic measurements, so that a single measurement is made each time you press the **Reset/Local** key.

Rate Setting Example



1 **Press the Rate key to enter the rate-setting mode.**

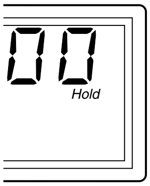
The current rate setting is displayed (the current value and the indicator between the arrow keys are flashing to indicate that you can use the up- and down-arrow keys to change the setting).

2 **Press the up-arrow or down-arrow key to decrease or increase the measurement rate.**

You can press these keys as many times as necessary to locate the setting you want to use. The available resolution settings are FAST, MED, SLOW, and HOLD.

3 **Press the Enter key to activate your setting and exit the rate-setting mode.**

The setting you chose is now in effect. The measurement rate is adjusted accordingly; you can observe the effect on measurement speed by monitoring the flash rate of the Gate indicator. The rate annunciator is activated when either SLOW or MEDIUM is selected for the rate. When you select HOLD, the HOLD annunciator is activated.



4 **If you set the rate to HOLD, press the Reset/Local key to initiate a measurement.**

The instrument computes the measurement and then displays the result (if averaging is enabled, the instrument displays the AVERAGING message while it computes the measurement). Press the **Reset/Local** key again each time you want to take an additional measurement.

2

Setting the Number of Averages

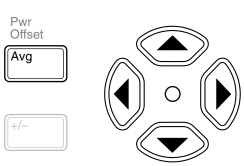
You can set the instrument to take a variable number of frequency, power, or voltage measurements and average them mathematically before displaying the result. You can use this feature to determine the effective measurement of a signal that is fluctuating. When measuring the frequency of a fluctuating signal, you can also use averaging to retain some of the precision of a maximum-resolution measurement.

The default number of averages is 1, which means that no averages are performed, and the maximum setting is 99. Note that the tens position (10 through 90) and the units position (0 through 9) are adjusted separately, and that it is not possible to set the number of averages to 0.

NOTE When a large number of averages is selected for a frequency measurement in combination with a high resolution setting (e.g., 1 Hz), it takes a considerable amount of time for the instrument to take the measurements, compute the averages, and display an initial reading. For example, when the number of averages is set to 60, and the resolution is set to 1 Hz, the first reading is displayed after 60 seconds (approximately). Subsequent computations do not require as much time, since the averaging function computes a running average. However, the rate at which the display is updated after the initial average computation is also slower than at lower resolution settings.

Averages Setting Example

1 Press the Avg key to enter the averages-setting mode.



The current averages setting is displayed (the current value and the indicator between the arrow keys are flashing to indicate that you can use the up- and down-arrow keys to change the setting).

2 Press the up-arrow or down-arrow key to decrease or increase the value for the units position of the number of averages.

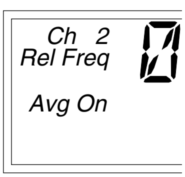
NOTE

For most of the instrument's settings, when you continue to press either the up-arrow or the down-arrow key when you reach the end of the available settings, the value for the setting "rolls over" to the value at the opposite end of the range. For example, if the GPIB address is set to 31, and you press the up-arrow key, the value changes to 1. However, when you adjust the value in the units position for the number of measurements to be averaged, rollover does not occur. If you press the up-arrow when the value in the tens position is 0 and the value in the units position is 9, or if you press the down-arrow when the value in the tens position is 0 and the value in the units position is 1, there is no change. If the value in the units position could roll over (in either direction), it would allow you to set a value of 0 for the number of averages. Since at least one measurement must be taken, 0 is an illegal value.

3 **Press the left-arrow key once to move the focus to the tens position, and then use the up- and/or down-arrow key to set the value for the tens position (if desired)**.

Note that the tens and units values are set separately.

4 **Press the Enter key to activate your setting and exit the averages-setting mode.**



The Avg On annunciator is activated, and the instrument displays AVERAGING while it takes the first set of measurements. The length of time that the AVERAGING message is displayed varies primarily with setting for the number of averages, since this determines the number of measurements that must be made and averaged before displaying a result. When the first set of averages is complete and the result is displayed, the instrument immediately takes another measurement, discards the oldest measurement included in the current average computation, recomputes the average and displays the new result. This continues until you change the setting for the number of averages or disable averaging (by setting the number of averages to 0).

In certain situations, the length of time that the AVERAGING message is displayed can be affected by additional factors. When you are measuring frequency, the current resolution setting, the rate setting, and the quality of the signal all affect the length of time required to make the measurements and complete the average computation.

NOTE If the measurement rate is set to HOLD, and a value larger than 1 is set for averages, the first set of measurements is not initiated until you press the **Reset/Local** key. When you do, the instrument displays the AVERAGING message while it takes the first set of measurements. When the first set of measurements is complete, and the averaging result is displayed, the instrument remains in this state until you press the **Reset/Local** key to initiate another set of measurements, change the value for averages back to one, or change the setting for the measurement rate to SLOW, MED, or HIGH. When the measurement rate is set to HOLD, the instrument performs a block-average computation instead of a running-average computation.

Measuring Relative Frequency

You can measure the difference in frequency from one measurement to another (frequency drift) or between two separate input signals using the Relative Frequency function.

Relative Frequency Example

Press the **Rel Freq** key. The Shift annunciator activates when you press the **Shift** key. When you press the **Rel Freq** key, the Rel Freq annunciator in the upper-left corner of the display activates. At the same time, the Counter saves the frequency measurement it was displaying at the time you pressed the **Rel Freq** key, and it computes and displays the difference between the stored measurement and all subsequent measurements until the relative frequency function is deactivated.

You can also use the Relative Frequency function to measure the difference between two different signals. To do this, activate the Relative Frequency function, as described in the previous paragraph, disconnect the cable supplying the signal to the input connector, and then connect the second signal to the same input connector. The value displayed when the Counter acquires the second signal is the frequency difference between the two signals.

Offsetting a Frequency Measurement

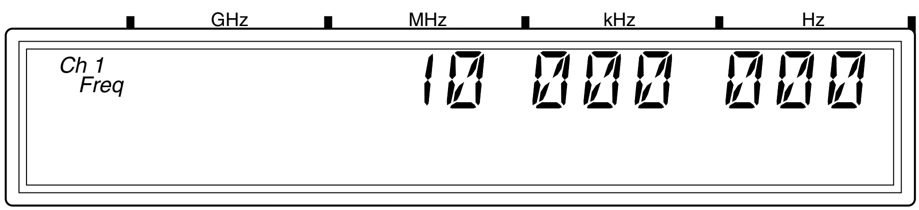
You can use the Frequency Offset (Freq Offset) function to add or subtract a constant value to/from a frequency measurement. For example, you can use an offset to compensate for a systematic error or to display the difference in frequency between two signals.

To display an offset frequency measurement, you need to set the value and sign (**+/–**) of the offset and to turn the Frequency Offset function on.

Frequency Offset Example

1 Connect a cable from the 10 MHz reference output on the back panel to the Channel 1 input connector, and press the Chan Select key (if necessary) to activate Channel 1.

The display should look like this:



2 Press the Shift key, and then press the Freq Offset (Resol) key in the MODIFY section of the front panel.

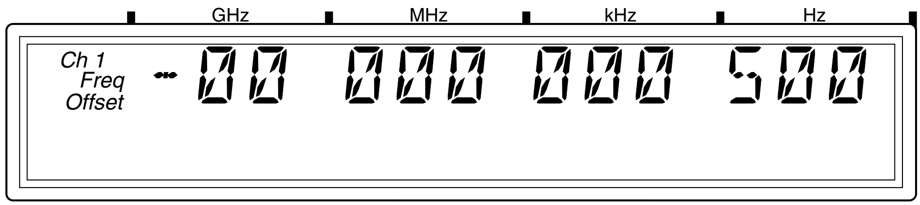
The Shift annunciator activates when you press the **Shift** key. When you press the **Freq Offset** key, the Shift annunciator disappears, and the Freq Offset annunciator at the left side of the display activates.

3 **Use the left- and right-arrow keys to move the focus to the digit(s) in the frequency-offset display that you need to adjust to enter the offset value, and then use the up- and down-arrow keys to adjust the value for each digit. Enter a value of 500 Hz.**

The flashing digit is the digit that currently has the focus. This means that you can change the value of the flashing digit using the up- and down-arrow keys.

4 **Press the sign (+/–) key (if desired) to change the sign of the offset value.**

The display should look like this:



5 **Press the Enter key to confirm the offset value and exit the offset-entry display.**

The Freq Offset annunciator is deactivated, and the measurement display returns.

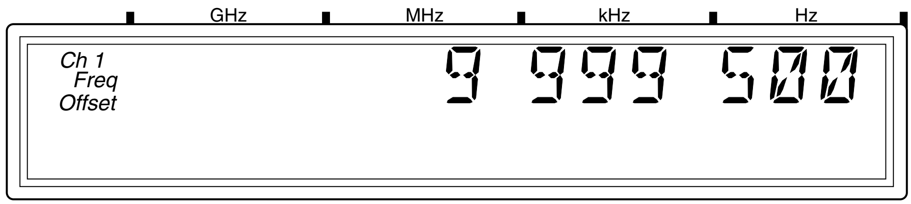
NOTE

When you are entering a value for Frequency Offset (or Power Offset), you can use the **Reset** key to restore all of the displayed digits to zero. These are the only two functions in which the **Reset** key has this effect.

6 Press the Offset On/Off key in the COUNTER section of the front panel.

The Freq Offset annunciator is activated, and the value of the display is adjusted to reflect the value and sign of the offset entered in Steps 2 and 3.

The display should look like this:



Since the offset function can be used to add or subtract a fixed value to/from the measurement result, you can use this feature to tune or align the odd frequencies of a local oscillator (LO). If you enter the target frequency as a negative offset, the Counter displays the difference between the LO's frequency and the target frequency. You can then adjust the LO until the Counter displays a value of zero.

NOTE The maximum value that can be entered for Frequency Offset is ± 49,999,999,999 Hz.

Measuring Power

The Agilent 53147A/53148A/53149A can measure signal power in the power and frequency ranges listed in the specifications in Chapter 4. The power measurement, which is shown in a dedicated area of the display, includes a digital readout and an analog representation. The display, which can be configured to show power in units of dBm or Watts, is auto-ranging when set to measure in Watts.

Selecting a Power Head (Sensor)

There are a number of Agilent power heads that can be used with the Power Meter in this instrument. Choosing the appropriate power head is a matter of matching the head's characteristics to the signal to be measured.

Before you can make any power measurement, you must determine which power head (sensor) to use for the measurement, select the power head in the instrument's menu (see "Using the Menu" on page 2-43), and configure the Power Meter to use the appropriate calibration factor for the frequency of the signal. The five power head models that have pre-recorded calibration-factor tables in the instrument's non-volatile memory are listed under "Power Head Selection (HEAD)" on page 2-50.

You can also modify the data points (frequency/calibration-factor data pairs) in the preconfigured calibration-factor tables, add data points to these tables, and add up to three custom tables for power heads that are not included in the instrument's menu. Instructions for modifying and adding data points in calibration-factor tables are provided in "Modifying and Adding Calibration Factor Tables" on page 2-27.

Making a Power Measurement

When you turn the Power Meter on, you must always zero and calibrate it with the power head connected before making any measurements. If you are using a different model power head than the one used the last time the Power Meter was used, you must also set the power head model in the instrument's menu. As part of the measurement sequence, you must input either the frequency of the signal you intend to measure or the power factor for that frequency (from the table provided with the power head).

NOTE

You must re-zero and recalibrate the Power Meter if you change the power head, if the instrument is shut off for any period of time, if the ambient temperature changes by 5° C (9° F) or more, and if the GPIB "INIT" command is sent to the instrument. In any case, you should calibrate the Power Meter at least once a day.

CAUTION

Always follow the directions provided with the power head in addition to the instructions provided in this manual.

Power Measurement Example

NOTE

The instrument must be powered on and must remain at the same ambient temperature for 15 minutes before beginning this procedure. If the temperature changes by 5° C (9° F) or more, wait another 15 minutes.

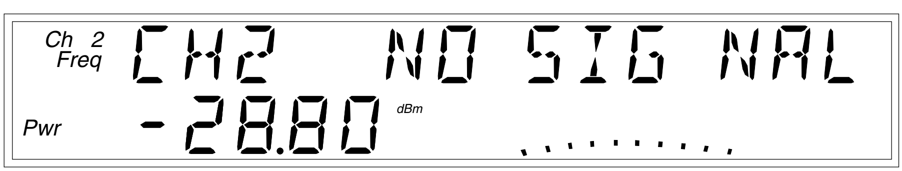
1 **Connect the output cable from the power-meter head to the Power Meter Input connector.**

This example assumes that you have a power head available that is appropriate for the measurement to be taken.

2 **Press the Display Power key to enable power measurement.**

The Pwr annunciator at the left side of the display is activated, and the Power Meter's digital and analog power displays show the power measurement in dB or dBm (the default units of power measurement).

The display should look like this:



NOTE

When there is no signal applied to the power head, the Power Meter reads the noise level, as shown in the illustration above. This reading is generally below –25 dBm prior to zeroing and will vary.

NOTE The upper portion of the display may show a frequency measurement or a voltage measurement if a signal is applied to the Counter or DVM input and the Counter or DVM is enabled. In this example, the Counter is enabled, but no signal is applied, so the upper portion of the display shows CH2 NO SIGNAL. If the DVM is enabled with no signal applied, the upper portion of the display will show VDC 0.000.

3 **Press the Shift key, and then press the Menu (Reset/Local) key.**

One of the items in the instrument's menu is displayed (if the menu has not been used since the instrument was turned on, the initial menu display is "REF OSC> INT").

4 **Use the up and/or down arrow keys to cycle through the menu until "HEAD > OFF" is shown.**

Note that a power head model number may appear instead of "OFF" if a power head was previously chosen.

5 **Press the right arrow key.**

The flashing indicator after HEAD changes from › to ‹ , and "OFF" (or the currently selected power head model number) begins to flash.

6 **Select the model number of the power head you intend to use by pressing the up- and/or down-arrow key repeatedly until the correct model number is displayed, and then press Enter.**

NOTE You can change the values of the frequency/power-factor data points that are stored in the instrument's memory (or add data points) by pressing the right-arrow key while a power-head model number is displayed and pressing the right-arrow key again when "LIST" is displayed. For instructions on entering or changing data, see "Numeric Entry" on page 2-6.

The instrument is shipped with calibration tables in nonvolatile memory for five of the supported power heads. The data points in these tables are almost always sufficient to provide accurate readings, so it is usually unnecessary to add or modify the values in the tables.

2

NOTE Three empty tables are provided for compatible power-sensor heads that the instrument does not have pre-recorded tables for. You can create your own table by entering a set of frequency/power-factor data points for a power head by selecting CUST 1, CUST 2, or CUST 3 from the HEAD menu. You then enter a set of frequency/power factor data points for the power head. For instructions on entering or changing data, see "Numeric Entry" on page 2-6.

7 **Press the Zero key.**

The Power Meter displays ZEROING and then returns to the display shown in Step 2.

8 **Connect the power-head input connector to the Power Meter Output connector**.

9 **Press the Cal key.**

During calibration, the Power Meter displays CALIBRATING. It then returns to the display shown in Step 2.

10 **If you know the frequency of the signal you intend to measure, press the Freq key, enter the frequency value, and press Enter (for instructions on entering or changing values, see "Numeric Entry" on page 2-6).**

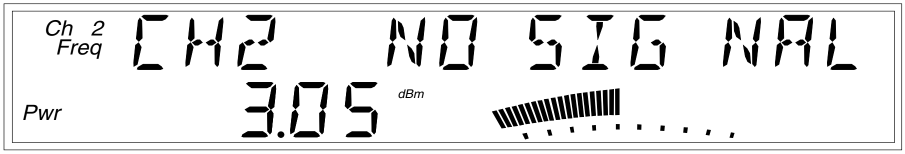
The Power Meter uses the frequency to set the power-factor per the values in the stored calibration tables. If you prefer, you can use the **Cal Factor** key to enter the calibration factor value directly.

NOTE If the signal you intend to measure is already applied to one of the Counter's input channels, you can press the **Store** key (**Shift** + **Cal**) to input the frequency value instead of using either the **Freq** or **Cal Factor** keys and entering a value manually. This saves time and has the same effect.

2

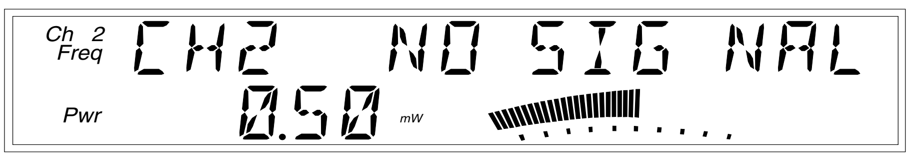
11 **Disconnect the power-head input connector from the Power Meter Output connector and connect it to the signal to be measured.**

The Power Meter measures the signal power and displays it, as shown below:



12 **To measure the signal power in Watts, press the Shift key, and then press the dBm/W (Display Power) key.**

When you press the **Shift** key, the Shift annunciator is activated. When you press the **dBm/W** (**Display Power**) key, the Shift annunciator goes off, and the units of measurement annunciator group to the right of the digital power measurement changes from dB or dBm to Watts, mW, µW, or nW, as shown below:



Modifying and Adding Calibration Factor Tables

The HEAD menu option provides access to preconfigured, editable calibration-factor tables for five models of Agilent power-sensor heads (models 8481A, 8481D, 8482A, 8485A, and 8487A) and three custom tables. You can modify the frequency/calibration-factor values in any of the data points for any power head, and you can input data to build new calibration tables (CUST 1, CUST 2, and CUST 3). Table 2-1 shows the changes you can and cannot make to the various data points in the five factory-configured calibration-factor tables (for models 8481A, 8481D, 8482A, 8485A, and 8487A) and the three custom calibration tables (CUST 1, CUST 2, and CUST 3).

Table 2-1. Calibration Factor Data Point Modifications

Calibration Table Data Points	Modify	Delete	Reset	Add
Factory defined data points (for 8481A, 8481D, 8482A, 8485A, and 8487A)	All	None	All	Yes
Data points added to factory-defined tables by user	All	All	N/A	N/A
Custom calibration-factor tables (CUST1, CUST2, and CUST3)	All	All	N/A	Yes

Calibration Table Modification Example

This example demonstrates how to view and modify the values in any of the preconfigured calibration tables or in one of the three custom calibration tables.

1 Press the Shift key, and then press the Menu (Reset/Local) key.

One of the items in the instrument’s menu is displayed (if the menu has not been used since the instrument was turned on, the initial menu display is “REF OSC> INT”).

2 Use the up and/or down arrow keys to cycle through the menu until “HEAD > OFF” is shown.

Note that a power head model number (or CUST 1, CUST 2, or CUST 3) may appear instead of “OFF” if a power-head model was previously selected.

3 Press the right arrow key.

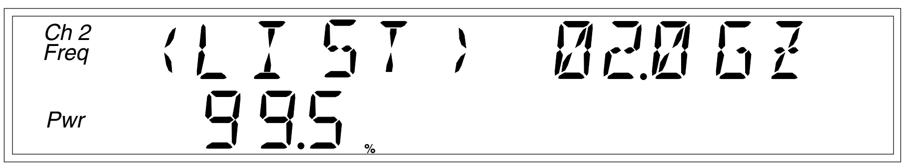
The flashing indicator after HEAD changes from } to { , and “OFF” (or the currently selected power head model number) begins to flash.

4 Select the model number of the power head you intend to modify the data point(s) for by pressing the up- and/or down-arrow key repeatedly until the correct model number is displayed, and then press Enter.

You can now change the values of the frequency/power-factor data points that are stored in the instrument's memory (or add data points) by pressing the right-arrow key while a power-head model number is displayed and pressing the right-arrow key again when "LIST" is displayed. For instructions on entering or changing data, see "Numeric Entry" on page 2-6.

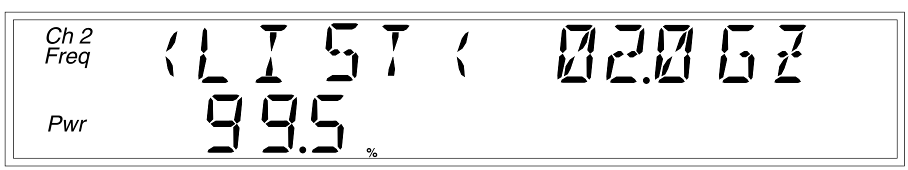
5 Press the right arrow key.

The display scrolls right-to-left and displays LIST and the frequency (on the top line) and calibration-factor (on the bottom line) values in the first data point. You can now use the up and down arrow keys to cycle through the data points in the currently displayed calibration table.



6 Press the right arrow key again.

The flashing indicator after LIST changes from ⟩ to ⟨, and the first digit in the frequency value begins to flash. You can now use the up and down arrow keys to change the value of the first digit of the frequency value.



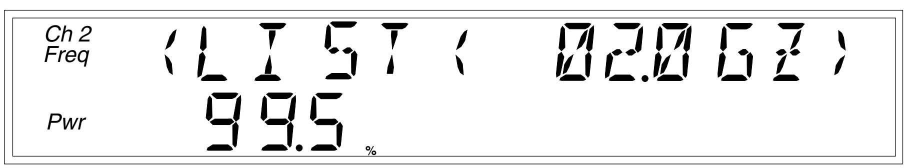
You can also use the right and left arrow keys to move between the digits of the frequency value and use the up and down arrow keys to change the values of these digits.

NOTE

In instruments that have firmware that is modified as described in *Service Note 53147/8/9A-01*, you can change the instrument's setting to match the 50 MHz reference calibration factor (RCF) of your power head. When the frequency reading on the display is 00.05 GZ (50 MHz), you can change the RCF to the one for your particular power head. After doing this, always re-zero and recalibrate the instrument (see Steps 7 through 9 on page 2-26).

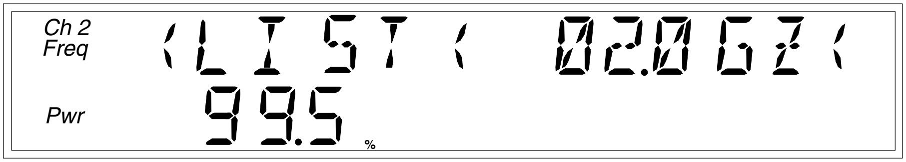
All units shipped from the factory after August 2001 have the modified firmware installed. To determine whether your instrument has the modified firmware, display the menu as described in "Sequencing Through the Menu" on page 2-5. The instrument's model number is listed between the **Preset** and **Op Hours** menu items. Press the right arrow key once to display the model number. If your instrument's model number is any number lower than 2060166-99, you should obtain and install the firmware kit (Agilent part number 53147-80018).

7 **When you move the focus to the last digit of the frequency value (the one furthest to the right), an additional flashing indicator (⟩) appears at the right end of the display, and the indicator to the left of the frequency value (⟨) stops flashing.**



This indicates that, in addition to being able to use the up and down arrow keys to adjust the value of the flashing digit in the frequency value, you can also press the right arrow key to move the focus from the last digit of the frequency value to the first digit of the calibration-factor value.

8 **Press the right arrow key until the focus moves from the last digit of the frequency value to the first digit of the calibration-factor value (the first calibration-factor digit begins flashing). The flashing indicator at the right of the frequency value changes direction (from } to {), which indicates that you can use the left arrow to return to the frequency value, if you need to.**



You can now use the left and right arrow keys to move between the digits of the calibration-factor, and you can use the up and down arrow keys to adjust the values of the individual digits of the calibration-factor.

9 **If you want to change values in additional data points, press the right arrow key to save your changes and move to the next data point. If you are done changing data point values, press the Enter key to save your changes and exit the menu.**

Whether you save and move to the next data point or save and exit, all of the data points in the current table are immediately resorted into order by frequency. This is important to keep in mind, since the next data point in order may no longer be the same one that was in that position in the list before you made changes to the data point you just adjusted.

NOTE

You can use the same steps to create a calibration table for a power head model that the Power Meter does not have a preconfigured calibration table for, or you can create an alternate calibration table for one of the five power head models that does have a preconfigured table. To do this, simply choose CUST 1, CUST 2, or CUST 3 from the HEAD menu option instead of choosing one of the preconfigured tables identified with a power-head model number.

NOTE

To delete a data point entirely, set the calibration-factor to a value of 50 or lower. When you move to the next data point or exit the menu, the data point containing the =< 50 value is automatically deleted from the table.

Table 2-2 lists the factory-set values in all of the data points for all five of the pre-recorded power head calibration tables.

Table 2-2. Calibration Table Data-Point Values

Power Head Model Number	Frequency	Calibration Factor
8481A	RCF	100.0
	50 MHz	100.0
	100 MHz	99.8
	2 GHz	99.0
	3 GHz	98.6
	4 GHz	98.0
	5 GHz	97.7
	6 GHz	97.4
	7 GHz	97.1
	8 GHz	96.6
	9 GHz	96.2
	10 GHz	95.4
	11 GHz	94.9
	12.4 GHz	94.3
	13 GHz	94.3
	14 GHz	93.2
	15 GHz	93.0
	16 GHz	93.0
	17 GHz	92.7
	18 GHz	91.8

Table 2-2. Calibration Table Data-Point Values (continued)

Power Head Model Number	Frequency	Calibration Factor
8481D	RCF	99.0
	50 MHz	99.0
	500 MHz	99.5
	1 GHz	99.4
	2 GHz	99.5
	3 GHz	98.6
	4 GHz	98.6
	5 GHz	98.5
	6 GHz	98.5
	7 GHz	98.6
	8 GHz	98.7
	9 GHz	99.5
	10 GHz	98.6
	11 GHz	98.7
	12 GHz	99.0
	12.4 GHz	99.1
	13 GHz	98.9
	14 GHz	99.4
	15 GHz	98.9
	16 GHz	99.1
	17 GHz	98.4
	18 GHz	100.1

Table 2-2. Calibration Table Data-Point Values (continued)

Power Head Model Number	Frequency	Calibration Factor
8482A	RCF	98.0
	0.1 MHz	98.0
	0.3 MHz	99.5
	1 MHz	99.3
	3 MHz	98.5
	10 MHz	98.5
	30 MHz	98.1
	100 MHz	97.6
	300 MHz	97.5
	1 GHz	97.0
	2 GHz	95.0
	3 GHz	93.0
	4.2 GHz	91.0

Table 2-2. Calibration Table Data-Point Values (continued)

Power Head Model Number	Frequency	Calibration Factor
8485A	RCF	100.0
	50 MHz	100.0
	2 GHz	99.5
	4 GHz	98.9
	6 GHz	98.5
	8 GHz	98.3
	10 GHz	98.1
	11 GHz	97.8
	12 GHz	97.6
	12.4 GHz	97.6
	14 GHz	97.4
	16 GHz	97.0
	17 GHz	96.7
	18 GHz	96.6
	19 GHz	96.0
	20 GHz	96.1
	21 GHz	96.2
	22 GHz	95.3
	23 GHz	94.9
	24 GHz	94.3
	25 GHz	92.4
	26 GHz	92.2
	26.5 GHz	92.1

Table 2-2. Calibration Table Data-Point Values (continued)

Power Head Model Number	Frequency	Calibration Factor
8487A	RCF	100.0
	50 MHz	100.0
	100 MHz	99.9
	500 MHz	98.6
	1 GHz	99.8
	2 GHz	99.5
	3 GHz	98.9
	4 GHz	98.8
	5 GHz	98.6
	6 GHz	98.5
	7 GHz	98.4
	8 GHz	98.3
	9 GHz	98.3
	10 GHz	98.3
	11 GHz	98.1
	12 GHz	97.9
	13 GHz	98.0
	14 GHz	98.2
	15 GHz	97.7
	16 GHz	96.8
	17 GHz	97.0
	18 GHz	96.3
	19 GHz	95.9
	20 GHz	95.2
	21 GHz	95.6
	22 GHz	95.5
	23 GHz	95.4
	24 GHz	95.0
	25 GHz	95.4
	26 GHz	95.2
	27 GHz	95.1
	28 GHz	95.0
	29 GHz	94.4
	30 GHz	94.0
	31 GHz	93.7

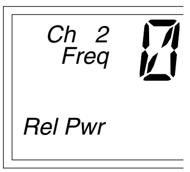
Table 2-2. Calibration Table Data-Point Values (continued)

8487A (continued)	32 GHz	93.8
	33 GHz	93.0
	34 GHz	93.2
	34.5 GHz	93.5
	35 GHz	93.1
	36 GHz	92.0
	37 GHz	92.4
	38 GHz	90.9
	39 GHz	90.3
	40 GHz	91.4
	41 GHz	90.6
	42 GHz	89.9
	43 GHz	89.1
	44 GHz	88.1
	45 GHz	86.9
	46 GHz	85.8
	47 GHz	85.4
	48 GHz	83.2
	49 GHz	81.6
	50 GHz	80.2

Measuring Relative Power

You can measure the difference in power from one measurement to another or between two separate input signals using the Relative Power function.

Relative Power Example



Press the **Shift** key, and then press the **Rel Pwr** (POWER METER: **Offset On/Off**) key. The Shift annunciator activates when you press the **Shift** key. When you press the **Rel Pwr** key, the Shift annunciator disappears, and the Rel Pwr annunciator at the left side of the display activates. At the same time, the Power Meter saves the power measurement it was displaying at the time you pressed the **Rel Pwr** key, and it computes and displays the difference in power between the stored measurement and all subsequent measurements until the relative power function is deactivated.

NOTE

When the Power Meter is set to measure power in dBm, relative power is expressed in dB. When the Power Meter is set to measure power in Watts, relative power is expressed as a percentage (%).

You can also use the Relative Power function to measure the difference in power between two different signals. To do this, activate the Relative Power function, as described in the previous paragraph, disconnect the signal to the power head (sensor), and then connect the second signal to the same power head. The value displayed when the Power Meter acquires the second signal is the power difference between the two signals.

Offsetting a Power Measurement

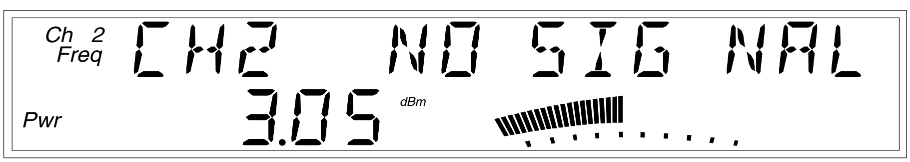
You can use the power offset (**Pwr Offset**) function to add or subtract a constant value to/from a power measurement. For example, you can use an offset to compensate for a systematic error, to display the difference in power between two signals, or to compensate for losses and attenuation in cables or components that are between the signal source and the Power Meter.

To display an offset power measurement, you set the value and sign (+/–) of the offset and turn the Power Offset function on.

Power Offset Example

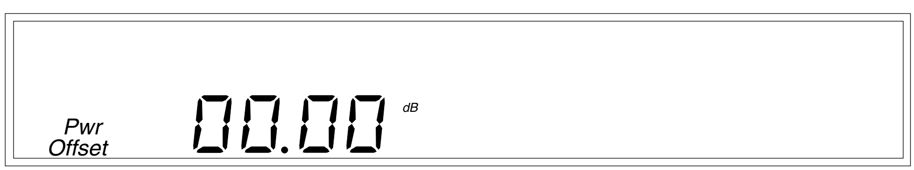
1 **Connect a signal to the Power Meter input connector, and activate power measurement by pressing the Display Power key.**

The display should look like this (the values are simulated in these illustrations):



2 **Press the Shift key, and then press the Pwr Offset (Avg) key.**

The Shift annunciator activates when you press the **Shift** key. When you press the **Pwr Offset** key, the Shift annunciator and the frequency display disappear, the Pwr Offset annunciator at the left side of the display activates, and the power-offset value is set to 00.00, as shown below:

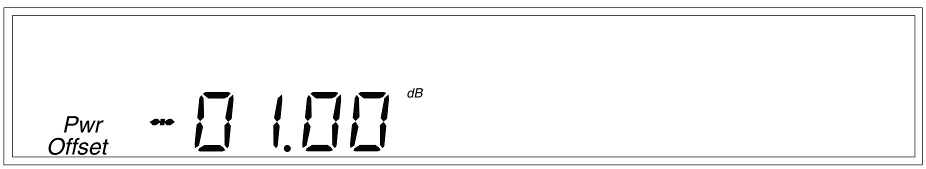


NOTE If the power-offset value was previously changed, the previous value is displayed instead of 00.00.

3 **Use the left- and right-arrow keys to move the focus to the digit(s) in the power-offset display that you need to adjust to enter the offset value, and then use the up- and down-arrow keys to adjust the value for each digit.**

The flashing digit is the digit that currently has the focus. This means that you can change the value of the flashing digit using the up- and down-arrow keys.

4 **Press the sign-change (+/–) key (if desired) to change the sign of the offset value.**



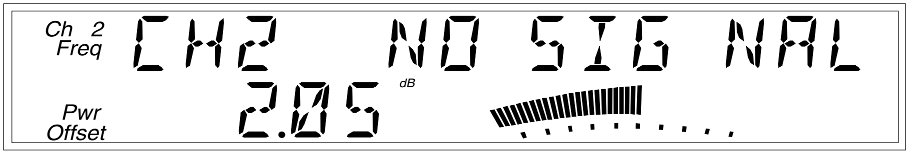
5 **Press the Enter key to confirm the offset value and exit the offset-entry display.**

The Pwr Offset annunciator is deactivated, and the measurement display returns.

6 **Press the Offset On/Off key (in the POWER area of the front panel).**

The Pwr Offset annunciator is activated, and the value of the display is adjusted to reflect the value and sign of the offset entered in Steps 3 and 4.

The display should now look like this (values are simulated):



NOTE When you are entering a power- or frequency-offset value, you can use the **Reset** key to restore all of the displayed digits to zero. These are the only two functions in which the **Reset** key has this effect.

Measuring Voltage

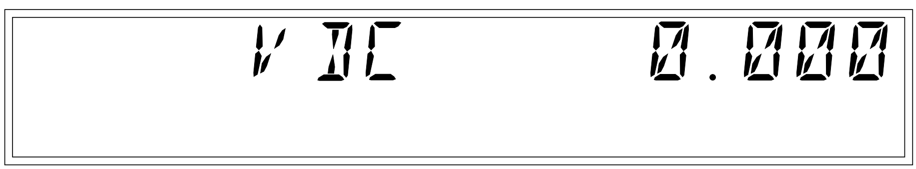
The Agilent 53147A/148A/149A included a digital voltmeter (DVM) that can measure voltages from – 50 VDC to +50 VDC. To measure voltage, use the following procedure:

Voltage Measurement Example

1 **If the instrument is not already turned on, connect the power cord to the power-input connector on the rear panel and to an appropriate power source (or, with the Battery option, turn on the Battery power switch).**

2 **Press the Display DVM key in the DVM section of the front panel.**

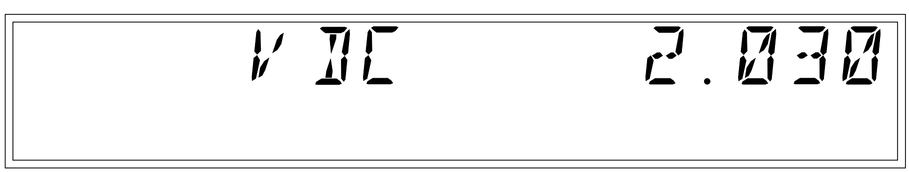
The DVM display is activated, as shown below:



3 **Insert the connector on the end of the red test lead into the red + DVM connector, and insert the connector on the black test lead into the black – DVM connector.**

4 **Touch the red and black test prods to the points at which you want to measure the voltage.**

The display should look like this (assuming a voltage source of +2.030 VDC):

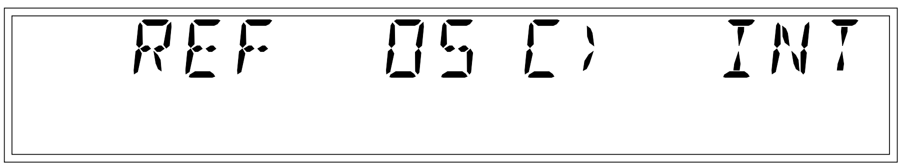


Using the Menu

The Agilent 53147A/148A/149A's Menu makes it easy to control a number of the instrument's features and functions. You use the Selection (arrow) keys to navigate to the setting you want to change and then to actually make the changes.

1 Press the Shift key and then the Menu (Reset/Local) key to display the Menu.

When you press the **Shift** key, the Shift annunciator (near the bottom-right corner of the display) activates. When you press the **Menu** (**Reset/Local**) key, the Shift annunciator goes off, and the first menu item is displayed. If you have not previously invoked the Menu since you last turned the instrument on, the first menu item is REF OSC, the Reference Oscillator.



2 Press the right-arrow key to change the setting for the Reference Oscillator.

The flashing annunciator (⟩) in the display reverses direction to indicate that you can now change the setting by pressing either the up-arrow key or the down-arrow key. In the case of the Reference Oscillator function, which has only two possible settings (INTernal and EXTernal), pressing either the up- arrow or the down-arrow has the same effect (it toggles the setting from INT to EXT or from EXT to INT).

NOTE

The Counter will not switch to EXT (external) unless a suitable reference signal is available at the External Reference connector.

2

3 Press the Enter key to activate the setting and exit the Menu.

The setting you chose is put into effect, and the Menu closes.

If you need to exit the Menu without changing any of the settings, press the **Clear** key. To restore the setting of any menu item to the setting that was in effect when you opened the Menu, press the **Reset/Local** key (this restores the original setting for the current menu item but does not close the Menu).

The Menu contains the following items (these items are displayed in the order they are listed if you repeatedly press the up-arrow key after opening the Menu):

- REF OSC — Sets the Counter to use the internal timebase (INT) or an external timebase (EXT) connected to the Reference connector on the back panel.
- PWR REF — Turns the reference signal available on the Power Meter Output connector ON or OFF.
- SAVE — Saves a copy of the current user settings in non-volatile memory. Nine sets (0 – 8) can be saved, and Set 0 is automatically read on startup.
- RECALL — Reads and implements a stored set of user settings from one of nine (0 – 8) that are stored in non-volatile memory.
- CH1 LPF — Turns the Channel 1 Low-Pass Filter (approx. 50 kHz) ON or OFF.
- FM — Turns the Counter's ability to compensate for frequency modulation on (AUTO) or OFF.
- BAUD — Sets the data rate for the RS-232 serial port (1200, 2400, 4800, 9600, 14400, or 19200).
- PRESET — Resets all functions to the factory-default settings.
- Model number, firmware version number, serial number, OPTNS (installed options).
- OP HRS — Displays the total number of hours the instrument has been in operation since it was last calibrated.

- BATT VOLTAGE — Displays the current voltage level in the rechargeable battery packs (only if the Battery option is installed).
- DO SELF TEST — Starts the sequence of built-in tests.
- HEAD — Displays a list of compatible power-sensor heads that have tables of frequency/power-factor data points recorded in the instrument's memory (there are also three empty tables, CUST 1, CUST 2, and CUST 3 (Custom 1, 2, and 3), in which you can enter and save your own sets of data points). You can choose the head model that you intend to use, enter the compensation factors for the head, or select OFF.
- GPIB ADDR — Sets the address for the GPIB interface (0-30).

Each of these menu items is described in greater detail on the following pages.

Navigating in the Menu and Changing Settings

When you select the Menu (with the **Shift** and **Menu** [**Reset/Local**] keys), the indicator between the arrow keys flashes to indicate that the arrow keys are now active. Since the Reference Oscillator setting is the first one displayed when you invoke the Menu (unless you've used the Menu to change another setting since you turned the instrument on), you don't have to use the up-arrow key or the down-arrow key to get to it.

When you press the right-arrow key, the flashing annunciator ( ) changes direction, and the current setting for the Reference Oscillator INT (internal) or EXT (external) flashes. This indicates that you can now change this setting. Use either the up-arrow key or the down-arrow key to change the setting.

If there are more than two settings available for the currently selected function, you can cycle through the available settings by repeatedly pressing either the up-arrow key or the down-arrow key. For example, to change the setting for the Baud rate for the serial port, invoke the Menu, and then repeatedly press the up-arrow or down-arrow key until BAUD is shown on the display. Then, press the right-arrow key to select the BAUD option, and press the up- or down-arrow repeatedly until the setting you want is displayed. Finally, press the **Enter** key to implement your choice.

2

You navigate to and adjust the remaining settings available in the Menu in the same manner. If you modify a setting and then press the **Enter** key, the Menu closes, so you have to reinvoke it to change additional settings. However, you can change more than one setting if you wait to press the **Enter** key until you have made all the changes you need to make.

Some of the menu items listed on the previous page provide information only (no settings are required [or possible] for these), such as Battery Voltage, Operation Hours, and information that identifies the instrument (Agilent model number, firmware version number, serial number, and installed option codes). These menu options are described in the remainder of this chapter and also in "The Front Panel Menus at a Glance" on page 1-5.

NOTE Always terminate each setting you change in a menu option by pressing the **Enter** key. You can abort any change while the Menu is displayed by pressing the **Reset/Local** key or the **Clear** key. Both keys nullify the change you made to the current menu option, but they do not affect any of the other menu options. The **Clear** key terminates the current menu session, but the **Reset/Local** key does not.

2

Reference Oscillator (REF OSC)

By default, the Counter uses its internal 10 MHz reference oscillator (or the optional Oven Timebase, Option 001) as a timebase for all measurements, unless REF OSC is set to EXT, and it detects a 1, 2, 5, or 10 MHz reference signal on the Reference connector on the back panel. If an external reference signal is present, you can force the Counter to use the internal reference oscillator by setting the REF OSC menu option to INT.

The available settings are EXT (external) and INT (internal), and the default setting is INT.

NOTE When REF OSC is set to internal (INT), the Counter outputs a 10 MHz, 1 V rms signal on the Reference connector on the back panel.

Power Reference (PWR REF)

The Power Meter includes an internal reference-signal generator that can output its 1.00 mW at 50 MHz (nominal) signal to the Power Meter's OUTPUT connector. The PWR REF menu option turns the reference-signal output on and off (the PWR REF annunciator flashes on and off while the PWR REF menu option is displayed and is on steady when you have set the power-reference output to on). The Power Meter also turns the power-reference signal output on and off automatically during calibration (when you press the **Cal** key), so there are very few situations in which you need to use this menu option to turn this output on manually.

NOTE When calibration is complete, the power reference output is restored to the state it was in before calibration was initiated. If PWR REF is set to ON in the menu, and you calibrate the Power Meter, the reference-signal output remains on when calibration is complete.

Save User Settings (SAVE)

The SAVE menu option allows you to save the instrument's current settings for configurable functions in non-volatile memory for use at a later time. Nine sets of settings can be saved (set 0 is automatically used when the instrument is powered on). The Save and Recall functions enable faster and easier operation, reduce operator errors, and reduce training requirements.

Recall User Settings (RECALL)

Up to nine sets of settings you make for the instrument's configurable functions can be saved in non-volatile memory. The RECALL menu option allows you to select and implement any of the sets you have previously saved. The settings in set zero are automatically loaded on power-up. The Save and Recall functions enable faster and easier operation, reduce operator errors, and reduce training requirements.

Channel 1 Low-Pass Filter (CH1 LPF)

The Counter has a built-in 50 kHz low-pass filter that can be enabled from the Menu to eliminate measurement distortions that result from noise in low-frequency signals. When the low-pass filter is enabled, signals above 50 kHz are attenuated.

Frequency Modulation (FM)

The Counter can measure signals that are modulated in frequency, such as a microwave radio carrier. When FM is set to AUTO (the default setting), the Counter automatically detects FM signals and modifies its measurement algorithm accordingly. Since this increases the time it takes to compute each measurement, you can turn this feature OFF to increase measurement speed, or leave it set to AUTO to increase accuracy when measuring FM signals.

RS-232 Serial Port Data Rate (BAUD)

The Baud rate for the RS-232 serial port is configurable at 1200, 2400, 4800, 9600, 14,400, and 19,200 bps. The default setting is 9600 bps.

Preset

When PRESET is displayed, pressing the **Enter** key loads the default settings for most of the instrument's functions. These functions and their default settings are listed in the following table:

Table 2-3. Factory Default Function Settings

Function	Available Settings	Default Setting
Reference Oscillator (REF OSC)	INT (Internal), EXT (External)	INT (Internal)
Power Reference Signal (PWR REF)	OFF, ON	OFF
Save Settings (SAVE)	0 through 8	0
Recall Settings (RECALL)	0 through 8	0
Channel 1 Low-Pass Filter (CH1 LPF)	OFF, ON	OFF
Frequency Modulation (FM)	AUTO, OFF	AUTO
Serial Port Data Rate (BAUD)	1200, 2400, 4800, 9600, 14400, 19200	9600
Power Meter Head Model (HEAD)	OFF, 8487A, 8485A, 8482A, 8481D, 8481A, CUSTOM 1, CUSTOM 2, CUSTOM 3	OFF
GPIB Address (GPIB)	0-30	19
Resolution (**Resol** key)	1 Hz, 10 Hz, 100 Hz; 1kHz, 10 kHz, 100 kHz, 1 MHz	1 Hz
Frequency Offset (**Freq Offset** key) COUNTER: **Offset On/Off** key	frequency limits vary with model Off, On	0 Off
Frequency value (**Freq** key)	00.0 GZ through 19.9 GZ, 26.4 GZ, or 46.4 GZ (for 53147A,148A, and 149A respectively)	00.1 GZ (GHz)
Calibration Factor (**Cal Factor** key)	80.0 through 110.0 (%)	100.0

Table 2-3. Factory Default Function Settings (continued)

Function	Available Settings	Default Setting
Averages (**Avg** key)	01 through 99	01
Power Offset (**Pwr Offset** key) POWER METER: **Offset On/Off** key	–99.99 through +99.99 dBm Off, On	0 Off
Measurement Rate (**Rate** key)	FAST, MED, SLOW, HOLD	FAST
Display Backlight On/Off (☼ **On/Off** key)	On, Off	On
Channel Selection (**Chan Select** key)	Channel 1, Channel 2	Channel 2
Power Measurement Units (**dBm/W** key)	dBm (dBm, dB) W (W, mW, μW, nW)	dBm
Relative Frequency (**Rel Freq** key)	Off, On	Off
Relative Power (**Rel Pwr** key)	Off, On	Off
DVM On/Off (**Display DVM** key)	Off, On	Off
Power Meter On/Off (**Display Power** key)	Off, On	Off

Model Number, Firmware Version, Serial Number, and Option Codes

This menu item displays a series of numbers and codes that are used to identify the instrument, its software version number, and the options that are installed. These items are displayed sequentially, and you use the left- and right-arrow keys to move between the information fields. The flashing annunciators at either end of the first line of the display indicate that you can use the equivalent arrow key to scroll left and/or right to the next field of information.

The option-code display lists the code number for each of the installed options. For example, in a instrument that has the Battery and Oven Timebase options installed, the display would show: <OPTNS 1-2- - ->.

Operating Hours (OP HOURS)

This is an informational menu item that displays the total number of hours the instrument has been in operation since its last calibration. This value does not include Standby hours. This information is useful for scheduling routine maintenance and calibration. For additional information on maintenance and calibration, see the *Assembly-Level Service Guide*.

Battery Voltage (BATT VOLTAGE)

If the Battery Option (Option 002) is installed, the current battery voltage is displayed in digital and analog form in this menu item, so you can estimate the remaining time that the instrument can operate from the batteries. The batteries are fully charged when the voltage reading is 13.5 V, and the minimum battery voltage for proper operation is approximately 10 V. For additional information on the Battery Option, see Appendix C.

Do Self Test

The instrument automatically performs a series of tests on critical components each time you turn it on. If at any time during operation, you want to repeat these tests, you can do so by invoking the Menu, navigating to DO SELF TEST, and pressing the **Enter** key.

The individual tests that comprise the Self Test, and the error messages that are displayed if problems are detected, are described in Appendix B, "Messages."

Power Head Selection (HEAD)

The instrument's Power Meter works with a number of different Agilent power heads. This menu option allows you to choose the model number of the power head you intend to use for the current measurement.
The power-head models included in the menu are: 8481A, 8481D, 8482A, 8485A, and 8487A. You can also use this menu option to change the frequency and power-factor values in the data points for these power heads, to input additional data points for these power heads, and to enter data points for power heads other than the five preconfigured models (by selecting CUST 1, CUST 2, and/or CUST 3 instead of one of the five preconfigured power head models). The maximum number of data points that can be saved for any single power head is 100.

GPIB Address (GPIB ADDR)

This menu allows you to set the GPIB address to be used when remotely controlling the instrument's operation using the GPIB interface.
The available addresses are in the range from 0 to 30.

3

Programming

Introduction

This chapter assumes you are familiar with the front-panel operation of the Agilent Technologies 53147A, 53148A, and 53149A. See Chapters 1 and 2 for detailed information about front-panel operation. You should use this chapter together with Chapters 1 and 2. Knowing how to control the instrument from the front panel and understanding the measurements you want to perform makes the programming task much easier. Chapters 1 and 2 provide explanations and procedures for all of the instrument's measurement functions. and contain the specifications for the instrument.

By sending Standard Commands for Programmable Instruments (SCPI) commands, you can remotely operate many of the instrument's front-panel functions via the General Purpose Interface Bus (GPIB) or the RS-232 serial interface. These programming commands conform to the *Standard Commands for Programmable Instruments (SCPI) Standard Version 1992.0*. The SCPI standard does not completely redefine how to program instruments over the GPIB or the RS-232 serial interface. However, it does standardize the structure and content of an instrument's command set to reflect the best programming practices developed by people using GPIB. It also establishes standard command mnemonics for similar functions in all of the instruments that conform to the SCPI standard.

If you have programmed any Agilent instruments that have been released over the last few years, you have probably seen a general trend toward the techniques specified in the SCPI standard. For example, several instruments are already using a hierarchy of commands that is similar to the command structure defined by the SCPI standard.

Chapter Summary

The following information is contained in this chapter:

3

How to Use This Chapter

How you use this chapter depends upon how much you already know about programming instruments and how complex your measurement requirements are. Let's start by establishing your programming background and then discuss the type of measurements you want to perform.

NOTE

With two minor exceptions, the only difference between programming the instrument using the GPIB interface and the RS-232 serial interface is the manner in which you connect the instrument to the computer. These exceptions are:

1. The instrument sends a command prompt over the RS-232 interface (but not the GPIB) after receiving and executing each command.

2. When an error is detected (during the Self-Test or during operation), the instrument automatically sends an error message (or messages) over the RS-232 interface (error messages must be requested over the GPIB). For additional information on error messages, see Appendix B.

New Users

What You Should Understand

As a new user, you must have some understanding of a high-level language, such as BASIC or C, before you can use the command set defined in this guide to control the instrument. (In "Programming the Instrument for Remote Operation," there are programming examples provided in BASIC, Microsoft QuickBASIC, and Borland Turbo C.) However, whatever language you use, the command strings that control the instrument remain the same.

Learning to Program the Instrument

To learn how to program the Instrument, perform the following:

- Scan the summary tables in the section titled "Command Summary" on page 3-16 to get a feeling for the number and structure of commands available to you.
- Read and study map drawings in the section titled "Front Panel to SCPI Command Map" on page 3-11.
- Read the section titled "Programming the Instrument for Remote Operation" on page 3-30 for an overview of SCPI concepts as they relate to the Agilent 53147A, 53148A, and 53149A. Look at the flowcharts, which illustrate some of the decisions you must make when programming the Instrument.
- Read the section titled "Programming Examples" on page 3-80.
- Modify some of the programming examples to select specific measurement functions. If the programs work, consider yourself an experienced programmer and use the section titled "Command Reference" on page 3-86 as a reference for detailed information of all the instrument's SCPI commands.

Experienced Programmers

If you have programmed other GPIB instruments, you are probably familiar with many of the concepts and techniques discussed in this guide. Using the SCPI commands is also very similar to using the earlier GPIB commands. The main difference between the two command sets is the hierarchy of the subsystem commands. (However, this type of structure has previously been used on other instruments.)

Because the SCPI command set and some of the status reporting techniques are new, we advise you to use the following sequence to learn the instrument's programming requirements:

- Look over the steps for a new user, and perform any that you think are applicable to your current level of knowledge. In particular, look at the measurement techniques and examples provided in the section titled "Programming the Instrument for Remote Operation."

- Review the summary tables in the section titled “Command Summary” on page 3-16.If this section contains sufficient information to get you started, write some test programs to explore the instrument's capabilities. If you need additional information on any command, refer to the applicable command description in the section titled “Command Reference” on page 3-86.
- Review the remaining information in this guide to determine what is applicable to your programming requirements.

If you need more information than is contained in this guide, see the section titled “Related Documentation” on page 3-9.

Applications

After you have read the appropriate information and written some measurement programs, you may want to expand the scope of your applications. The following two techniques are explained in detail:

- If you are going to write interrupt-driven programs (or if you just want to determine the status of the instrument), read the section titled “Status Reporting” on page 3-51.
- If you are going to write programs to transfer data between the instrument and an external computer, read the section titled “Overview of Command Types and Formats” on page 3-38.

Assumptions

This section assumes the instrument is correctly installed and interfaced to an external computer. If it is not, and you intend to use the GPIB, see the IEEE GPIB Interconnection information in *Hewlett-Packard Company, Tutorial Description of the Hewlett-Packard Interface Bus, 1987*. (See the section in this chapter titled “Related Documentation” on page 3-9 for ordering information.) If you intend to use the RS-232 serial interface, see the section titled “Connecting With the RS-232 Serial Interface” on page 3-33.

As previously mentioned, this guide also assumes you are familiar with the front-panel operation of the instrument. See Chapters 1 and 2 for detailed information about front-panel operation. Knowing how to control the instrument from the front panel and understanding the measurements you need to perform makes the programming task much easier.

Related Documentation

This section contains a list of documentation that relates to the use of the Agilent 53147A/148A/149A. Additional information that may be useful is contained in the following publications:

1. *Beginner's Guide to SCPI* (Agilent Part Number H2325-90002, July 1990 Edition).
2. *Beginner's Guide to SCPI*, Barry Eppler (Hewlett-Packard Press, Addison-Wesley Publishing Co. 1991).
3. *Standard Commands for Programmable Instruments (SCPI)*, (latest version).

   This standard is a guide for the selection of messages to be included in programmable instrumentation. It is primarily intended for instrument firmware engineers. However, you may find it useful if you are programming more than one instrument that claims conformance to the SCPI standard. You can verify the use of standard SCPI commands in different instruments.

   To obtain a copy of this standard, contact:

   SCPI Consortium
   8380 Hercules, Suite P3
   La Mesa, CA 91942 USA
   Phone: (619) 697-8790
   FAX: (619) 697-5955

4. The International Institute of Electrical Engineers and Electronic Engineers, *IEEE Standard 488.1-1987*, *IEEE Standard Digital Interface for Programmable Instrumentation*.

   This standard defines the technical details required to design and build a GPIB (IEEE 488.1) interface. This standard contains electrical specifications and information on protocol that is beyond the needs of most programmers. However, it can be useful to clarify formal definitions of certain terms used in related documents.

To obtain a copy of this standard, write to:

Institute of Electrical and Electronic Engineers Inc.
345 East 47th Street
New York, NY 10017 USA

5. The International Institute of Electrical Engineers and Electronic Engineers, *IEEE Standard 488.2-1987*, *IEEE Standard Codes, Formats, Protocols, and Common Commands for Use with ANSI/IEEE Std 488.1-1987 Programmable Instrumentation*.

   This standard defines the underlying message formats and data types used in SCPI. It is intended more for firmware engineers than for instrument users/programmers. However, it can be useful if you need to know the precise definition of specific message formats, data types, or common commands.

   To obtain a copy of this standard, write to:

   The Institute of Electrical and Electronic Engineers Inc.
   345 East 47th Street
   New York, NY 10017 USA

6. Hewlett-Packard Company, *Tutorial Description of the Hewlett-Packard Interface Bus*, 1987.

   To obtain a copy of this manual, contact the nearest Agilent Technologies Sales office.

Front Panel to SCPI Command Map

Figures 3-1 and 3-2 are command maps that shows the relationships between the front-panel keys and the SCPI commands. This map should help you to identify commands, if you are already familiar with the front panel.

Some SCPI Syntax Conventions:

[ ]	An element inside brackets is optional. Note, the brackets are *not* part of the command and should *not* be sent to the instrument.
1 | 2	Means use either 1 or 2.
<numeric_value>	Means enter a number.
SENSe	Means you *must* use either all the upper case letters or the entire word. The lower case letters are optional. For example, SENS and SENSE are both valid. However, SEN is not valid. (Note SENSe is used here as an example, but this convention applies to all SCPI commands.)

NOTE

When you see quotation marks in a command's parameter (shown in the Parameter Form column in Table 3-2), you must send the quotation marks with the command. Refer to the section titled "Using BASIC" on page 3-80 for details on how to use double quotes or single quotes to enclose the string parameter of a command.

3

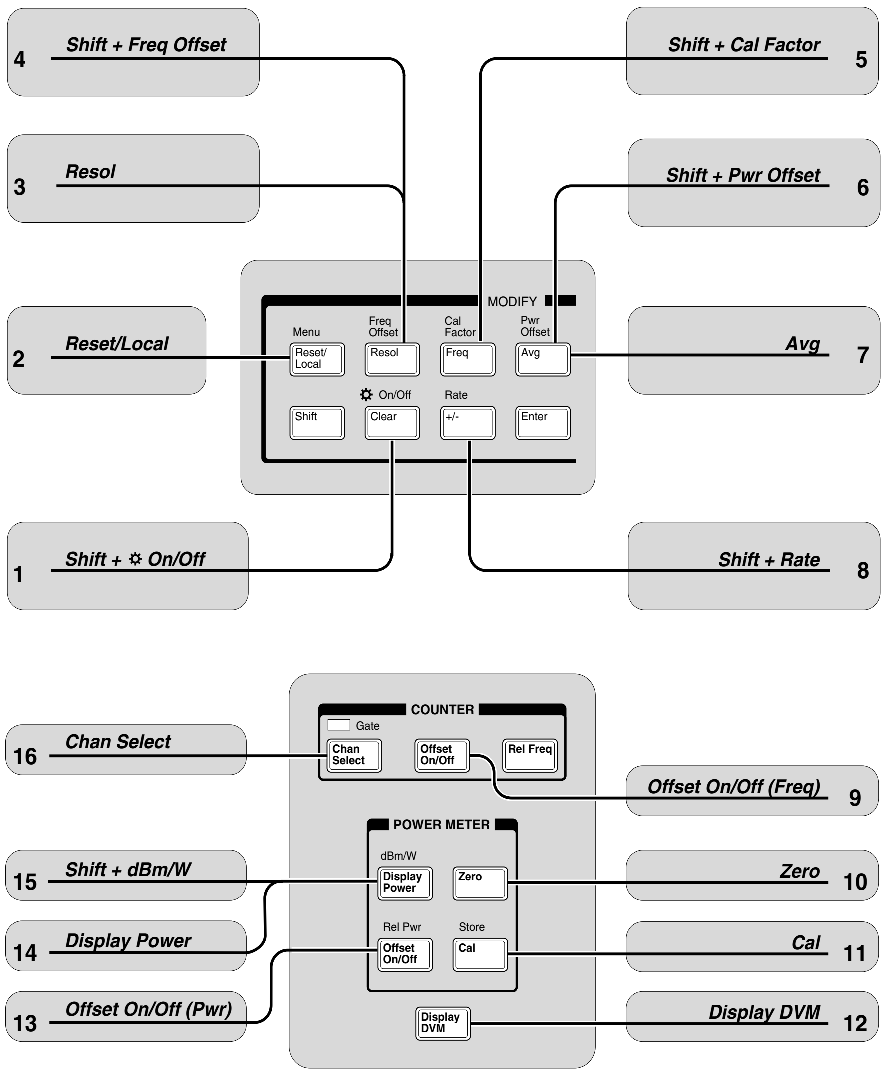


Figure 3-1. Front Panel Control to SCPI Command Map (Part 1 of 2)

1 DISPlay:BACKground[:STATe]

2 INITiate[:IMMediate]

3 [SENSe]:FREQuency:RESolution

4 [SENSe]:FREQuency:OFFSet

5 CALibration:RCFactor

6 [SENSe]:POWer:OFFSet

7 [SENSe]:AVERage:COUNt

8 TRIGger[:SEQuence]:HOLDoff

9 [SENSe]:FREQuency:OFFSet:STATe

10 CALibration:Zero:AUTO ONCE

11 CALibration:AUTO ONCE

12 SENSe:FUNCtion:ON “VOLT”
SENSe:FUNCtion:OFF “VOLT”

13 [SENSe]:POWer:OFFSet:STATe

14 [SENSe]:FUNCtion:ON “POW”
[SENSe]:FUNCtion:OFF “POW”

15 UNITs:POWer DBM
UNITs:POWer W

16 [SENSe]:FUNCtion:ON “FREQ1”
[SENSe]:FUNCtion:ON “FREQ2”

Figure 3-1. Front Panel Control to SCPI Command Map (Part 2 of 2)

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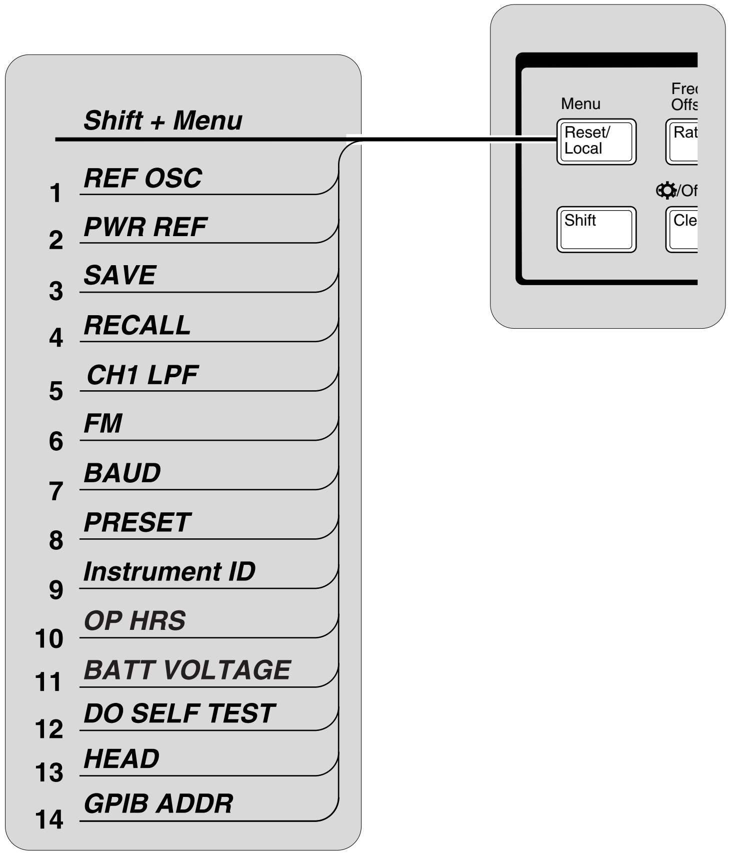

Figure 3-2. Front Panel Menu to SCPI Command Map (Part 1 of 2)

1 [:SENSe]:ROSCillator:SOURce

2 OUTPut:ROSCillator:STATe

3 *SAV

4 *RCL

5 :INPut:FILTer[:LPASs][:STATe]

6 [:SENSe]:FILTer:FM:AUTO

7 :SYSTem:COMMunicate:SERial[:RECeive]:BAUD

8 *RST

9 *IDN?

10 See Service Manual

11 See Service Manual

12 *TST?

13 [:SENSe]:CORRection:CSET:SELect

14 :SYSTem:COMMunicate:GPIB[:SELF]:ADDRess

Figure 3-2. Front Panel Menu to SCPI Command Map (Part 2 of 2)

Command Summary

This section summarizes both the IEEE 488.2 Common and Agilent 53147A/148A/149A Standard Commands for Programmable Instruments (SCPI) commands in tabular format. IEEE 488.2 Common Commands are listed first, followed by SCPI commands.

SCPI Conformance Information

The SCPI commands used in the Agilent 53147A/148A/149A are in conformance with the SCPI Standard Version 1995.0. The SCPI command set consists of the following:

- Common Commands as defined in IEEE 488.2-1987—listed and summarized in Table 3-1.
- SCPI Subsystem commands as confirmed (and listed) in the SCPI Standard—the commands defined in Table 3-2 as “Std.”
- SCPI Subsystem commands designed for the instrument in conformance with SCPI standards but not yet listed in the SCPI Standard—the commands defined in Table 3-2 as “New.”
- Details of all Agilent 53147A/148A/149A commands can be found in the section titled “Command Reference” on page 3-86.

Information on the SCPI commands format, syntax, parameter, and response types is provided in the section titled “Programming the Instrument for Remote Operation” on page 3-30.

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IEEE 488.2 Common Commands

The Common Commands are general-purpose commands that are common to all instruments (as defined in IEEE 488.2). Common Commands are easy to recognize because they all begin with an " * " (for example, *RST, *IDN?, *OPC). These commands are generally not related to measurement configuration. They are used for functions like resetting the instrument, identification, or synchronization.

Table 3-1 lists the IEEE 488.2 Common Commands supported by the Agilent 53147A/148A/149A in alphabetical order by mnemonic, name, and function. More information concerning the operation of IEEE 488.2 status-reporting commands and structure can be found in the "Status Reporting" section on page 3-51. Standard explanations of the IEEE 488.2 Common Commands can be found in the *ANSI/IEEE Std. 488.2-1987, IEEE Standard Codes, Formats, Protocols, and Common Commands* document.

Table 3-1. IEEE 488.2 Common Commands

Mnemonic	Command Name	Function
*CLS	Clear Status	Clears all event status registers summarized in the status byte and empties the Error Queue.
*DDT <arbitrary block>	Define Device Trigger Command	Defines which command is executed when the instrument receives a GET or *TRG command.
*DDT?	Define Device Trigger Query	Queries which command is executed when the instrument receives a GET or *TRG command.
*ESE <NRf>	Standard Event Status Enable	Sets the Standard Event Status Enable Register.
*ESE?	Standard Event Status Enable Query	Queries the Standard Event Status Enable Register.
*ESR?	Event Status Register Query	Queries and then clears the Standard Event Status Register.
*IDN?	Identification Query	Queries the instrument's identification.
*IST?	Instrument Status Query	Queries the current state of the parallel poll response (Instrument Status).
*OPC	Operation Complete	Causes the instrument to set the operation complete bit in the Standard Event Status Register when all pending operations (see Note at end of table) are finished.
*OPC?	Operation Complete Query	Places an ASCII "1" in the Output Queue when all pending operations (see Note at end of table) are completed.
*PRE <NRf>	Parallel Poll Enable Register	Sets the value of the Parallel Poll Enable register.
*PRE?	Parallel Poll Enable Register Query	Queries the value of the Parallel Poll Enable register.
*RCL <NRf>	Recall	Restores the state of the instrument's user settings from a copy stored in local non-volatile memory (0 through 9 are valid memory registers).
*RST	Reset	Resets the instrument to a known state, as defined in this manual.
*SAV <NRf>	Save	Stores the current state of the instrument's user settings in local non-volatile memory (0 through 9 are valid memory registers).

Table 3-1. IEEE 488.2 Common Commands (continued)

Mnemonic	Command Name	Function
*SRE <NRf>	Service Request Enable	Sets the Service Request Enable register.
*SRE?	Service Request Enable Query	Queries the Service Request Enable register.
*STB?	Status Byte Query	Queries the Status Byte and Master Summary Status bit.
*TRG	Trigger	This trigger command is the device-specific analog of the IEEE 488.1 defined GET. It initiates the action specified by the *DDT command.
*TST?	Self-Test Query	Executes an internal self-test and reports the results.
*WAI	Wait-to-Continue	Makes the instrument wait until all pending operations (see Note) are completed before executing commands that follow the *WAI command.
Note: Pending operations include measurements in progress.		

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Agilent 53147A/148A/149A SCPI Subsystem Commands

SCPI Subsystem commands include all measurement functions and some general-purpose functions. SCPI Subsystem Commands use a hierarchy relationship between keywords that is indicated by a colon (:). For example, in the SYST:ERR? query, the ":" between SYST and ERR? indicates ERR? is subordinate to SYST.

Table 3-2 lists the SCPI Subsystem Commands in alphabetical order by the command keyword. The table shows the Subsystem commands hierarchical relationship, related parameters (if any), and any associated information and comments.

CAUTION Not all commands have a query form. Unless otherwise stated in Table 3-2, commands have both a command and a query form. Any command in the table that is shown with a "?" at the end, is a "Query Only" command.

Std/New Column

The **Std/New** column in Table 3-2 shows the status of the command with respect to the SCPI standard. The "Std" commands operate as defined in the SCPI standard and as defined in this guide.

The category of "New" consists of commands that could be:

- SCPI approved but are not yet in the SCPI manual
- Agilent approved and submitted for SCPI approval.
- Not approved at all.

The "New" commands operate as defined in this guide.

Parameter Form Column

Refer to the sections titled "Parameter Types" on page 3-41 and "Programming the Instrument for Remote Operation" on page 3-30 for descriptions of the different parameter types (such as <Boolean>, <NRf>, <arbitrary block>, etc.).

Table 3-2. Agilent 53147A/148A/149A SCPI Command Summary

Keyword/Syntax	Parameter Form	Std/New	Comments
:ABORt		Std	Event; no query. Resets the trigger system and aborts any measurement in progress. Places the trigger system in the IDLE state.
:CALibration		Std	Subsystem. Controls the calibration of the Power meter.
[:ALL]			Zeros the power meter and calibrates it.
:AUTO	<character_data> ONCE		Calibrates the power meter.
:DATA	<numeric_value1><numeric_value2>		Writes checksum and other data relating to the calibration data.
:HEADer	<numeric_value3><string>		
:SECurity	<Boolean>		
:CODE	<numeric_value>		Changes/sets the CAL:SECurity code.
:STATe	<Boolean><numeric_value>		Enables/disables access to calibration memory. The <numeric_value> is the current value of CAL:SECurity:CODE.
:RCFactor	<numeric_value>		Corrects all power readings when calibration tables are disabled.
:ZERO			
:AUTO	<character_data> ONCE		Zeros the Power Meter.
:CONFigure		Std	See Measurement Instructions in this table.
:DISPlay		Std	Subsystem. Controls the selection and presentation of textual information on the display.
:ENABle	<Boolean>	Std	Controls whether or not the entire display is visible.
[:WINDow]			
:BACKground			
[:STATe]	<Boolean>	New	Turns the LCD display backlight ON or OFF.
:FETCh		Std	See Measurement Instructions in this table.
:INITiate		Std	Subsystem. Controls the initiation of measurements.
:CONTinuous	<Boolean>	Std	Sets the instrument for continuously initiated or user-initiated measurements.
[:IMMediate]		Std	Event; no query. Causes the instrument to initiate and complete one full measurement cycle.

Table 3-2. Agilent 53147A/148A/149A SCPI Command Summary (continued)

Keyword/Syntax	Parameter Form	Std/New	Comments
:INPut		Std	Subsystem. Controls the characteristics of the instrument's Channel 1 input port.
:FILTer		Std	Subtree. Controls a filter that can be inserted in the path of the measurement signal.
[:LPASs]		Std	Subtree. Selects the Low-PASs filter.
[:STATe]	<Boolean>	Std	Enables or disables the Channel 1 low-pass filter (approx. 50 KHz).
:MEASure		Std	See Measurement Instructions in this table.

Table 3-2. Agilent 53147A/148A/149A SCPI Command Summary (continued)

Keyword/Syntax	Parameter Form	Std/New	Comments
Measurement Instructions			
:CONFigure[:SCALar]:<function>	See <parameters> and <source_list> below.	Std	Configures the instrument to perform the specified measurement.
:CONFigure?		Std	Returns the function configured by the last :CONFigure or :MEASure command.
:MEASure:[:SCALar]:<function>?	See <parameters> and <source_list> below.	Std	Configures the instrument, initiates measurement, and queries for the result (i.e., provides a complete measurement sequence.
:READ[:SCALar]:<function>?		Std	Initiates measurement, and queries for the result. (Performs a :FETCh? on “fresh” data.)
:FETCh[:SCALar]:<function>?		Std	Queries the measurement made by a previous :MEASure, :READ, or :INITiate command.

*The <function> and corresponding <parameters> and <source_list> are defined below:

<function>	<parameters>	[,<source_list>]*	Std/New
[:VOLTage][:DC]FREQuency	[<expected_value>[, <resolution>]]	[,(@1) ǀ (@2)] [,(@2)]	Std
:POWer[:AC]	[<expected_value>[, <resolution>]]	[,(@3)]	Std
:VOLTage[:DC]	<expected_value>	[,(@4)]	Std

*<source_list> has the same syntax as SCPI <channel_list>. For example, a frequency measurement on channel 2 uses (@2) to specify channel 2.

Table 3-2. Agilent 53147A/148A/149A SCPI Command Summary (continued)

Keyword/Syntax	Parameter Form	Std/New	Comments
:MEMory		Std	Subsystem. Manages instrument memory.
:CLEAr[:NAME]	<name>	Std	Event; no query. Restores the frequency values in the named correction profile to the default values and sets all loss values to zero.
:DATA	<name>, <data>	Std	Stores data in the named correction profile.
:DATA?	<name>	Std	Queries the data in the named correction profile.
:NSTates?		Std	Query only. Returns the number of available *SAV/*RCL states in the instrument.
:READ		Std	See Measurement Instructions in this table.
[:SENSe]		Std	Subsystem setup commands.
:AVERage		New	Subtree. Configures the averaging function.
[:STATe]	<Boolean>	New	Turns averaging ON and OFF.
:COUNt	<numeric_value>	New	Specifies the number of measurements to combine when AVERage:STATe is ON.
:CORRection		Std	Subtree. Configures the power-correction function.
:CSET			
:SELect	<character_data> CORR1 | CORR2 . . . CORR9	Std	Selects a power-correction profile.
:STATe	<Boolean>	Std	When STATe is ON, power measurements are modified according to the data in the correction profile selected with :SELect.
:DATA?	<data_handle>	Std	Query only. Returns the current measurement result data of the SENSe subsystem.
	"[XNONe]FREQuency [1|2]"	Std	Frequency on channel 1 or 2.
	"[XNONe]POWer [2]"	Std	Power on channel 2.
:FILTer		Std	Subtree. Controls the use of filtering routines in the instrument.
:FM			
:AUTO	<Boolean>	New	Turns automatic FM compensation ON or OFF.

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Table 3-2. Agilent 53147A/148A/149A SCPI Command Summary (continued)

Keyword/Syntax	Parameter Form	Std/New	Comments
[:SENSe] (cont.)			
:FREQuency		Std	Subtree. Controls the frequency-measuring capabilities of the instrument.
:OFFSet	<numeric_value>[frequency unit]	Std	Sets a reference frequency for all other absolute frequency settings in the instrument.
:STATe	<Boolean>	New	When STATe is ON, frequency measurements are modified by the value of FREQ:OFFset.
:RESolution	<numeric_value>[frequency unit]	Std	Sets the frequency-measurement resolution.
:TRACking	<character_data> FAST | SLOW | OFF	New	Selects one of three signal-tracking modes.
:FUNCtion		Std	Subtree. Selects the <sensor_function>(s) to be sensed by the instrument.
[:OFF]	<sensor_function>[,<sensor_function>] "[XNONe]FREQuency [1|2]" "[XNONe]POWer"	New	Selects the <sensor_function>(s) to be turned OFF.
[:ON]	<sensor_function>[,<sensor_function>] "[XNONe]FREQuency [1|2]" "[XNONe]POWer"	Std	Selects the <sensor_function> to be sensed by the instrument.
:STATe?	<sensor_function>	Std	Query that returns a Boolean value which indicates whether the specified <sensor_function> is ON or OFF.
:POWer		Std	Subtree. Configures the instrument for power measurement on channel 2.
:AC			
:REFerence	<numeric_value>	Std	Sets a reference amplitude (in dB) for display of power measurements.
:STATe	<Boolean>	Std	Determines whether amplitude is measured in absolute or relative mode.
:OFFset	<Boolean>	Std	Turns the Power Offset function on or off.
:ROSCillator		Std	Subtree. Controls the reference oscillator.
:SOURce	<character_program_data> INTernal | EXTernal	Std	Sets the selection of a reference timebase (INTernal or EXTernal).

Table 3-2. Agilent 53147A/148A/149A SCPI Command Summary (continued)

Keyword/Syntax	Parameter Form	Std/New	Comments
:STATus		Std	Subsystem. Controls the SCPI-defined (Operation and Questionable) status-reporting structures.
:OPERation		Std	Subtree.
:CONDition?		Std	Query only. Queries the Operation Condition Status Register.
:ENABle	<non-decimal numeric> | <NRf>	Std	Sets the Operation Event Status Enable Register.
[:EVENt]?		Std	Query only. Queries and then clears the Operation Event Status Register.
:NTRansition	<non-decimal numeric> | <NRf>	Std	Sets and queries the negative transition filter for the Operation status reporting structure.
:PTRansition	<non-decimal numeric> | <NRf>	Std	Sets and queries the positive transition filter for the Operation status reporting structure
:PRESet		Std	Event; No query. Presets the enable registers and transition filters associated with the Operation and Questionable status reporting structures.
:QUEStionable		Std	Subtree.
[:EVENt]?		Std	Query only. Queries and then clears the Questionable Data Event Status Register.
:CONDition?	<non-decimal numeric> | <NRf>	Std	Query only. Queries the Questionable Data Condition Status Register.
:ENABle		Std	Sets the Questionable Data Event Status Enable Register structures.

3

Table 3-2. Agilent 53147A/148A/149A SCPI Command Summary (continued)

Keyword/Syntax	Parameter Form	Std/New	Comments
:SYSTem		Std	Subsystem. Collects the functions that are not related to instrument performance.
:COMMunicate		Std	Subtree. Collects together configuration of control/communication interfaces.
:GPIB		Std	Subtree. Controls the GPIB.
[:SELF]			
:ADDRess	<numeric_value>	Std	Sets the GPIB address of the instrument.
:SERial		Std	Subtree.
[:RECeive]			
:BAUD	<numeric_value>	Std	Sets the baud rate.
:ERRor?		Std	Query only. Queries the oldest error in the Error Queue and removes the error from the queue (first in-first out). See "Errors" on page 3-150 for error definitions.
:VERSion?		Std	Query only. Returns the SCPI version number with which the instrument complies.
:TRIGger		Std	Subsystem.
[:SEQuence]			
:HOLDoff	<numeric_value>	Std	When INIT:CONT ON, this command specifies the length of the delay between measurements.
:UNIT		Std	Subsystem.
:POWer	<character_data> DBM I W	Std	Subtree. Selects the unit type for power measurements (dBm or Watt).

3

*RST Response

The IEEE 488.2 *RST command returns the instrument to a specified state optimized for remote operation. (Use *CLS to clear the status event registers and the SCPI error queue.)

The states of command settings affected by the *RST command are described in Table 3-3. Table 3-4 lists command settings that are unaffected by *RST.

Table 3-3. Agilent 53147A/148A/149A *RST State

Command Header	Parameter	State
*DDT	<arbitrary block>	#14INIT
:DISPlay[:WINDow]:BACKground[:STATe] :DISPlay:ENABle	<Boolean> <Boolean>	ON ON
:INITiate:CONTinuous	<Boolean>	OFF
:INPut:FILTer:[:LPASs][:STATe]	<Boolean>	OFF
[:SENSe]:AVERage:[STATe] [:SENSe]:AVERage:[COUNt] [:SENSe]:FILTer:FM:AUTO	<Boolean> <numeric_value> <Boolean>	OFF 1 ON
[:SENSe]:CORRection:CSET:SELect [:SENSe]:CORRection:CSET:STATe [:SENSe]:FREQuency:OFFset [:SENSe]:FREQuency:OFFset:STATe [:SENSe]:FREQuency:RESolution [:SENSe]:FREQuency:TRACking [:SENSe]:FUNCtion:OFF [:SENSe]:FUNCtion[:ON] [:SENSe]:POWer:AC:REFerence [:SENSe]:POWer:AC:REFerence:STATe [:SENSe]:ROSCillator:SOURce	<character_data> <Boolean> <numeric_value>[frequency unit> <Boolean> <numeric_value>[frequency unit> <character_program_data> <sensor_function> <sensor_function> <numeric_value> <Boolean> INTernal I EXTernal <Boolean>	CORR1 OFF 0 OFF 1 Hz SLOW “FREQuency 1”, “POWer 2” “FREQuency 2” 0 OFF INTernal
:TRIGger[:SEQuence]:HOLDoff	<numeric_value>	0

Table 3-4. Unaffected by *RST

Item
*ESE
*PRE
*SRE
:MEMory:NSTates?
:STATus subsystem—all command settings
:SYSTem subsystem—all command settings

3

Programming the Instrument for Remote Operation

This section provides remote-operation setup and programming information. You can use this information to configure the instrument to operate as a remote device.

NOTE

Most of this chapter deals with programming the Agilent 53147A, 53148A, and 53149A using SCPI and IEEE 488.2 commands. With two minor exceptions, the only difference between programming these instruments using the GPIB interface and the RS-232 serial interface is the manner in which you connect the instrument to the computer. These exceptions are:

1. The instrument sends a command prompt over the RS-232 interface (but not the GPIB) after receiving and executing each command.

2. When an error is detected (during the Self-Test or during operation), the instrument automatically sends an error message (or messages) over the RS-232 interface (error messages must be requested over the GPIB). For additional information on error messages, see Appendix B.

Connecting the Instrument to a Computer

To program the instrument to operate remotely, you need to interface the instrument with a computer. The Agilent 53147A, 53148A, and 53149A provide two interfaces for remote, computer-controlled operation—GPIB and RS-232. The following sections describe how to connect and configure both interfaces for remote instrument operation.

Connecting With the GPIB

To connect the instrument to a computer using the GPIB, install an GPIB cable (such as the Agilent 10833A cable) between the two units, as shown in Figure 3-3.

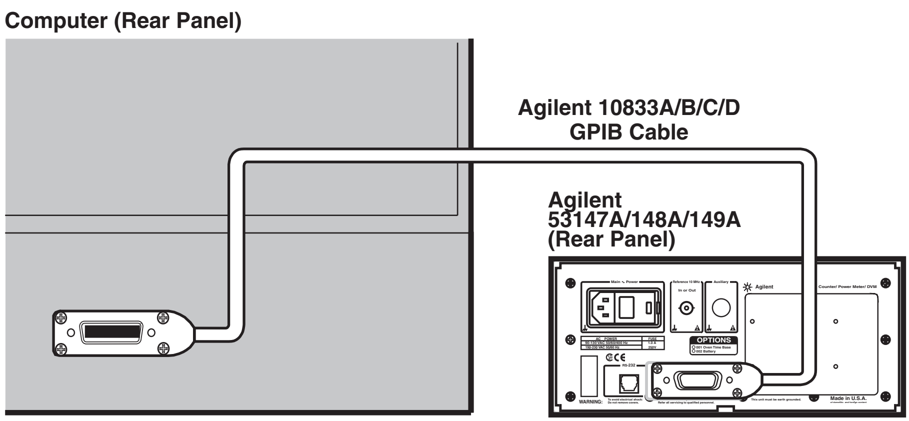


Figure 3-3. GPIB Interconnection

Configuring the GPIB

The instrument's GPIB operates in Addressed (talk/listen) mode, which provides bi-directional communication. The instrument can receive commands and setups from a computer, and it can send data and measurement results. There is one configurable setting related to GPIB communication—the GPIB Address.

The following section, titled "Changing the GPIB Address," provides instructions for setting the GPIB address from the instrument's front panel.

NOTE Once the instrument is in Remote mode, all front-panel keys except the **Reset/Local** key are disabled. As long as local-lockout is off, pressing the **Reset/Local** key returns the instrument to Local mode.

Changing the GPIB Address

1 Press and release the **Shift** key, and then press **Menu(Reset/Local)**. The instrument's menu is displayed. Press the up or down arrow key repeatedly until GPIB ADDR is displayed, and the LED indicator between the arrow keys flashes. The current GPIB address is shown to the right of the blinking indicator (>) flashes.

2 Press the right-arrow key. The blinking indicator changes direction (from > to <), and the current GPIB address blinks.

3 Press (or press and hold) the up-arrow or down-arrow key to change the GPIB address (the available addresses are 0 to 30).

4 When your desired address is displayed, press the **Enter** key. The address you selected is assigned, and the display returns to its normal operating mode. You *must* press the **Enter** key to complete the entry.

NOTE To configure the instrument so that the a specific GPIB address is automatically assigned each time you turn the instrument on, select the address, and then save your current settings in SAV 0. The settings in SAV 0 are recalled each time the instrument is turned on.

IEEE 488.1 Interface Capabilities

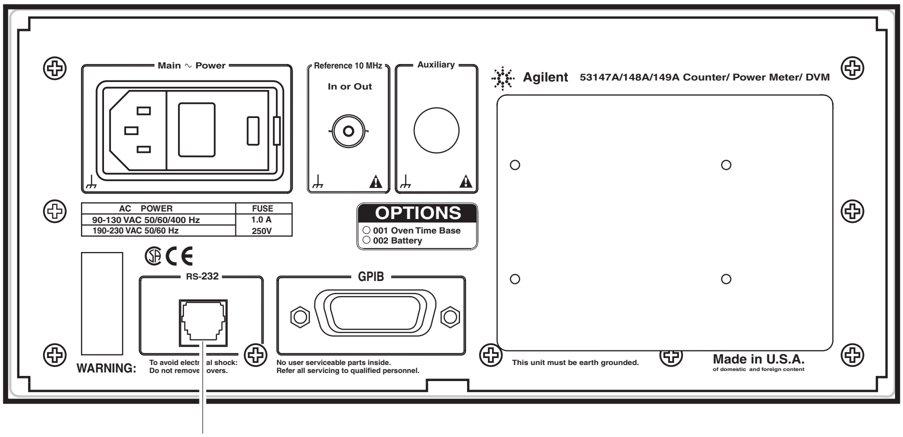
The Agilent 53147A, 53148A, and 53149A have the following IEEE 488.1 Interface capabilities:

SH1	SR1	DT1
AH1	RL1	C0
T6	PP1	E1
L3	DC1	

3

Connecting With the RS-232 Serial Interface

The Agilent 53147A, 53148A, and 53149A use an RJ12 modular connector for the RS-232 interface. This connector is accessible through the back panel of the instrument, as shown in Figure 3-4.



RS-232 (RJ12) Connector

Figure 3-4. Location of the RS-232 (RJ12) Connector

To connect the instrument to a computer using the RS-232 interface, you need a serial cable that has an RJ12 modular connector at the instrument end and a female DB25 connector at the computer end.

Making an RS-232 Cable

Most computers use male DB25 connectors for their serial ports. Therefore, you must use either a cable with an RJ12 plug at the instrument end and a female DB25 connector at the computer end or a double-ended RJ12 cable and an RJ12-to-DB25F adapter to interface the instrument with a computer. Since pre-manufactured RJ12/DB25 cables are rare, it is probably most efficient to obtain the necessary parts, and assemble the cable yourself.

Assembling the DB-25/RJ12 Adapter and the Cable

Use the following procedure to wire the adapter and assemble the cable:

1 Obtain a male DB25 to female RJ12 adapter, such as the Voltrex MAK206F (manufactured by SPC Technology) or equivalent, and either a 6-conductor male-to-male RJ12 cable of a suitable length or a similar length of 6-conductor, flat telephone cable and two RJ12 plugs. RJ12 modular plugs (SPC part number TA30-6) and 6-conductor, flat telephone cable (SPC part number TXW6151) are also available from SPC Technology (and other manufacturers).

2 Adapter kits like the Voltrex MAK206F usually include a pre-wired RJ12 modular receptacle, a DB25F connector, and the adapter body, or wiring shroud. Wire the RJ12 receptacle to the DB25F connector according to the diagrams in Figure 3-5, and then assemble the adapter according to the instructions included in the kit.

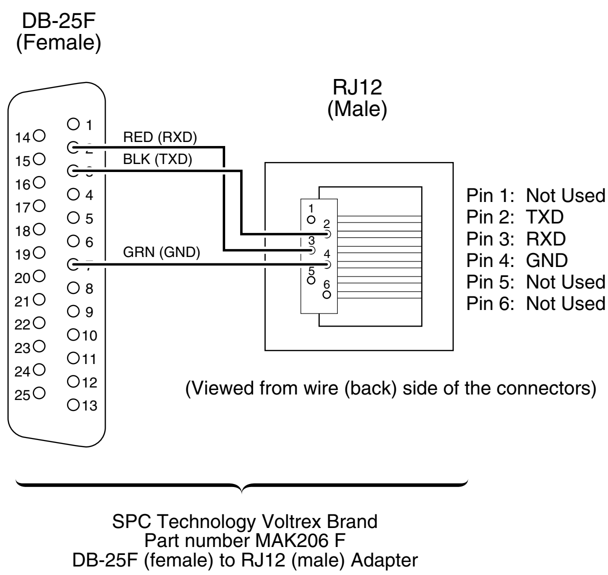


Figure 3-5. Wiring the RJ12/DB25 Adapter (1 of 2)

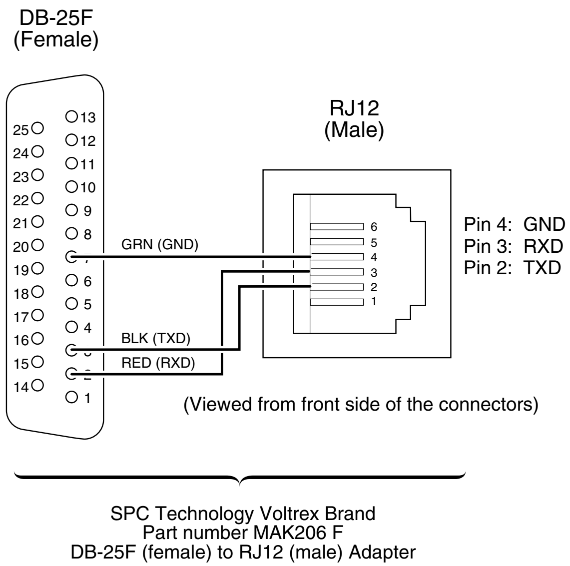


Figure 3-5. Wiring the RJ12/DB25 Adapter (2 of 2)

3 Attach an RJ12 modular plug to each end of a suitable length of 6-conductor, flat telephone cable as shown in Figure 3-6. Be sure to attach the connectors in the orientations shown in the figure.

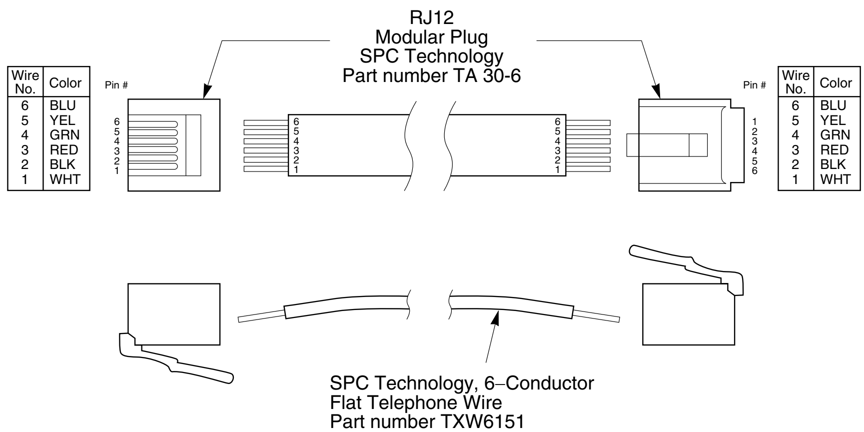


Figure 3-6. Assembling the Cable

4 Connect either end of the cable to the adapter by inserting the RJ12 plug into the receptacle on the adapter.

NOTE

This cable can be purchased from Agilent as part number 53150-60215.

Connecting with the Serial Interface

Connect the female DB25 connector on the adapter to the male DB25 serial-port connector on the computer, and then insert the RJ12 plug at the other end of the cable into the RJ12 receptacle on the back of the instrument as shown in Figure 3-7.

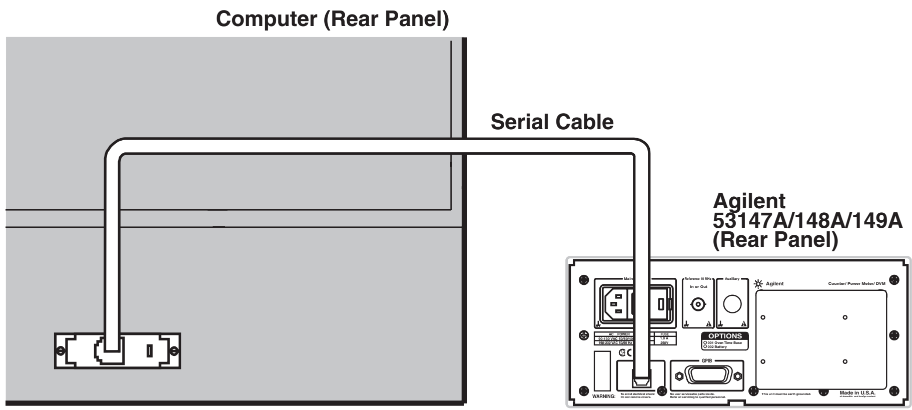


Figure 3-7. RS-232 Serial Interconnection

Remote/Local Operation

When the instrument is connected to a computer via the GPIB, and it is in Remote mode, the **Rmt** indicator is visible on the display, and the instrument settings cannot be affected using the front-panel controls. The **Reset/Local** key can be used to manually return the instrument to local control (if local-lockout is off).

When the instrument is in Local mode, the front-panel **Rmt** indicator in the display is off.

Overview of Command Types and Formats

There are two types of Agilent 53147A/148A/149A programming commands: IEEE 488.2 Common Commands and Standard Commands for Programmable Instruments (SCPI). The format of each type of command is described in the following paragraphs. (Refer to the section titled "Command Summary" on page 3-16 for SCPI conformance information.)

Common Command Format

The IEEE 488.2 Standard defines Common Commands as commands that perform functions like reset, self-test, status byte query, and identification. Common Commands always begin with the asterisk (*) character, and may include parameters. The command keyword is separated from the first parameter by a space character. Some examples of Common Commands are as follows:

```
*RST        *IDN?        *RCL 1
```

SCPI Command and Query Format

SCPI commands perform functions like instrument setup. A subsystem command has a hierarchical structure that usually consists of a top level (or root) keyword, one or more lower-level keywords, and parameters. The following example shows a command and its associated query:

```
:DISPlay:ENABle:ON
:DISPlay:ENABle?
```

In this example, DISPlay is the root-level keyword, ENABle is the second-level keyword, and ON is the command parameter.

3

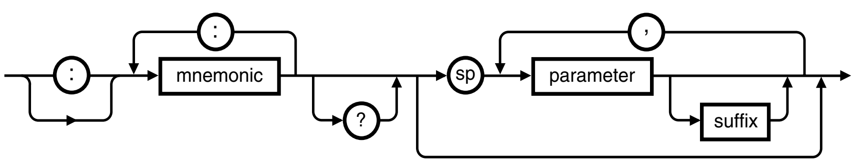
Elements of SCPI Commands

A program command or query is composed of functional elements that include a header (or keywords with colon separators), program data, and terminators. These elements are sent to the instrument over the GPIB or the RS-232 interface as a sequence of ASCII data messages. Examples of a typical Common Command and Subsystem Command are:

```
OUTPUT 712;"*CLS"
OUTPUT 712;":DISP:ENAB ON;:FREQ:RES 1KHz"
```

Subsystem Command Syntax

Figure 3-8 shows the simplified syntax of a Subsystem Command. You must use a space (SP) between the last command mnemonic and the first parameter in a Subsystem Command. Note that if you send more than one parameter with a single command, you must separate adjacent parameters with a comma.

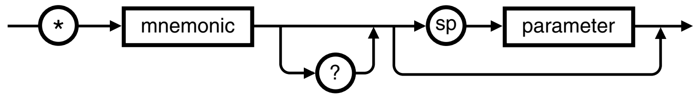


NOTE: sp = space. ASCII character decimal 32

Figure 3-8. Simplified Program Command Syntax Diagram

Common Command Syntax

Figure 3-9 shows the simplified syntax of a Common Command. You must use a space (SP) between the command mnemonic and the parameter in a common command.



NOTE: sp = space. ASCII character decimal 32

Figure 3-9. Simplified Common Command Syntax Diagram

Abbreviated Commands

The command syntax shows most keywords as a mixture of upper- and lowercase letters. Uppercase letters indicate the abbreviated spelling for the command. For better program readability, you may send the entire keyword. The Agilent 53147A/148A/149A accepts either command form and is not case sensitive.

For example, if the command syntax shows DISPlay, then DISP and DISPLAY are both acceptable forms. Other forms of DISPlay, such as DISPL or DISPLA are illegal, and they generate errors. You may use upper and/or lower case letters. Therefore, DISPLAY, display, and DiSpLaY are all acceptable.

Keyword Separator

A colon (:) always separates one keyword from the next lower-level keyword as shown below:

:DISPlay:ENABle?

Optional Keyword

Optional keywords are those which appear in square brackets ([ ]) in the command syntax. (Note that the brackets are not part of the command and are not sent to the instrument.)

Suppose you send a second level keyword without the preceding optional keyword. In this case, the instrument assumes you intend to use the optional keyword and responds as if you had sent it.

3

Examine the portion of the [:SENSe] subsystem shown below:

```
[:SENSe]
  :FREQuency
    :RESolution
```

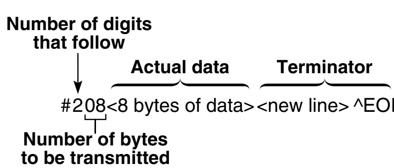
The root-level keyword [:SENSe] is an optional keyword. To set the instrument's frequency resolution, you can use either of the following:

```
:SENS:FREQ:RES
     or
:FREQ:RES
```

Parameter Types

Table 3-1 contains explanations and examples of parameter types. Parameter types may be numeric value, Boolean, literal, NRf, string, non-decimal numeric, or arbitrary block.

Table 3-5. Command and Query Parameter Types

Type	Explanations and Examples
<numeric value>	Accepts all commonly used decimal representation of numbers including optional signs, decimal points, and scientific notation: 123, 123e2, –123, –1.23e2, .123, 1.23e–2, 1.23000E–01. Special cases include MINimum and MAXimum as follows: MINimum selects minimum value available, and MAXimum selects maximum value available. Queries using MINimum or MAXimum return the associated numeric value.
<Boolean>	Represents a single binary condition that is either true or false: 1 or ON, 0 or OFF (Query response returns only 1 or 0.) An <NRf> is rounded to an integer. A non-zero value is interpreted as 1.
<literal>	Selects from a finite number of choices. These parameters use mnemonics to represent each valid setting. An example is the INPut:COUPling AC I DC command parameters (AC I DC). Flexible numeric representation. The following BASIC statement sends a command containing a <string> parameter: **OUTPUT 703;"FUNC ‘FREQ’"**
<non-decimal numeric>	Format for specifying hexadecimal (#H1F), octal (#Q1077), and binary (#B10101011) numbers using ASCII characters. May be used in :STATus subsystem commands.
<arbitrary block>	The syntax is a pound sign (#) followed by a non-zero digit representing the number of digits in the subsequent decimal integer. The decimal integer specifies the number of 8-bit data bytes being sent. This is followed by the actual data. The terminator is a line feed asserted with EOI. For example, for transmitting 8 bytes of data, the format could be: 

Parameter Separator

If you send more than one parameter with a single command, you must separate adjacent parameters with a comma.

Query Parameters

All selectable <numeric value> parameters (except Common Commands) can be queried to return the minimum, maximum, and DEFault values they are capable of being set to by sending a MINimum, MAXimum, or DEFault parameter after the "?." For example, consider the AVERage:COUNt? query.

If you send the query without specifying a parameter (AVER:COUN?), the present setting is returned. If you send the MIN parameter (using AVER:COUN? MIN), the command returns the minimum acceptable count. If you send the MAX parameter, the command returns the maximum level currently available. Be sure to place a space between the question mark and the parameter.

Suffixes

A suffix is the combination of suffix elements and multipliers that can be used to interpret some <numeric value>. If a suffix is not specified, the instrument assumes that <numeric value> is unscaled (that is, Volts, seconds, etc.)

For example, the following two commands are equivalent:

```
OUTPUT 703;"FREQ:RES 1kHz"
OUTPUT 703;"FREQ:RES 1E+3"
```

Suffix Elements

Suffix elements, such as HZ (Hertz), S (seconds), V (volts), OHM (Ohms), PCT (percent), and DEG (degrees) are allowed within this format.

Suffix Multipliers

Table 3-6 lists the suffix multipliers that can be used with suffix elements (except PCT and DEG).

Table 3-6. Suffix Multipliers

Definition	Mnemonic	Name
1E15	PE	PETA
1E12	T	TERA
1E9	G	GIGA
1E6	MA (or M for OHM and HZ)*	MEGA
1E3	K	KILO
1E-3	M (except for OHM and HZ)*	MILLI
1E-6	U	MICRO
1E-9	N	NANO
1E-12	P	PICO
1E-15	F	FEMTO
1E-18	A	ATTO
*The suffix units, MHZ and MOHM, are special cases that should not be confused with <suffix multiplier>HZ and <suffix multiplier>OHM.		

Command Terminator

A command may be terminated with a <new line> (ASCII character decimal 10), an EOI (End-of-Identify) asserted concurrent with last byte, or an EOI asserted concurrent with a <new line> as the last byte.

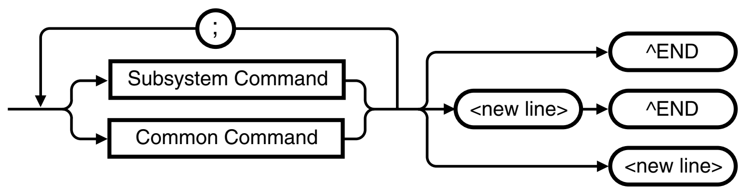
Using Multiple Commands

Program Messages

Program Messages are a combination of one or more properly formatted SCPI Commands. Program messages always go from a computer to the instrument. They are sent to the instrument over its GPIB or serial interface as a sequence of ASCII data messages.

Program Message Syntax

Figure 3-10 shows the simplified syntax of a program message. You can see Common Commands and Subsystem Commands in the same program message. If you send more than one command in one message, you must separate adjacent commands with a semicolon.



<new line> = ASCII character decimal 10
^END = EOI asserted concurrent with last byte

Figure 3-10. Simplified Program Message Syntax Diagram

When using IEEE 488.2 Common Commands with SCPI Subsystem commands on the same line, use a semicolon between adjacent commands. For example:

```
*RST;:SENS:AVER ON
```

When multiple subsystem commands are sent in one program message, the first command is always referenced to the root node. Subsequent commands, separated by “;”, are referenced to the same level as the preceding command if no “:” is present immediately after the command separator (the semicolon).

For example, sending :SENS:AVER:COUN 5; STAT ON is equivalent to

sending:

```
:SENS:AVER:COUN 5
:SENS:AVER:STAT ON
      or
:SENS:AVER:COUN 5;:SENS:AVER:STAT ON
```

The “:” must be present to distinguish another root level command. For example:

```
:SENS:AVER:COUN 5;:INIT:CONT OFF
```

is equivalent to sending:

```
:SENS:AVER:COUN 5
:INIT:CONT OFF
```

If the “:”(which is following the “;” and is in front of INIT) is omitted, the instrument assumes that the second command is “:SENS:AVER:INIT:CONT OFF” and generates a syntax error.

3

Overview of Response Message Formats

Response Messages

Response messages are data sent from the instrument to a computer in response to a query. A query is a command followed by a question mark. Queries are used to find out how the instrument is currently configured and to transfer data from the instrument to the computer.

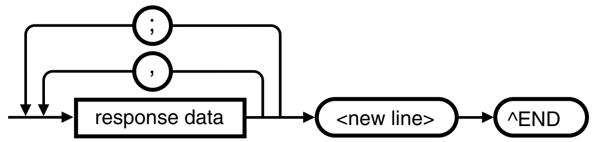
After receiving a query, the instrument interrogates the requested configuration and places the response in its output queue. The output message remains in the queue until it is read or another command is issued. When read, the message is transmitted across the GPIB or the serial interface to the computer. You read the message by using some type of enter statement that includes the device address and an appropriate variable. Use a print statement to display the message. The following BASIC example illustrates how to query the instrument and display the message:

```
10 OUTPUT 703;":ROSC:SOUR?"
20 ENTER 703; A$
30 PRINT A$
40 END
```

Response Message Syntax

Figure 3-11 shows the simplified syntax of a Response Message. Response messages may contain both commas and semicolon separators. When a single query command returns multiple values, a comma is used to separate each item. When multiple queries are sent in the same program message, the groups of data corresponding to each query are separated by a semicolon. Note that a <new line> ^END is always sent as a response message terminator.

3



NOTE

<new line> = ASCII character decimal 10
^END = EOI asserted concurrent with last byte
; = multiple response separator (ASCII character decimal 59)
, = data separator within a response (ASCII character decimal 44)

Figure 3-11. Simplified Response Message Syntax Diagram

3

Response Message Data Types

Table 3-7 contains explanations of response data types.

Table 3-7. Response Message Data Types

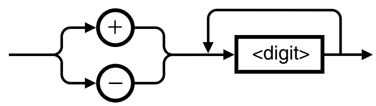
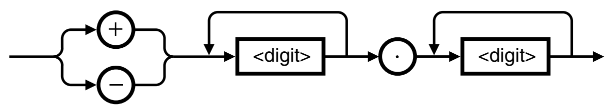
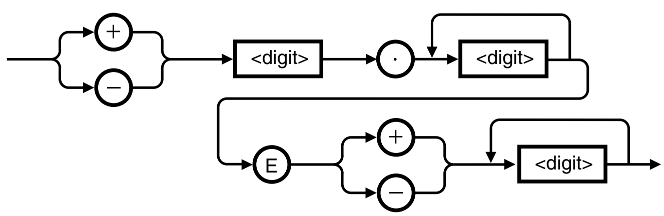
Type	Description
<NR1>	This numeric representation has an implicit radix point.  The maximum number of characters in <NR1> response data is 17 (maximum 16 digits, 1 sign).
<NR2>	This numeric representation has an explicit radix point.  The maximum number of characters in <NR2> response data is 17 (maximum 15 mantissa digits, 1 sign, 1 decimal point).
<NR3>	This numeric representation has an explicit radix point and an exponent.  The maximum number of characters in <NR3> response data is 22 (maximum 15 mantissa digits, 2 signs, 1 decimal point, 1 ’E’ character, 3 exponent digits).
Not a Number	“Not a Number” is represented by the value 9.91E37. (Not a Number is defined in IEEE 754). The instrument responds with this numeric value when queried for a floating point number it cannot provide. This value will be formatted as an <NR3>.
<Boolean>	A single ASCII-encoded byte, 0 or 1, is returned for the query of settings that use <Boolean> parameters.
<literal>	ASCII-encoded bytes corresponding to the short form of the literal used as the command parameter.

Table 3-7. Response Message Data Types (continued)

Type	Description
<string>	A string response consists of ASCII characters enclosed by double quotes. For example, string data is used for the “<error description>” portion of :SYST:ERR? response and for [:SENS]:FUNC? response.
<definite length block>	The syntax is a pound sign (#) followed by a non-zero digit representing the number of digits in the subsequent decimal integer. The decimal integer specifies the number of 8-bit data bytes being sent. This is followed by the actual data. The terminator is a line feed asserted with EOI. For example, for transmitting 8 bytes of data, the format might be: **Number of digits that follow** **Actual data** **Terminator** #208<8 bytes of data><new line> ^EOI **Number of bytes to be transmitted** The “2” indicates the number of digits that follow and the two digits “08” indicate the number of *data* bytes to be transmitted. A zero-length block has the format: #0<new line>^EOI <new line> is defined as a single ASCII-encoded byte corresponding to 10 decimal.

Status Reporting

The Agilent 53147A, 53148A, and 53149A status registers conform to the SCPI and IEEE 488.2 standards.

Figure 3-12 shows all of the status-register groups and queues in the instrument. This is a high level diagram that does not show all the registers that are contained in each group. It is intended as a guide to the bits used in each of these register groups to monitor the instrument's status. Note that a summary of the Standard Status Structure Registers (defined by IEEE 488.2-1987) is shown in addition to the Operation Status and Questionable Data/Signal Register groups.

Refer to the section titled "Programming the Instrument for Status Reporting" on page 3-67 and the flowchart in Figure 3-16 for detailed information on programming the status-reporting system.

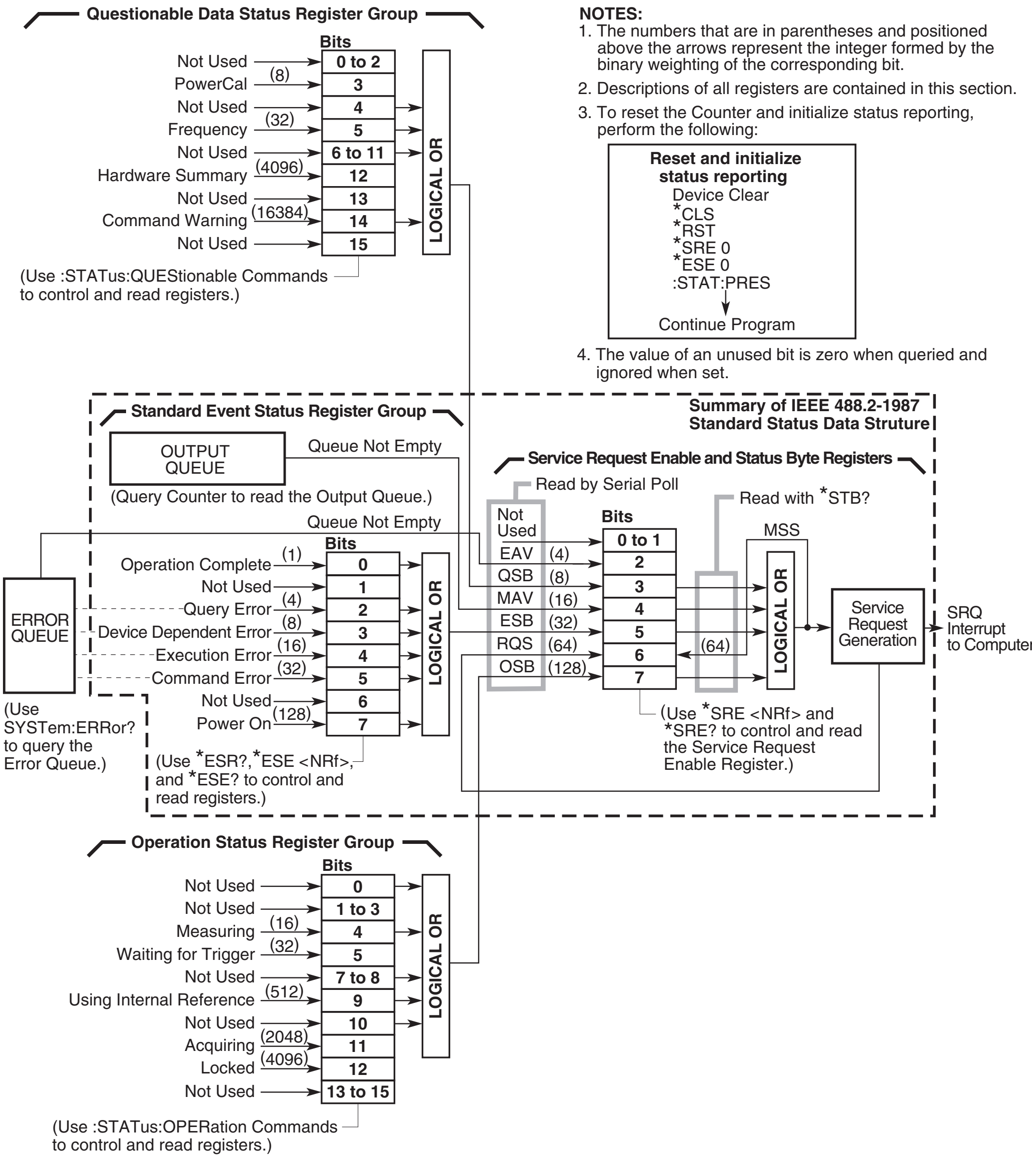


Figure 3-12. 53147A/148A/149A SCPI Status Reporting Summary Functional Diagram

Status Byte Register and Service Request Enable Register

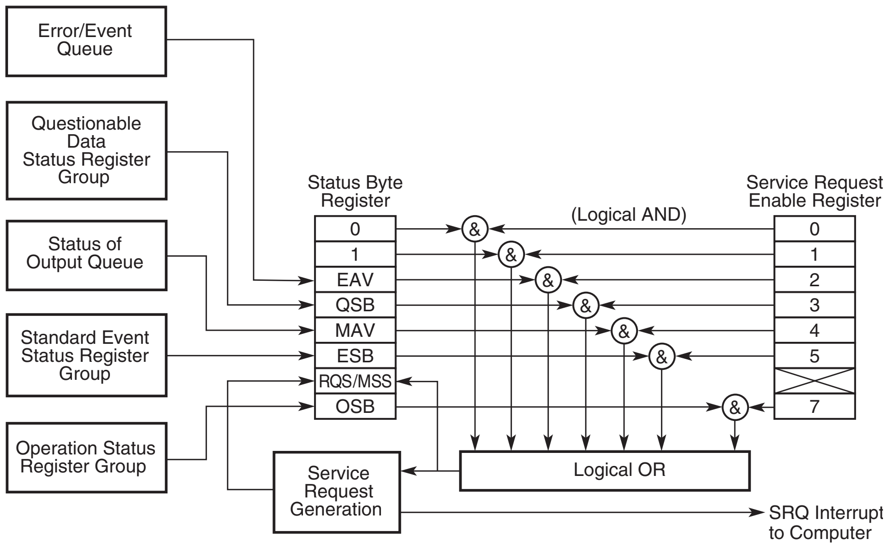


Figure 3-13. Status Byte and Service Request Enable

Status Byte Register

The Status Byte Register is the summary-level register in the status reporting structure. It contains summary bits that monitor activity in the other status registers and queues as shown in Figure 3-13. The Status Byte Register is a live register—its summary bits are set TRUE or FALSE (one or zero) by the presence or absence of the condition which is being summarized.

The Status Byte Register can be read with either a serial poll or the *STB? query, but it is altered only when the state of the overlying status data structures is altered. The entire Status Byte Register can be cleared by sending just the *CLS command to the instrument in a program message.

Table 3-8 lists the Status Byte Register bits and briefly describes each bit.

Table 3-8. Status Byte Register

Bit	Weight	Symbol	Description
0	—	—	Not used
1	—	—	Not used
2	4	EAV	Error/Event Queue Not Empty
3	8	QSB	Questionable Data/Signal Status Register Summary Bit
4	16	MAV	Message Available Summary Bit
5	32	ESB	Standard Event Status Register Summary Bit
6	64	RQS/MSS	Request Service/Master Status Summary Bit
7	128	OSB	Operation Status Register Summary Bit

A detailed description of each bit in the Status Byte Register follows:

- **Bits 0 - 1** are not used.
- **Bit 2 (EAV)** Summarizes the Error/Event Queue.

  This bit is set when the Error/Event Queue is not empty.
- **Bit 3 (QSB)** summarizes the Questionable Data Status Event Register.

  This bit indicates whether or not one or more of the enabled Questionable Data events have occurred since the last reading or clearing of the Questionable Data Status Event Register.

  This bit is set TRUE (one) when an enabled event in the Questionable Data Status Event Register is set TRUE. Conversely, this bit is set FALSE (zero) when no enabled events are set TRUE.
- **Bit 4 (MAV)** (Message AVailable) summarizes the Output Queue.

  This bit indicates whether or not the Output Queue is empty.

  This bit is set TRUE (one) when the instrument is ready to accept a request by the external computer to output data bytes; that is, the Output Queue is not empty. This bit is set FALSE (zero) when the Output Queue is empty.

- **Bit 5 (ESB)** summarizes the Standard Event Status Register.

  This bit indicates whether or not one of the enabled Standard Event Status Register events have occurred since the last reading or clearing of the Standard Event Status Register.

  This bit is set TRUE (one) when an enabled event in the Standard Event Status Register is set TRUE. Conversely, this bit is set FALSE (zero) when no enabled events are set TRUE.

- **Bit 6 (RQS/MSS)** summarizes IEEE 488.1 RQS and Master Summary Status.

  When a serial poll is used to read the Status Byte Register, the RQS bit indicates if the device was sending SRQ TRUE. The RQS bit is set FALSE by a serial poll.

  When *STB? is used to read the Status Byte Register, the MSS bit indicates the Master Summary Status. The MSS bit indicates whether or not the instrument has at least one reason for requesting service.

- **Bit 7 (OSB)** summarizes the Operation Status Event Register.

  This bit indicates whether or not one or more of the enabled Operation events have occurred since the last reading or clearing of the Operation Status Event Register.

  This bit is set TRUE (one) when an enabled event in the Operation Status Event Register is set TRUE. Conversely, this bit is set FALSE (zero) when no enabled events are set TRUE.

Service Request Enable Register

The Service Request Enable Register selects which summary bits in the Status Byte Register may cause service requests as shown in Figure 3-7.

Use *SRE to write to this register and *SRE? to read this register.

Use *SRE 0 to clear the register. A cleared register does not allow status information to generate the service requests. (Power-on also clears this register.)

Standard Event Status Register Group

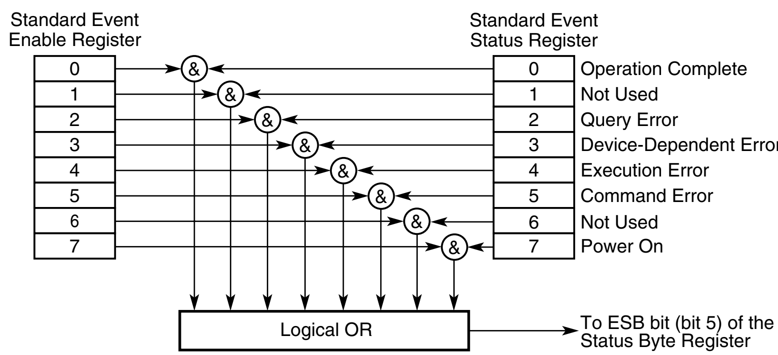


Figure 3-14. Standard Event Status Reporting

Standard Event Status Register

The Standard Event Status Register contains bits that monitor specific IEEE 488.2-defined events as shown in Figure 3-14.

Use *ESR? to read this register.

Use *ESR? or *CLS to clear this register.

3

Table 3-9 lists the Standard Event Status Register bits and briefly describes each bit.

Table 3-9. Standard Event Status Register

Bit	Weight	Symbol	Description
0	1	OPC	Operation Complete
1	—	(RQC)	Not used because this instrument cannot request permission to become active IEEE 488.1 controller-in-charge.
2	4	QYE	Query Error
3	8	DDE	Device-Specific Error
4	16	EXE	Execution Error
5	32	CME	Command Error
6	—	(URQ)	Not used, because this instrument does not define any local controls as “User Request” controls.
7	128	PON	Power On

A detailed description of each bit in the Standard Event Status Register follows:

- **Bit 0 (Operation Complete)** is an event bit which is generated in response to the *OPC command. This bit indicates that the instrument has completed all pending operations (the pending operation condition has transitioned from TRUE to FALSE).

  If AVERage:STATe is OFF, the command INIT;*OPC sets the OPC bit once the instrument completes a measurement; if AVERage:STATe is ON, the command INIT;*OPC sets the OPC bit once the instrument completes a measurement consisting of AVERage:COUNt measurements.

NOTE

The OPC bit is not in any way affected by the *OPC? query.

- **Bit 1** is not used.
- **Bit 2 (Query Error)** is an event bit which indicates that either 1) an attempt was made to read the Output Queue when it was empty or 2) data in the Output Queue has been lost.

  Errors -400 through -499 are query errors.

3

- **Bit 3 (Device-Specific Error)** is an event bit which indicates an operation did not properly complete due to some condition of the instrument.

  Errors -300 through -399 and all those with positive error numbers are device-specific errors.

- **Bit 4 (Execution Error)** is an event bit which indicates that a command could not be executed 1) because the parameter was out of range or inconsistent with the instrument's capabilities, or 2) because of some condition of the instrument.

  Errors -200 through -299 are execution errors.

- **Bit 5 (Command Error)** is an event bit which indicates one of the following has occurred: 1) an IEEE 488.2 syntax error, 2) a semantic error indicating an unrecognized command, or 3) a Group Execute Trigger was entered into the input buffer inside of a program message.
- **Bit 6** is not used.
- **Bit 7 (Power On)** is an event bit which indicates that an off-to-on transition has occurred in the instrument's power supply.

Standard Event Status Enable Register

The Standard Event Status Enable Register selects which events in the Standard Event Status Register are reflected in the ESB summary bit (bit 5) of the Status Byte Register as shown in Figure 3-8.

Use *ESE to write to this register and *ESE? to read this register.

Use *ESE 0 to clear the register. (Power-on also clears this register.)

3

The Operation and Questionable Data Status Register Groups

The Operation and Questionable Data Status Register Groups have the following registers:

- a condition register
- one or more transition filters
- an event register
- an event enable register

Figure 3-15 shows the model that these register groups follow.

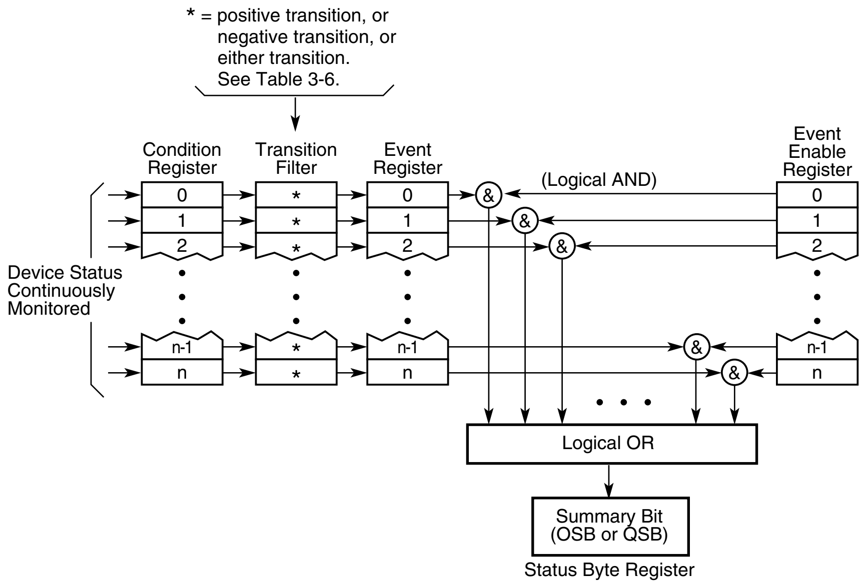


Figure 3-15. Operation and Questionable Data Status Reporting Model

Condition Register

A condition register continuously monitors the hardware and firmware status of the instrument. There is no latching or buffering for this register; it is updated in real time. Reading a condition register does not change its contents.

To read the condition registers use:

```
:STATus:OPERation:CONDition?
:STATus:QUEStionable:CONDition?
```

Transition Filter

A transition filter specifies the transition criteria for setting event bits TRUE.

When the transition filter specifies a positive transition, the event becomes TRUE when its associated condition makes a FALSE to TRUE transition only.

When the transition filter specifies a negative transition, the event becomes TRUE when its associated condition makes a TRUE to FALSE transition only.

When the transition filters specify both a positive and a negative transition, the event becomes TRUE when its associated condition makes either a FALSE to TRUE or a TRUE to FALSE transition.

A transition filter is defined by positive and negative transition filter registers. Table 3-10 describes how the transition filter registers define the transition criteria for setting an event bit TRUE.

Table 3-10. Transition Filter Definition

Positive Transition Filter Bit	Negative Transition Filter Bit	Transition Which Causes the Event-Bit to be set TRUE
TRUE	FALSE	positive transition
FALSE	TRUE	negative transition
TRUE	TRUE	either a positive or negative transition
FALSE	FALSE	neither transition (event reporting is disabled)

Transition filters are unaffected by *CLS or queries. Transition filters are set to default values by :STATus:PRESet and power-on.

To write to the Operation Status transition filter registers use:

```
:STATus:OPERation:PTRansition
:STATus:OPERation:NTRansition
```

To read these registers use:

```
:STATus:OPERation:PTRansition?
:STATus:OPERation:NTRansition?
```

Event Register

An event register captures changes in conditions.

An event register bit (event bit) is set TRUE when an associated event occurs. These bits, once set, are “sticky.” That is, they cannot be cleared even if they do not reflect the current status of a related condition, until they are read.

To read the event registers use:

:STATus:OPERation[:EVENt]?
:STATus:QUEStionable[:EVENt]?

Use event register queries or *CLS to clear event registers.

Event Enable Register

An event enable register selects which event bits in the corresponding event register can generate a summary bit.

To write the event enable registers use:

:STATus:OPERation:ENABle
:STATus:QUEStionable:ENABle

To read the event enable registers use:

:STATus:OPERation:ENABle?
:STATus:QUEStionable:ENABle?

The event enable registers are cleared by :STATus:PRESet and power-on.

Operation Status Register Group

The Operation Status Register Group monitors conditions which are part of the instrument's normal operation and has a complete set of registers that consist of the following:

- a condition register
- a positive transition filter register (PTR)
- a negative transition filter register (NTR)
- an event register
- an event enable register

Table 3-11 lists the Operation Status Register bits and briefly describes each bit. Figure 3-15 shows the model that these register groups follow.

Table 3-11. Operation Status Register

Bit	Weight	Description
0	—	Not used
1 - 3	—	Not used
4	16	Measuring
5	32	Waiting for Trigger
6 - 8	—	Not used
9	512	Using Internal Reference
10	—	Not used
11		Acquiring
12		Locked
13 - 14	—	Not used
15	—	Not used, since some controllers may have difficulty reading a 16-bit unsigned integer. The value of this bit is always 0.

A detailed description of each bit in the Operation Status Register follows:

- **Bits 0-3** are not used.
- **Bit 4 (Measuring)** is a condition bit which indicates the instrument is actively measuring.

  The condition bit is TRUE (one) during a measurement and FALSE (zero) otherwise.
- **Bits 5 (Waiting for Trigger)**

  The condition bit is TRUE (one) when the instrument is in the HOLD mode (INIT:CONT OFF), and it has not been triggered.
- **Bits 6-8** are not used.
- **Bit 9 (Using Internal Reference)** is a condition bit which indicates the instrument is using the internal reference.

  The condition bit is TRUE (one) when the instrument is using the internal reference. The condition bit is FALSE (zero) while the instrument is using the external reference. The setting of this bit is not affected by the setting of the REF OSC option in the user settings menu.
- **Bit 10** is not used.
- **Bit 11 (Acquiring)** indicates that the instrument is searching for a signal.

  The condition bit is high while the instrument is searching. It goes low when a search is complete, whether or not a signal was found. If a signal was not found, the bit goes high again after a delay (when the next search begins).
- **Bit 12 (Locked)** a value of 1 indicates that the instrument has found a measurable signal and has locked onto it.
- **Bits 13-15** are not used.

Questionable Data Status Register Group

The Questionable Data Status Register Group monitors SCPI-defined conditions.

NOTE For this register group, the transition filter is fixed as PTR with all bits set to ones. This cannot be changed or queried.

Table 3-12 lists the Questionable Data Status Register bits and briefly describes each bit.

Table 3-12. Questionable Data Status Register

Bit	Weight	Description
0 - 2	—	Not used
3	8	Power
4	—	Not used
5	32	Frequency
6 - 11	—	Not used
12	4096	Hardware Summary
13	—	Not Used
14	16384	Command Warning
15	—	Not used, since some controllers may have difficulty reading a 16-bit unsigned integer. The value of this bit is always 0.

A detailed description of each bit in the Questionable Data Status Register Group follows:

- **Bits 0-2** are not used.
- **Bit 3 (Power)**. Power Cal is turned off or the Power Cal tables in EEPROM are defective or missing.
- **Bit 5 (Frequency)** is a condition bit which indicates that frequency measurements may be affected by component failures.
- **Bits 6-11** are not used.

- **Bit 12 (Hardware Summary)** This condition is TRUE when an internal hardware fault has been detected, either in normal operation or by the self test.
- **Bit 13** is not used.
- **Bit 14 (Command Warning)** is an *event* bit indicating a command, such as CONFigure or MEASure, ignored a parameter during execution.

  Since this is an event bit, the transition filters have no effect on it.
- **Bit 15** is not used.

Programming the Instrument for Status Reporting

Determining the Condition of the Instrument

The instrument has status registers that are used to indicate its condition. There are four register groups that can be examined individually, or used to alert a computer. These registers, shown in Figure 3-15, are:

- Operation Status Register Group
- Questionable Data/Signal Register Group
- Standard Event Status Register Group
- Status Byte Register Group

The first three groups all have event registers that can be fed into the Status Byte Register. The Status Byte Register can be used to assert the SRQ line and thus alert the computer that the instrument needs attention. The following examples show how each of the register groups can be used. (Figure 3-16 is a flowchart that shows how to program the instrument for Status Reporting.)

Resetting the Instrument and Clearing the Remote Interface—Example 1

Before attempting any programming, it is a good idea to set the instrument to a known state. The following command grouping shows how to reset the instrument. Before issuing these commands, execute a device clear to reset the interface and instrument. Consult your interface card's documentation for how to issue a device clear since the device clear command will be specific to your interface. Perform the following:

1. Issue an Interface Clear and a Device Clear. (See your computer or interface card documentation on how to issue this command).
2. Issue the following commands:

```
*RST
*CLS
*SRE 0
*ESE 0
:STAT:PRES
```

Using the Standard Event Status Register to Trap an Incorrect Command—Example 2

The following command grouping shows how to use the Standard Event Status Register and the Status Byte Register to alert the computer when an incorrect command is sent to the instrument. The command *ESE 32 tells the instrument to summarize the command error bit (bit 5 of the Event Status Register) in the Status Byte Register. The command error bit is set when an incorrect command is received by the instrument. The command *SRE 32 tells the instrument to assert the SRQ line when the Event Status Register summary bit is set to 1. If the instrument is serial-polled after a command error, the serial poll result is 96 (Bit 6 + Bit 5).

Event Status Register

*ESE 32	Enable for bad command.
*SRE 32	Assert SRQ from Standard Event Status Register summary.

3

Using the Operation Status Register to Alert the Computer When Measuring is Complete—Example 3

The following command grouping illustrates how to use the Operation Status register and the Status Byte register to alert the computer when measuring has completed. This is useful if the instrument is making a long measurement. When the measurement is complete, the instrument can alert the computer.

The first line tells the instrument to watch for a negative transition from true (measuring) to false (non-measuring) of bit 4. This negative transition indicates that the instrument has completed a measurement. The next line tells the instrument to summarize the detected event (bit 4 of the Operation Status Register) in the Status Byte Register. The command *SRE 128 tells the instrument to assert SRQ when the summary bit for the Operation Status register is set to 1. A serial poll will return 192 when a measurement has completed.

Operation Status Register

:STAT:OPER:PTR 0; NTR 16	Detect transition from measuring to non-measuring.
:STAT:OPER:ENABLE 16	Enable to detect measuring.
*SRE 128	Assert SRQ on Operation Summary bit.

3

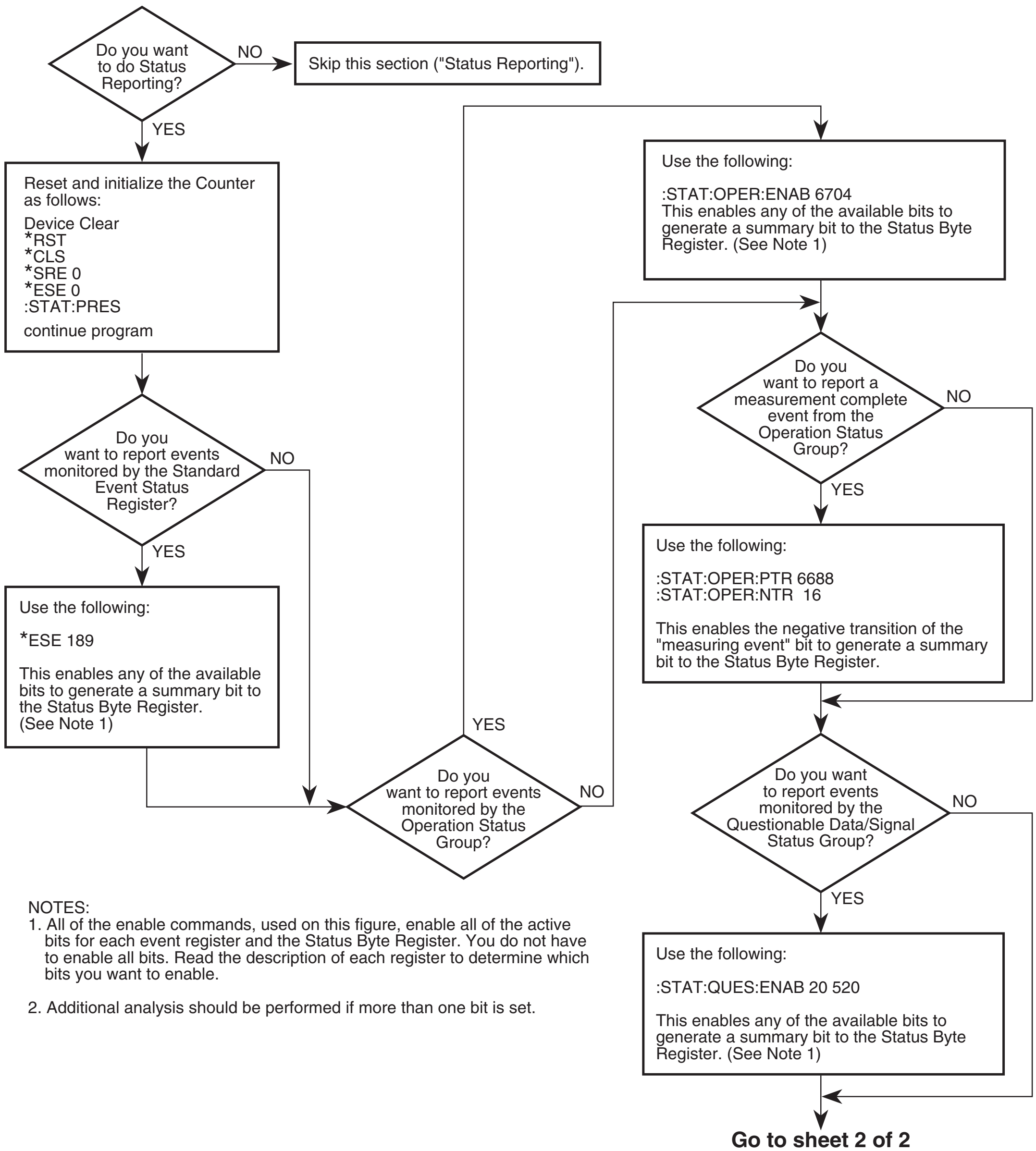


Figure 3-16. Status Reporting Flowchart (1 of 2)

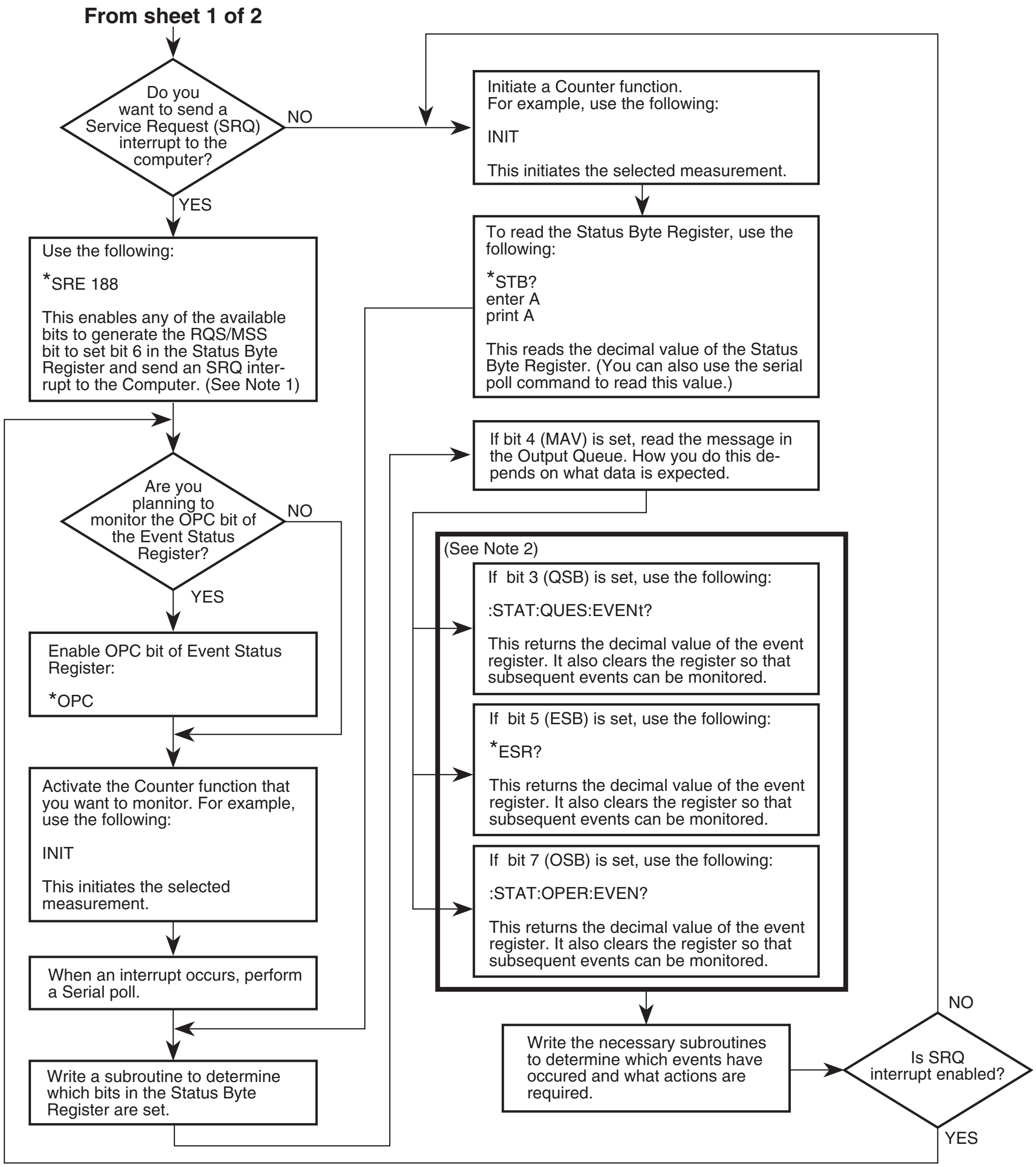


Figure 3-16. Status Reporting Flowchart (2 of 2)

Programming the Instrument to Display Results

Configuring the Instrument's Display

The instrument has three display modes:

1. Raw results. This display mode is used on power-up.
2. Relative results - results modified by offset values
3. Display Disabled - All LCD display segments disabled.

The following command groupings show how to program the instrument to any of the above display modes.

Commands for Displaying Results

Command for Displaying Raw Results

The following command always causes raw measurement results to be displayed:

*RST	Turns off all offsets.

Commands for Displaying Relative Results

FREQ:OFFS:STAT ON	Turns on offsets.
POW:AC:REF:STAT ON	Turns on offsets.

Commands for Enabling and Disabling the Display

The instrument display can be turned on or off. The normal condition is for the display to be on.

:DISP:ENABLE OFF	Disable the display, all segments off.
:DISP:ENABLE ON	Normal display mode.

Programming the Instrument to Synchronize Measurements

Synchronizing Measurement Completion

There are three commands for synchronizing the end of a measurement and computer transfer of data:

1. The *WAI command
2. The *OPC? command
3. The *OPC command to assert SRQ

The following discussion shows how to use these three commands.

Resetting the Instrument and Clearing the Interface

Before attempting any programming, it is best to set the instrument to a known state. The following command grouping illustrates how to reset the instrument. Before issuing these commands, execute a device clear to reset the interface and the instrument. You should consult your interface card's documentation for information on issuing a device clear, since the device clear command is specific to the interface you are using. Perform the following steps:

1. Issue an Interface Clear and a Device Clear. (See your computer or interface card documentation for information on how to issue this command.)
2. Issue the following commands:

```
*RST
*CLS
*SRE 0
*ESE 0
:STAT:PRES
```

Using the *WAI Command

This command is most useful when only the instrument is on the bus, and you want the instrument to send the data when it is ready. In this example, the instrument is instructed to take 50 measurements and return the average for these 50 measurements. The *WAI command that follows the :INIT command instructs the instrument to hold off execution of any further commands until the 50 measurements are complete. When the instrument has completed the 50 measurements and averages, it executes the DATA? command, which requests the results.

:AVERAGE:COUNT 50	Base the result on 50 measurements
:AVERAGE:STATE ON	Enable averaging.
:INIT	Start 50 measurements.
*WAI	Wait until 50 measurements are complete before parsing another command. At this point, commands can be issued to other instruments. The instrument stores subsequent commands but ignores them until the measurement is complete.
DATA?	Asks for the results of the 50 measurements. This command is not executed until all 50 measurements are complete and the average is computed.

3

Using the *OPC? Command

This method is useful if you want to hold off execution of the program while you wait for the instrument to complete any pending activity. In the *WAI example above, the line following the *WAI command is accepted by the instrument. However, the instrument does not execute the command because of the preceding *WAI command. If this line had been a command to address another instrument, it would be immediately executed. If you had wanted to hold off the command to another instrument, you would use the *OPC? command instead of the *WAI command.

:AVERAGE:COUNT 50	On INIT, take 50 measurements.
:AVERAGE:STATE ON	Enable averaging.
:INIT	Start making measurements.
*OPC?	Tells the instrument to put a 1 in the output buffer when 50th measurement is complete.

Read the instrument. The program waits until the instrument returns a “1”. (The GPIB timeout must be set so that it is longer than the expected measurement time.)

Using the *OPC Command to Assert SRQ

This method is recommended when the instrument is interfaced with many other instruments, any of which can assert SRQ. The commands *OPC, *ESE 1, and *SRE 32 are used to assert the SRQ line to alert the computer that the instrument has completed a measurement. It is up to the computer to use the serial poll command to determine which of the instruments on the bus requested service.

Of the three procedures discussed here, this one is the most flexible, but it is also the most complex:

:AVERAGE:COUNT 50	On INIT, take N measurements.
:AVERAGE ON	Enable averaging.
*ESE 1	Summarize OPC bit for Status Byte Register.
*SRE 32	SRQ when event summary bit is 1.

Set up program to specify service routine and enable interrupt when SRQ is asserted:

:INIT	Start measurements.
*OPC	Enable OPC bit.

The program can do other things while it is waiting for SRQ.

When SRQ occurs, and the instrument has been identified as the cause of the SRQ, ask for the data:

DATA?	Ask for data.

Writing SCPI Programs

Figure 3-17 is a general summation of how to write SCPI programs. It shows a typical sequence you might go through in the process of writing a program. You do not have to follow this exact sequence, but it will help you to become familiar with the instrument's capabilities and to direct you to sections of the guide which will be useful while writing programs.

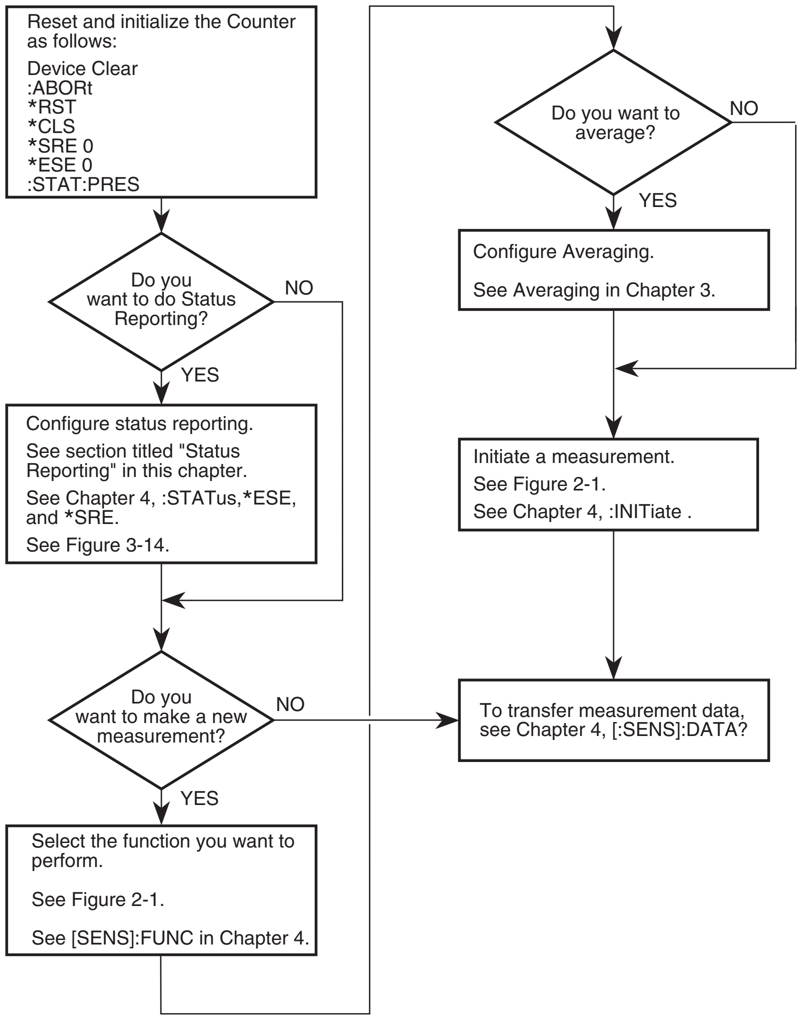


Figure 3-17. SCPI Programming Flowchart

Programming Examples

In this section, you will see how to program the Agilent 53147A/148A/149A to make common measurements. Examples are provided in the following programming languages:

- BASIC
- Microsoft® QuickBASIC
- C

Using BASIC

This guide uses doubles quotes to enclose string parameters in syntax descriptions, but uses single quotes in the BASIC programming examples for readability.

The instrument allows string parameters to be enclosed by either double or single quotes. Each method is discussed in the following sub-sections.

Sending Double-Quoted and Single-Quoted Strings

In BASIC OUTPUT statements, strings enclosed in double quotes need special consideration. For example, you can send the FUNC "FREQ 1" command as follows:

```
OUTPUT 703;"FUNC ""FREQ 1"""
```

Note that a pair of double quotes (shown in bold) is required to embed a double quote within an BASIC string. For more readable BASIC OUTPUT statements, you can send the following command instead:

```
OUTPUT 703;"FUNC 'FREQ 1'"
```

Note that the pair of single quotes (shown in bold) is more readable.

---

* Microsoft is a U.S. registered trademark of Microsoft Corporation.
** Turbo C is a product of Borland International, Inc.

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Using C

The C examples assume you have an Agilent 82335A GPIB Interface card inside your computer.

List of the Programming Examples

The following examples are provided:

1. Making a Frequency Measurement (BASIC)
2. Making a Frequency Measurement (QuickBASIC)
3. Making a Frequency Measurement (C)

These examples can easily be modified to measure power or voltage by substituting POW (to measure power) or VOLT (to measure voltage) for FREQ.

NOTE All programming examples use the ASCII format to transfer data from the instrument to the computer. The ASCII format is the default format when *RST is used.

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Making a Frequency Measurement (BASIC)

```
10 ! This program sets up the instrument to make 10 frequency
20 ! measurements on channel 2.
30 ! The results are displayed on the computer CRT.
40 ! ASCII format is used to preserve resolution.
50 !
60    INTEGER I                       ! Declare variables
70    DIM Freq$(10)[22]                ! Declare string to enter data
80                                     ! Using strings to enter ASCII format
90                                     ! data yields results formatted to the
100                                    ! correct resolution. ASCII is the
110                                    ! default format for the instrument.
120   Samples=10                       ! Take 10 measurements
130 !
140   ASSIGN @Count TO 703             ! Assign I/O path for instrument
150   CLEAR 703                        ! Clear the instrument and interface
160   OUTPUT @Count;"*RST"             ! Reset the instrument
170   OUTPUT @Count;"*CLS"             ! Clear event registers and error queue
180   OUTPUT @Count;"*SRE 0"           ! Clear service request enable register
190   OUTPUT @Count;"*ESE 0"           ! Clear event status enable register
200   OUTPUT @Count;":STAT:PRES"       ! Preset enable registers and 210
210                                    ! transition filters for operation and
220                                    ! questionable status structures.
230   OUTPUT @Count;":CONF:FREQ DEFAULT,DEFAULT, (@2)"
240                                    ! Measure frequency on channel 2
270 !
280   CLEAR SCREEN                     ! Clear the computer display
290   FOR I=1 TO Samples               ! Start making measurements
300   OUTPUT @Count;"INIT:IMM"         ! Trigger new  measurement
310   OUTPUT @Count;"READ?"            ! Process measurement
320     ENTER @Count;Freq$(I)          ! fetch the data
330     PRINT USING "11A,DD,4A,22A,3A";"Frequency (";I;") = ";Freq$(I);" Hz"
340   NEXT I
350   LOCAL 703                        ! Return instrument to local
360   END
```

Making a Frequency Measurement (QuickBASIC)

```
'This program configures the instrument to make 10 frequency measurements
'on channel 2.
'The results are printed on the computer monitor.
'Data is sent in ASCII format to preserve resolution.
'
'The SUB sendhp sends commands to the instrument

DECLARE SUB sendhp (code$)
DIM SHARED source AS LONG            'Address and select code
DIM i AS INTEGER                     'i is used for loops
DIM samples AS INTEGER
samples = 10                         'Number of measurements
DIM freqs(10) AS STRING * 23         'String to be read
                                     'Reading ASCII formatted data
                                     'gives results to the correct
                                     'resolution. Must be read into
                                     'a string. The maximum number
                                     'of characters that can ever be
                                     'sent is 20 per measurement.
source& = 703                        'instrument at address 3
isc&p; = 7                           'Select code 7
state% = 1                           'Used in IOEOI

CLS                                  'Clear screen
CALL IOEOI(isc&p;, state%)           'Make sure EOI enabled
CALL IOCLEAR(source&)                'Clear the instrument and interface
CALL sendhp("*RST")                  'Reset instrument and stop autotrig
CALL sendhp("*CLS")                  'Clear event registers and error queue
CALL sendhp("*SRE 0")                'Clear service request enable register
CALL sendhp("*ESE 0")                'Clear event status enable register
CALL sendhp(":STAT:PRES")            'Preset enable registers and
                                     'transition filters for operation and
                                     'questionablestatus structures
CALL sendhp(":CONF:FREQ DEFAULT,DEFAUTL,(@2)
                                     'Set to measasure frequency in Band 2
CLS                                  'Clear computer screen
FOR i = 1 TO samples
CALL sendhp("INIT:IMM")              'Initiate a measurement and
CALL sendhp("READ?")                 'get the result
CALL IOENTERS(source&ng, freqs(i), 23, actf%)
                                     'Read the ASCII characters
PRINT "Frequency"; i; "= "; freqs(i)
NEXT i
END

' Subroutine to send command to Agilent 5314xA/
SUB sendhp (code$)
CALL iooutputs(source, code$, LEN(code$))
END SUB
```

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Making a Frequency Measurement (C)

```
/* This program configures the instrument to make 10 frequency measurements
   on channel 1 followed by 10 frequency measurements on channel 2, 10
   power measurements, and 10 voltage measurements.
   The results are displayed on the computer monitor.
   The program comments discuss the meaning of each command.
   ASCII result format is used to preserve resolution. */
#include <stdio.h
#include <string.h
#include "CGPIB.H"
#include "CFUNC.H"
void sendhp(char *);          /* function to send command to instrument      */
                              /* global data                                 */
long ctr=703;    /* instrument is at address 03. GPIB is at select code 7   */
int  error;

void main()
{
    long isc=7;               /* Select code 7                               */
    int state=1;              /* Used in IOEOI                               */
    int i;                    /* Used for loop instrument                    */
    int samples=10;           /* Number of measurements to take              */
    int length=23;            /* Max number of bytes per measurements        */
    char freq[23];            /* Array to hold frequency string              */
    IORESET(isc);             /* Clear the GPIB interface                    */
    sendhp("*RST");           /* Reset the instrument                        */
    sendhp("*CLS");           /* Clear event registers and error queue       */
    sendhp("*SRE 0");         /* Clear service request enable register       */
    sendhp("*ESE 0");         /* Clear event status enable register          */
    sendhp(":STAT:PRES");     /* Preset enable registers and transition
                                 filters for operation and questionable
                                 status structures                           */
    IOEOI(isc,state);         /* Enable use of EOI                           */

                              /* Function to send command to Agilent 5315xA  */
void sendhp(gpib_cmd)
char *gpib_cmd;
{
   char hpcmd[80];            /* Variables used by function                  */
   int length;

   strcpy(hpcmd, gpib_cmd);
   length=strlen(hpcmd);
   error=IOOUTPUTS(ctr, hpcmd, length); /* Send command to Agilent 5314xA   */
   if (error!=0)
   printf("Error during GPIB: %d Command %s\n",error,hpcmd);
}

Sendhp( ":CONF:FREQ DEFAULT,DEFAULT,(@1)"); /* Set to Band 1                 */
Sendhp( "INIT:IMM");          /* Trigger new measurement                     */
Sendhp( "READ?")              /* Get measurement                             */

IOENTERS(ctr,freq,&length);   /* Fetch the data                              */
   length=strlen(freq);
   freq[length-1]='\0' ;
   printf ("Frequency in Band 1  = %s Hz\n",freq);
   printf("Press a key to continue\n");
   getch();
```

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```
Sendhp(":CONF:FREQ DEFAULT,DEFAULT,(@2)") /* Set to Band 2              */
Sendhp("INIT:IMM")
Sendhp("READ?")

IOENTERS(ctr,freq,&length);
   length=strlen(freq);
   freq[length-1]='\0' ;
   printf ("Frequency in Band 2  = %s Hz\n",freq);
   printf("Press a key to continue\n");
   getch();


Sendhp(":CONF:POW")       /* Set measurement function to Power       */
Sendhp("INIT:IMM")
Sendhp("READ?")

IOENTERS(ctr,pow,&length);
length=strlen(pow);
freq[length-1]='\0' ;
printf ("Power  = %s Hz\n",pow);
printf("Press a key to continue\n");
getch();


Sendhp(":CONF:VOLT")      /* Set to measure Voltage                  */
Sendhp("INIT:IMM")
Sendhp("READ?")

IOENTERS(ctr,volt,&length);
   length=strlen(volt);
   freq[length-1]='\0' ;
   printf ("Voltage  = %s Hz\n",volt);
   printf("Press a key to continue\n");
   getch();
```

Command Reference

This section describes the SCPI Subsystem commands and the IEEE 488.2 Common Commands for the Agilent 53147A, 53148A, and 53149A. The information in this section is intended to help you program the instrument over its GPIB or RS-232 serial interface.

The commands are presented in alphabetical order.

- SCPI Subsystem commands are described on pages 3-88 through 3-133.
- IEEE 488.2 Common command descriptions start on page 3-135.
- A description of the Group Execute Trigger command is also included on page 3-97.

For each command description:

- Where the phrase “Sets or queries” is used, the command setting can be queried by omitting the parameter and appending a “?” to the last command keyword.
- For example,

  :ROSC:SOUR INT | EXT

  can be queried with

  :ROSC:SOUR?
- Unless otherwise noted, a command described as an *event* cannot be queried.
- Unless otherwise noted, the command setting is affected by *SAV/*RCL.
- The square brackets, [ ], are used to indicate that the element(s) within the brackets are optional. Note, the brackets are *not* part of the command and should not be sent to the instrument.

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- The vertical bar, |, is used to mean “OR” and is used to separate alternative options.
- The short form of keywords is shown in uppercase.
- Quotation marks may be part of the command’s parameter; the quotation marks shown must be sent to the instrument.
- Unless otherwise noted, a command is sequential (not overlapped).

:ABORt Command

COMMAND **:ABORt**

This command causes the instrument to abort, as quickly as possible, any measurement in progress.

The :ABORt command is not complete until the current measurement is stopped. The execution of an ABORt command sets false any Pending Operation Flags that were set true by initiation of measuring.

COMMENTS

- If :ABORt is issued while the measurement cycle is idle (:INIT:CONT OFF and pending operation flag is false), the command is ignored.
- If :ABORt is issued while a single measurement is in progress, the measurement is aborted and the pending operation flag is set false.
- If :ABORt is issued while repetitive measurements are being made (:INIT:CONT ON), the measurement in progress is aborted, and the pending operation flag is set false. Then, a new measurement is automatically initiated, and the pending operation flag is set true.
- If :ABORt is issued while a block of measurements, such as an average, is in progress, the measurement block is aborted, and the pending operation flag is set false.
- When a measurement or block of measurements is aborted, the Measuring bit in the Operation Status Register is set false.
- Aborting a measurement in progress invalidates the result.

RELATED FRONT-PANEL KEYS **Reset/Local**

:CALibration Subsystem

This subsystem controls the Power Meter calibration system. This includes zeroing and calibrating the Power Meter and managing the data in the frequency/power-factor calibration tables stored in the instrument's nonvolatile memory.

COMMAND **:CALibration:ALL[?]**

Zeros the Power Meter and then calibrates it.

QUERY RESPONSE

- Single ASCII-encoded byte, 0 or 1.
- A value of 0 indicates pass (calibration was successful); a value of 1 indicates fail (calibration was not successful).

COMMENTS

- When the zero or calibration process fails, the relevant queue contains one of the following messages:

  –340, "Data Questionable: ZERO ERROR"
  –340, "Data Questionable: CAL ERROR"

RELATED FRONT-PANEL KEYS **Zero, Cal**

COMMAND **:CALibration:AUTO ONCE**

This command calibrates the Power Meter.

COMMENTS

- This command assumes that the power sensor is connected to a 1 mW reference signal.
- The power meter should be zeroed before calibration using the CALibration:ZERO:AUTO ONCE command.
- For the Agilent 8480 series power sensors, the reference calibration factor used during this calibration can be derived from either an active sensor calibration table or the value entered using CALibration:RCFactor.

- The actual value used is the one which was most recently set. That is, a value entered using CALibration:RCFactor is overridden if a sensor calibration table is subsequently selected and enabled. Conversely, CALibration:RCFactor overrides any reference calibration factor previously set from a sensor calibration table.
- To determine the currently set reference calibration factor use CALibration:RCFactor?

RELATED FRONT-PANEL KEYS **Cal**

COMMAND **:CALibration:AUTO?**

QUERY RESPONSE The query form always returns a value of 0.

COMMENTS
- If the calibration process was not successful, the error: –340, "Data Questionable; CAL ERROR" occurs.
- If this command is set to 1 | ON, the error –224, "Illegal parameter value" occurs.

RELATED FRONT-PANEL KEYS **Cal**

COMMAND **:CALibration:DATA:HEADer . . . <numeric_value1>, <numeric_value2>, <numeric_value3>, <string>**

Writes checksum and other control/verification data relating to the calibration data.

<numeric_value1>	Year (must be greater than or equal to 1997)
<numeric_value2>	Month
<numeric_value3>	Day

COMMENTS
- The data entry form of this command requires CAL:DATA:SECurity to be ON.
- This command should only be used after all calibration data have been entered.

- If this command is *not* issued, the instrument will generate an error when it is turned on. The error indicates that the calibration data is invalid, causing the Power Meter to use the default calibration tables stored in ROM instead of the ones in EEPROM.
- <string> can be up to 29 characters long and can contain any character string. This is useful to identify the person and/or entity that performs the calibration.

RELATED FRONT-PANEL KEYS None

COMMAND **:CALibration:DATA:HEADer?**

QUERY RESPONSE yyyy/mm/dd, day, Self Test Count = nnn, Operation Time = nnn Hrs

where:

yyyy=year
mm=month
dd=day
nnn=<numeric value>

RELATED FRONT-PANEL KEYS None

COMMAND **:CALibration:DATA:SECurity:CODE . . . <numeric_value>**

Changes or sets the CAL:SECurity code.

COMMENTS

- CAL:SEC:STATE must be OFF.
- This value is not stored or recalled by *SAV/*RCL.
- This value is not affected by *RST.

RELATED FRONT-PANEL KEYS None

3

COMMAND **:CALibration:DATA:SECurity:CODE?**

QUERY RESPONSE This command returns the current numeric value of the CAL:SECurity code.

RELATED FRONT-PANEL KEYS None

COMMAND **:CALibration:DATA:SECurity:STATe . . . <Boolean>,<numeric_value>**

Enables/disables access to the calibration memory.

COMMENTS
- <numeric_value> = the current value of CAL:SECurity:CODE.
- The numeric value can be omitted when the value of <Boolean> is ON.
- *RST ON.

RELATED FRONT-PANEL KEYS None

COMMAND **:CALibration:DATA:SECurity:STATe?**

QUERY RESPONSE 1 or 0 is returned:

- 1 indicates that access to the calibration memory is enabled.
- 0 indicates that access to the calibration memory is disabled.

RELATED FRONT-PANEL KEYS None

COMMAND **:CALibration:RCFactor . . . <numeric_value>**

This command is used to correct all power measurements when the power calibration tables are set to OFF (SENSe:CORRection:CSET:STATe OFF).

*RST	100
MIN	1
MAX	150

COMMENTS

- The current <numeric_value> of CALibration:RCFactor is altered if CALibration:RCFactor is reissued with a new <numeric_value> or if the STORE key is pressed.
- Pressing the STORE key sets CAL:RCF to the frequency displayed on the front-panel display.

RELATED FRONT-PANEL KEYS

Shift + Cal Factor; **Shift + Store**; **Shift + Menu** (HEAD > OFF)

COMMAND **:CALibration:RCFactor?**

QUERY RESPONSE

The current numeric value of CALibration:RCFactor.

RELATED FRONT-PANEL KEYS

Shift + Cal Factor

COMMAND **:CALibration:ZERO:AUTO ONCE**

This command causes the power meter to perform its zeroing routine. This adjusts the power meter for a zero power reading with no power supplied to the power sensor.

COMMENTS

- The command assumes that the power sensor is not connected to a power source.
- Pressing the **STORE** key sets CAL:RCF to the frequency displayed on the front-panel display.
- After *RST, automatic zeroing is disabled.

RELATED FRONT-PANEL KEYS

Shift + Zero; **Shift + Store**

COMMAND **:CALibration:ZERO:AUTO?**

QUERY RESPONSE The query always returns a value of 0.

- If zeroing was not successful, the error –340, “Data Questionable; ZERO ERROR” occurs.
- If this command is set to 1 | ON the error –224, “Illegal parameter value” occurs.

RELATED FRONT-PANEL KEYS None

3

:DISPlay Subsystem

This subsystem controls the selection and presentation of textual information on the instrument's display. This information includes measurement results. :DISPlay is independent of, and does not modify, how data is returned to the controller.

See the section titled "Programming the Instrument to Display Results" on page 3-72.

COMMAND **:DISPlay[:WINDow]:BACKground[:STATe] . . . <Boolean>**

Turns the display backlight ON or OFF.

QUERY RESPONSE

- Single ASCII-encoded byte, 0 or 1.
- A value of 0 indicates OFF; a value of 1 indicates ON.

COMMENTS

- *RST: ON
- Turning the display backlight OFF conserves battery power (if the instrument has the Battery option).
- If the instrument is operating from battery power (Battery option required), the display backlight is automatically turned off after a period of inactivity. When activity is subsequently detected (a measurable signal is applied, a front-panel key is pressed, or a setting is changed by a command sent over the GPIB or the RS-232 interface), the display backlight is restored to its previous state (i.e., if the backlight was set to OFF, it remains off; if the backlight was set to ON, it is turned on).

RELATED FRONT-PANEL KEYS

Shift + On/Off

COMMAND **:DISPlay:ENABle . . . <Boolean>**

Sets or queries whether the entire display (annunciators and indicators, with the exception of Rmt) is visible.

QUERY RESPONSE
- Single ASCII-encoded byte, 0 or 1.
- A value of 0 indicates OFF; a value of 1 indicates ON.

COMMENTS
- *RST: ON
- This value is unaffected by *SAV/*RCL.

RELATED FRONT-PANEL KEYS None

Group Execute Trigger (GET)

COMMAND **GET**

The full capability of the Group Execute Trigger IEEE 488.1 interface function is implemented in the instrument. This function permits the instrument to have its operation initiated over the Bus. In response to the IEEE 488.1 Group Execute Trigger (GET) remote interface message (while the instrument is addressed to listen), the instrument performs the action defined by the *DDT command (see page 3-28).

RELATED FRONT-PANEL KEYS None

:INITiate Subsystem

This subsystem controls the initiation of a measurement.

COMMAND **:INITiate:CONTinuous . . . <Boolean>**

Sets or queries the state of continuously initiated measurements.

When CONTinuous is set to OFF, no measurements are made until CONTinuous is set to ON or :INITiate[:IMMediate] is received. Once CONTinuous is set to ON, a new measurement is initiated. On the completion of each measurement, with CONTinuous ON, another measurement immediately commences.

QUERY RESPONSE

- Single ASCII-encoded byte, 0 or 1.
- A value of 0 indicates OFF; a value of 1 indicates ON.

COMMENTS

- *RST: OFF
- The commencement of the first measurement due to setting :INITiate:CONTinuous to ON sets the Pending Operation Flag to true. The Pending Operation Flag is set false by aborting a measurement, or by the completion of the last measurement after :INITiate:CONTinuous is set OFF.
- With the measurements being made continuously, the :ABORt command aborts the current measurement in progress, however, the value of :INITiate:CONTinuous is unaffected. If CONTinuous was set to ON prior to receiving :ABORt, it remains ON and a new measurement begins.
- When a single measurement is in progress (:INIT:CONT is OFF):
  - Error -213 (Init ignored) is generated and the state of INIT:CONT is unaffected by :INIT:CONT ON.
  - Error -210 (Trigger error) is generated by INIT:CONT OFF.

NOTE

The instrument powers up with :INIT:CONT set to ON, but *RST sets :INIT:CONT to OFF.

3

COMMAND **:INITiate[:IMMediate]**

This event command causes the instrument to initiate either a single measurement or a block of measurements.

COMMENT This command is an overlapped command (see IEEE 488.2, Section 12). Beginning a measurement or block of measurements with an :INITiate[:IMMediate] sets the Pending Operation Flag to true. Completing the measurement or block of measurements (normally or by aborting) sets Pending Operation Flag to false.

RELATED FRONT-PANEL KEYS None

:INPut Subsystem

This subsystem controls the characteristics of the instrument's input ports.

COMMAND **:INPut:FILTer:[:LPASs][:STATe] . . . <Boolean>**

Sets or queries the state of the Channel 1 low-pass filter.

QUERY RESPONSE

- Single ASCII-encoded byte, 0 or 1.
- A value of 0 indicates OFF; a value of 1 indicates ON.

COMMENT *RST: OFF

RELATED FRONT-PANEL KEYS **Shift** + **Menu** (CH1 LPF > OFF | ON)

3

:MEASure Subsystem

The :MEASure subsystem commands allow you to configure the instrument, initiate measurements, and place the results in the Output Queue using a minimum number of commands. These commands are described in detail in this section.

Measurement Instructions (:CONFigure, :FETCh, :MEASure, :READ)

The purpose of these commands is to acquire data using a set of high-level instructions. These commands are structured to allow you to trade off interchangeability between instruments. The :MEASure query provides the ability to configure the instrument, take a measurement, and store the results in the Output Queue in a single operation.

When more precise control of the measurement is required, the :CONFigure and :READ? commands can be used. The :CONFigure command is used to configure the instrument for the measurement to be taken, and the :READ? command acquires the data, performs any required post processing, and then places the results in the Output Queue. This allows you to configure the instrument generically (using :CONFigure) and then to customize the measurement with other commands (for example, commands from the [:SENSe] subsystem). The :READ? command completes the measurement process.

The :READ? command is composed of the :INITiate[:IMMediate] and :FETCh? commands. :INITiate[:IMMediate] performs the data acquisition. :FETCh? performs the post-processing function (if any) and places the result in the Output Queue. This allows more than one FETCh? on a single set of acquired data.

The functions of the measurement instruction commands are summarized in Table 3-13.

Table 3-13. Summary of the Measurement Instruction Commands

Command	Description
:MEASure query	This command is the simplest to use, but it allows little flexibility. This command lets the instrument configure *itself* for an optimal measurement, initiate the measurement, and return the result; i.e., it provides a complete measurement sequence (:MEAS query is equivalent to the :CONF, :INIT, :FETC? command sequence, but with no flexibility.)
:CONFigure :READ?	The combined use of these two commands allows for more control when the instrument performs a measurement, initiates a measurement, and returns the result. Use this command sequence when you want to customize the configuration between the measurement setup and acquisition.
:CONFigure :INITiate :FETCh?	This combination of commands provides the most flexibility the Measure Instructions allow. This command sequence configures the instrument, initiates the measurement as specified, and returns the result.

The <source_list> parameter has the same syntax as SCPI <channel_list>. For example, the Frequency function uses (@1) to specify channel 1.

If the instrument receives an unexpected parameter, it processes the command, ignoring the unexpected parameter, and sets the "Command Warning" bit of the Data Questionable status reporting structure.

The response format for :MEASure query, :READ?, and :FETCh? is ASCII data. If no valid data is available, the instrument generates error -230 (Data corrupt or stale).

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COMMAND **:CONFigure[:SCALar]:<function> <parameters> [,<source_list>]**

Configures the instrument to perform the specified function but does not initiate the measurement.

COMMENTS

- Use :INITiate;FETCh? or :READ? to make and query a measurement.
- Parameters (other than <source_list>) can be defaulted by substituting the keyword DEFault. The <source_list> parameter can be defaulted by omitting it. The default values are specified by the particular function description.
- This command defaults several instrument settings. To change the function only, while leaving all other instrument settings as they are, use [:SENS]:FUNC[:ON].
- If an <expected_value> parameter is outside the measurement capabilities of the instrument model, an error is generated, and the command does not execute.
- For :POWer, <resolution> must be defaulted or set to 0.01[dB].
- See "Descriptions of the Measurement Functions" on page 3-106 for a description of each of the measurement functions.
- See Table 3-14 for a summary of the <function>, <parameters>, and <source_list> for each of the measurement functions.

COMMAND **:CONFigure?**

Queries the function configured by the last :CONFigure command or :MEASure query.

QUERY RESPONSE

- A string of the form: "<function> <parameters>[,<source_list>]."
  The leading colon is omitted from the <function>.
- The response is unaffected by *RST, recall, and [:SENS]:FUNC.

COMMENTS

- If the instrument state has changed through commands other than :CONFigure or the :MEASure query, the instrument does not track these changes, and the query response does not reflect these changes.
- For :POWer, <resolution> must be defaulted or set to 0.01[dB].

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- If an <expected_value> parameter is outside the measurement capabilities of the instrument model, an error is generated, and the command does not execute.
- See "Descriptions of the Measurement Functions" on page 3-106 for a description of each of the measurement functions.
- See Table 3-14 for a summary of the <function>, <parameters>, and <source_list> for each of the measurement functions.

COMMAND **:FETCh?[[:SCALar]:<function>]?**

This query returns the measurement taken by the :INITiate or :READ? command or the :MEASure query.

QUERY RESPONSE If no valid result is available, no result is returned, and error -230 is generated.

COMMENTS

- When [:SCALar]:<function> is specified, the instrument retrieves the specified result if it matches the current measurement type or can be derived from the current measurement type.
- When [:SCALar]:<function> is omitted, the function specified/used by the last :CONFigure, :MEASure, :READ, or FETCh is used, if possible.
- Issuing this query while a measurement is in progress prevents further commands from being processed until the measurement completes. This hold-off action can only be canceled by the completion of the measurement, Device Clear, or power-on.
- If an <expected_value> parameter is outside the measurement capabilities of the instrument model, an error is generated, and the command does not execute.
- For :POWer, <resolution> must be defaulted or set to 0.01[dB].
- See "Descriptions of the Measurement Functions" on page 3-106 for a description of each of the measurement functions.
- Refer to Table 3-14 for a summary of the <function>, <parameters>, and <source_list> for each of the measurement functions.

COMMAND **:MEASure[:SCALar]:<function>? <parameters> [,<source_list>]**

This query provides a complete measurement sequence: configuration, measurement initiation, and query for result.

COMMENTS

- This query is used when generic measurement is acceptable, and fine adjustment of instrument settings is not necessary.
- Parameters (other than <source_list>) can be defaulted by substituting the keyword DEFault. The <source_list> parameter can be defaulted by omitting it. The default values are specified by the particular function description.
- For :POWer, <resolution> must be defaulted or set to 0.01[dB].
- If an <expected_value> parameter is outside the measurement capabilities of the instrument model, an error is generated, and the command does not execute.
- Issuing this query while a measurement is in progress aborts the current measurement before initiating the measurement specified in the query. The instrument then waits for the measurement to complete. This has the effect of holding off processing of further commands until the desired measurement completes. This hold-off action can be canceled only by the completion of the measurement, Device Clear, or power-on.
- If an <expected_value> parameter is outside the measurement capabilities of the instrument model, an error is generated, and the command does not execute.
- For :POWer, <resolution> must be defaulted or set to 0.01[dB].
- See “Descriptions of the Measurement Functions” on page 3-106 for a description of each of the measurement functions.
- Refer to Table 3-14 for a summary of the <function>, <parameters>, and <source_list> for each of the measurement functions.

COMMAND **:READ?[[:SCALar]:<function>]?**

This query provides a method for performing a :FETCh? on *fresh* data.

COMMENTS

- This command is commonly used in conjunction with a :CONFigure command to provide a capability similar to :MEASure?, in which the application programmer is allowed to provide fine adjustments to the instrument state by issuing the corresponding commands between :CONFigure and :READ?.
- When [:SCALar]:<function> is specified, the instrument retrieves the specified result if it matches the current measurement type or can be derived from the current measurement type.
- When [:SCALar]:<function> is omitted, the function specified/used by the last :CONFigure, :MEASure, :READ, or FETCh is used, if possible.
- Issuing this query while a measurement is in progress aborts the current measurement and idles the measurement cycle before initiating the desired measurement. The instrument then waits for the measurement to complete. This has the effect of holding off processing of further commands until the desired measurement completes. This hold-off action can be canceled only by the completion of the measurement, Device Clear, or power-on.
- If an <expected_value> parameter is outside the measurement capabilities of the instrument model, an error is generated, and the command does not execute.
- For :POWer, <resolution> must be defaulted or set to 0.01[dB].
- See “Descriptions of the Measurement Functions” on page 3-106 for a description of each of the measurement functions.
- Refer to Table 3-14 for a summary of the <function>, <parameters>, and <source_list> for each of the measurement functions.

Descriptions of the Measurement Functions

Table 3-14 lists the available measurement functions, the parameters that can be used with them, and the valid values for <source_list>.

Table 3-14. The <function>, <parameters>, and <source_list> for the Measure Instruction Commands

<function>	<parameters>	[,<source_list>]*
:FREQuency	[<expected_value>[,<resolution>]]	[,(@1) l (@2)]
:POWer[:AC]	[<expected_value>[,<resolution>]]	[,(@3)]
:VOLTage[:DC]	<expected_value>	[,(@4)]

* <source_list> uses the same syntax as SCPI <channel _list>.

COMMAND **:MEASure[:SCALar][:VOLTage]:FREQuency? [<expected_value>[,<resolution>]] [,(@1) l (@2)]**

This command measures frequency.

FUNCTION DESCRIPTION

<u><expected_value></u>

Channel 1 range	10 Hz to 125 MHz l MIN l MAX l DEF
Channel 2 range:	100 MHz to 20 GHz (53147A), 26.5 GHz (53148A), 46 GHz (53149A) MIN l MAX l DEF
default:	100 MHz

<u><resolution></u>

description:	The value specifies the frequency resolution for the measurement.
values:	1Hz l 10 Hz l 100 Hz l 1 KHz l 10 KHz l 100 KHz l 1 MHz l DEF
default:	1 Hz

<u><source_list></u>

description:	Specifies which front-panel input is used for the measurement.
values:	(@1) l (@2)
default:	(@2)
<u>response format:</u>	<NR1>

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:MEASure[:SCALar]:POWer[:AC] [<expected_value>[,<resolution>]][,(@3)]

This command measures power.

FUNCTION DESCRIPTION

<expected_value>

range:	-40 to +10 dBm
default:	0.00
resolution:	0.01

<resolution>

description:	<resolution> is supported only for compatibility with other instruments.
values:	0.01 dB | MIN | MAX | DEF
default:	0.01 dB

<source_list>

description:	Specifies which front-panel input is used for the measurement.
values:	DEF | (@3)
default:	(@3)

response format: <NR2> Power values are returned in dBm.

:MEASure[:SCALar]:VOLTage[:DC] <expected_value>

This command measures voltage.

FUNCTION DESCRIPTION

<expected_value>

range:	-50 to +50 vdc
default:	0.00

<source_list>

description:	Specifies which front-panel input is used for the measurement.
values:	DEF | (@4)
default:	(@4)

response format: <NR3> Voltage values are returned in volts.

3

How to Use the Measurement Instruction Commands

The Measure Instruction commands have a different level of compatibility and flexibility than other commands. The parameters used with commands from the Measure Instruction describe the signal you are going to measure. This means that the Measure Instructions give compatibility between instruments since you do not need to know anything about the instrument you are using.

Using :MEAsure

This is the simplest Measurement Instruction command to use, but it does not offer much flexibility. :MEASure causes the instrument to configure itself for a default measurement, starts the measurement, and queries the result. The following example shows how to use the :MEASure query to measure frequency.

Use

```
:MEASURE:FREQ?
```

to execute a default frequency measurement and have the result sent to the controller. The instrument selects settings and carries out the required measurement; it automatically starts the measurement and sends the result to the controller.

You can add parameters to provide more details about the signal you are going to measure.

Use

```
:MEASURE:FREQ?  50 MHZ, 1 HZ
```

where 50 MHz is the expected value (this value can also be sent as 50E6 HZ), and 1 Hz is the required resolution.

The channel numbers can also be specified. For example, you can send:

```
:MEASURE:FREQ?  (@1)
:MEASURE:FREQ?  50 MHz, 1 HZ, (@1)
```

3

Using :CONFigure with :READ?

The :CONFigure command causes the instrument to choose default settings for the specified measurement. :READ? starts the measurement and queries the result.

This sequence operates in the same way as the :MEASure query, but it allows you to insert commands between :CONFigure and :READ? to specify a particular setting.

For example, use

```
:CONF:FREQ  5 GHZ, 1HZ
```

to configure a default frequency measurement, where 1 Hz is the required resolution and 5 GHz is the expected value.

Use

```
:READ?
```

to start the measurement and query the result.

:MEMory Subsystem

This subsystem manages the instrument's memory.

COMMAND **:MEMory:DATA . . . <name>,<data>**

Stores and queries data in the named power calibration table.

QUERY RESPONSE

- Data points are returned in <definite length arbitrary block> format.
- A data point consists of comma-separated, NRf format number pairs.

COMMENTS

- Valid table names: 8481A, 8481D, 8482A, 8485A, 8487A, CUST1, CUST2, CUST3
- Valid data is stored in non-volatile memory. Any error in a data block causes all data in that block to be ignored and the data currently in the named profile to be retained.
- Data must be input in the form of two to ten comma-separated, NRf-format number pairs.
- The data-point number pairs in the named profile are automatically sorted by frequency value before the profile is stored.
- When a calibration table is in use, the instrument uses the data points in the currently selected table to determine the amount of loss correction to apply.
- If the measured frequency is between two defined data points, the instrument uses the two defined data points to linearly interpolate the appropriate correction value.
- If the measured frequency is above the highest frequency value in the profile (or below the lowest frequency value), the instrument determines a calbration factor by using the two highest (or lowest) defined data points to extrapolate a linear extension to the curve above the highest data point (or below the lowest data point).

RELATED FRONT-PANEL KEYS **Shift + Menu** (HEAD > OFF, 8481A, 8481D, 8482A, 8485A, 8487A, CUST1, CUST2, CUST3)

COMMAND **:MEMory:CLEAR[:NAME] . . . <name>**

Resets the contents of the named power calibration table to the default configuration.

COMMENTS
- Valid table names: 8481A, 8481D, 8482A, 8485A, 8487A, CUST1, CUST2, CUST3
- The data currently stored in non-volatile memory for the named calibration table is discarded.
- This is an event. There is no query form of this command.

RELATED FRONT-PANEL KEYS
Shift + Menu (HEAD > OFF, 8481A, 8481D, 8482A, 8485A, 8487A, CUST1, CUST2, CUST3)

COMMAND **:MEMory:NSTates?**

Queries the Number of available *SAV/*RCL STates in the instrument.

QUERY RESPONSE
- Numeric data transferred as ASCII bytes in <NR1> format.
- The value returned is 9.
- The response value is one greater than the maximum which can be sent as a parameter to the *SAV and *RCL commands.

COMMENTS
Query only.

RELATED FRONT-PANEL KEYS
None

[:SENSe] Subsystem

The [:SENSe] subsystem commands are divided into several sections. Each section, or subtree, deals with controls that directly affect instrument-specific settings and not those related to the signal-oriented characteristics.

COMMAND **[:SENSe]:AVERage[STATe] . . . <Boolean>**

Turns averaging ON and OFF. When averaging is ON, each new valid measurement result is the average of the number of measurements specified in the AVERage:COUNt command.

COMMENTS

- An ABORt command interrupts the averaging and prevents a valid measurement result.
- Averaging cannot be turned ON when the value of AVERage:COUNt is one. Attempting to turn averaging ON when AVERage:COUNt=1 causes an error.

RELATED FRONT-PANEL KEYS **Avg**

COMMAND **[:SENSe]:AVERage:COUNt . . . <numeric_value>**

Specifies the number of measurements to combine when AVERage:STATe is ON.

RANGE The acceptable range for the <numeric_value> parameter is 1 to 99.

COMMENT When averaging is ON, some devices may automatically set :COUNt values in the TRIGger subsystem based on the AVERage:COUNt value. This is done to ensure that the TRIGger subsystem provides enough triggers for the average.

RELATED FRONT-PANEL KEYS **Avg**

COMMAND **[:SENSe]:CORRection:CSET:SELect . . . <name>**

Selects a power calibration table by name from eight available profiles.

Valid table names: 8481A, 8481D, 8482A, 8485A, 8487A, CUST1, CUST2, CUST3

COMMENTS

- *RST: OFF
- The calibration-table name must be in this format: 848nX.
- If you are using VEE, the calibration-table name must be enclosed in single quote marks, e.g., '8482A'
- The calibration table setting is applied for the current session only. To store the profile selection in non-volatile memory, issue a *SAV command.

RELATED FRONT-PANEL KEYS

Shift + Menu (HEAD > OFF, 8481A, 8481D, 8482A, 8485A, 8487A, CUST1, CUST2, CUST3)

COMMAND **[:SENSe]:CORRection:CSET:STATe . . . <Boolean>**

Enables or disables power-correction mode with the currently selected power calibration table applied.

COMMENTS

- *RST: OFF
- The power-correction state is applied for the current session only. To store the calibration table selection in non-volatile memory, issue a *SAV command.

RELATED FRONT-PANEL KEYS

Shift + Menu (HEAD > OFF, 8481A, 8481D, 8482A, 8485A, 8487A, CUST1, CUST2, CUST3

COMMAND **[:SENSe]:DATA? . . . [<data handle>]**

Queries the current measurement result data of the :SENSe subsystem.

Valid <data handles>:

"[SENSe:][XNONE:]FREQuency [1] | 2"
"[SENSe:][XNONE:]POWer [3]"
"[SENSe:][XNONE:]VOLTage [4]"

QUERY RESPONSE

- Frequency values are returned in Hz as ASCII bytes in NR1 format.
- Power values are returned in dB in NR2 format.

COMMENTS

- Query only.
- Does not initiate any measurement action.
- The data handle is optional. If it is omitted, the query returns values for all functions enabled by the FUNCtion:ON command.
- Values are returned in the same order as the functions returned by the FUNCtion:ON? query.
- If this query executes while a measurement is in progress, the prior measurement result is returned, if the prior result was not invalidated.

RELATED FRONT-PANEL KEYS None

COMMAND **[:SENSe]:FILTer:FM:AUTO . . . <Boolean>**

Turns the instrument's ability to automatically compensate for frequency modulation ON or OFF. (*RST: ON)

COMMENTS

- When FM:AUTO is ON, the instrument automatically detects FM signals and modifies its measurement algorithm accordingly.
- Using FM:AUTO increases the time required to compute each measurement but increases the accuracy of FM signal measurements.

RELATED FRONT-PANEL KEYS **Shift + Menu** (FM > AUTO | OFF)

COMMAND **[:SENSe]:FREQuency:OFFSet . . . <numeric_value>[<frequency unit>]**

Sets a reference frequency for all other absolute frequency settings in the instrument.

RANGE The acceptable range for the <numeric_value> parameter is 0 to 50 GHz.

UNITS The offset frequency can be specified in Hz, KHz, or MHz only.

COMMENTS

- This command does not affect the hardware settings of the instrument. It affects only the entered and displayed frequencies.
- The instrument accepts only six digits of resolution for an offset entry through this command. For example, the command FREQ:OFFSet 12345.678912MHz results in an offset of approximately 12.3456 GHz.
- The coupling equation for this command is:

  Entered|Displayedfrequency=(Hardwarefrequency)+offset.

RELATED FRONT-PANEL KEYS **Shift + Freq Offset**

COMMAND **[:SENSe]:FREQuency:OFFSet:STATe . . . <Boolean>**

When FREQuency:OFFSet is ON, the frequency measurement results are modified by the setting of FREQ:OFFset before being displayed or reported (in response to a query).

RELATED FRONT-PANEL KEYS **Shift + Freq Offset**

3

COMMAND **[:SENSe]:FREQuency:RESolution . . . <numeric_value>[<frequency_unit>]**

Sets the resolution of the frequency measurement.

The allowable settings for <numeric_value> and <frequency unit> are:

1 Hz, 10 Hz, 100 Hz, 1 KHz, 10 KHz, 100 KHz, and 1 MHz.

COMMENTS

- *RST: 1 Hz
- This command does not affect the unit multipliers of any measurement queries.
- If no unit is specified, the global frequency unit in effect is used.

RELATED FRONT-PANEL KEYS **Resol**

COMMAND **[:SENSe]:FREQuency:TRACking . . . <character_program_data>**

Selects one of three signal-tracking modes (SLOW | FAST | OFF). When TRACking is set to SLOW, the instrument applies two tracking routines after each measurement; when it is set to FAST, it uses only one tracking routine; when it is set to OFF, it does not use either of the tracking routines.

COMMENTS

- *RST: FAST
- The SLOW setting provides the most accurate signal tracking but yields the smallest number of measurements in a given period of time.
- The FAST setting centers the IF in the IF bandwidth after each measurement to improve tracking.

RELATED FRONT-PANEL KEYS None

[:SENSe]:FUNCtion Subtree

This subtree controls the sensor functions.

COMMAND **[:SENSe]:FUNCtion[:OFF] . . . <sensor_function>[,<sensor_function>]**

Sets or queries the sensor functions to be sensed by the instrument.

The <sensor_function> strings are:

"[XNONe:]FREQuency [1 | 2]"

"[XNONe:]POWer"

"[XNONe:]VOLTage[:DC]"

QUERY RESPONSE

- The query form of this command returns a comma-separated list of functions that are OFF.
- The string omits default nodes (XNONe) and uses short-form mnemonics. If the channel specifier(s) are set to default value(s), no channel specifier is returned in response. If the channel specifier(s) are not set to default value(s), they are returned in the response with a single space separating the first channel specifier from the function name.

  For example:

  – "FREQ" is returned for frequency on Channel 1.

  – "FREQ 2" is returned for frequency on Channel 2.

COMMENTS

- *RST: "FREQ 2"
- This command can be used to turn individual function(s) OFF without affecting other functions.
- If the optional channel specification is omitted from the <sensor_function>, a default channel selection is made. For Frequency and Power, the default is Channel 2.

RELATED FRONT-PANEL KEYS Various

3

COMMAND **[:SENSe]:FUNCtion[:ON] . . . <sensor_function>[,<sensor_function>]**

Selects the sensor functions to be sensed by the instrument.

The supported <sensor_function> strings are:

"[XNONe:]FREQuency [1 | 2]"

"[XNONe:]POWer [3]"

"[XNONe:]VOLTage[:DC] [4]"

QUERY RESPONSE

- The query form of this command returns a comma-separated list of functions that are ON.
- The string omits default nodes (XNONe) and uses short-form mnemonics. If the channel specifier(s) are set to default value(s), no channel specifier is returned in response. If the channel specifier(s) are not set to default value(s), they are returned in the response with a single space separating the first channel specifier from the function name.

  For example:

  – "FREQ" is returned for frequency on Channel 1.

  – "FREQ 2" is returned for frequency on Channel 2.
- The only functions that can be turned ON simultaneously are "POW 2" and **"FREQ 2"**.

COMMENTS

- *RST: "FREQ 1"
- This command can be used to turn individual function(s) ON without affecting other functions.
- If the optional channel specification is omitted from the <sensor_function>, a default channel selection is made. For Frequency and Power, the default is Channel 2.

RELATED FRONT-PANEL KEYS

Various

3

COMMAND **[:SENSe]:FUNCtion:STATe? . . . <sensor_function>**

This query-only command returns a Boolean value that indicates whether the specified <sensor_function> is currently ON or OFF.

COMMENT See [:SENSe]:FUNCtion[:ON] on page 3-119 for valid <sensor_function> strings.

[:SENSe]:POWer Subtree

This subtree controls the power-measurement function.

COMMAND **[:SENSe]:POWer:AC:REFerence . . . <numeric_value><power_units>**

This command sets a reference amplitude (in dB) for display of power measurements. It is intended for use as a measurement offset, so that a measurement can be referenced to a known value.

RANGE –50 dBm to 10 dBm

UNITS dB, dBm

COMMENT *RST: 0

RELATED FRONT-PANEL KEYS **Shift + Pwr Offset**

COMMAND **[:SENSe]:POWer:AC:REFerence:STATe . . . <Boolean>**

Determines whether amplitude is measured in absolute or relative mode. If STATe is ON, amplitude is referenced to the value set in REFerence.

COMMENT *RST: OFF

RELATED FRONT-PANEL KEYS Power Meter **Offset On/Off**

3

[:SENSe]:ROSCillator Subtree

This subtree controls the Reference Oscillator.

COMMAND **[:SENSe]:ROSCillator:SOURce . . . <character_program_data>**

Sets or queries the current reference timebase to INTernal or EXTernal.

QUERY RESPONSE A sequence of ASCII-encoded bytes: INT or EXT

COMMENTS

- *RST: INT
- INTernal indicates the timebase is the internal reference. EXTernal indicates the signal at the external reference input (located on the rear panel of the instrument; **Reference** connector) is the reference timebase.
- The instrument does not switch to EXTernal unless a suitable 1, 2, 5, or 10 MHz signal is present on the **Reference** connector on the back panel.
- Execution of the command (that is, explicitly selecting internal or external timebase) sets [:SENS]:ROSC:SOUR:AUTO to OFF.
- If this is set to EXT, and no valid external signal is available at the back-panel **Reference** connector, the front-panel frequency display may show an error message.
- If this is set to INT, the 10 MHz signal generated by the internal reference oscillator is available as an output on the back-panel **Reference** connector.

RELATED FRONT-PANEL KEYS **Shift + Menu** (REF OSC > INT | EXT)

3

:STATus Subsystem

The :STATus subsystem commands allow you to specify or examine the status of the Operation Status Register group and the Questionable Data/Signal Register group.

:STATus:OPERation Subtree

The :STATus:OPERation subtree commands allow you to examine the status of the instrument monitored by the Operation Status Register Group, shown in Figure 3-18. The Operation Status Register Group consists of a condition register, two transition registers, an event register, and an enable register. The commands in this subtree allow you to control and monitor these registers.

See the sections titled “Operation Status Register Group” and “Questionable Data Status Register Group” on pages 3-63 and 3-65 for a detailed description of the Operation Status Register Group.

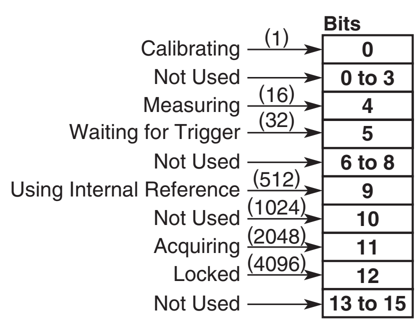

Figure 3-18. The Operation Status Register Group

COMMAND **:STATus:OPERation:CONDition?**

Queries the status of the Operation Condition Status Register.

QUERY RESPONSE

- Numeric data transferred as ASCII bytes in <NR1> format.
- Range is 0 to 32,767.
- The query response value is an integer formed by the binary weighting of the bits. The value of unused bits is zero.

COMMENTS

- Query only.
- The Operation Condition Status Register is cleared at power-on.
- Bits are not cleared when read.

RELATED FRONT-PANEL KEYS None

COMMAND **:STATus:OPERation:ENABle <non-decimal numeric> | <NRf>**

Sets or queries the Operation Event Status Enable Register.

RANGE The range for the <non-decimal numeric> or <NRf> parameter is 0 to 32,767.

QUERY RESPONSE Numeric data transferred as ASCII bytes in <NR1> format.

COMMENTS

- The parameter and query response value, when rounded to an integer value and expressed in base 2 (binary), represent the bit values of the Operation Event Status Enable Register.
- The value of unused bits is zero when queried and is ignored when set.
- This register is used to enable a single or inclusive OR group of Operation Event Status Register events to be summarized in the Status Byte Register (bit 7).
- At power-on and :STAT:PRES, the Operation Event Status Enable Register is cleared (value is 0).
- This value is unaffected by *RST and *SAV/*RCL.

RELATED FRONT-PANEL KEYS None

3

COMMAND **:STATus:OPERation[:EVENt]?**

Queries the status of the Operation Event Status Register.

QUERY RESPONSE

- Numeric data transferred as ASCII bytes in <NR1> format.
- Range is 0 to 32,767.
- The query response value is an integer formed by the binary weighting of bits. The value of unused bits is zero.

COMMENTS

- Each event bit in the Operation Event Status Register corresponds to a specific condition bit in the Operation Condition Status Register; this allows the Operation Event Status Register to detect changes in conditions.
- An event becomes TRUE when the associated condition makes the transition specified by the transition filters.
- The event bits, once set, are "sticky"—i.e., they cannot be cleared until they are read, even if they do not reflect the current status of a related condition.
- The Operation Event Status Register is cleared by *CLS, by :STAT:OPER[:EVEN]?, and at power-on.

RELATED FRONT-PANEL KEYS None

3

COMMAND **:STATus:OPERation:NTRansition <non-decimal numeric> | <NRf>**

Sets or queries the negative transition filter for the Operation status reporting structure.

RANGE The range of the <non-decimal numeric> or <NRf> parameter is 0 to 32,767

QUERY RESPONSE Numeric data transferred as ASCII bytes in <NR1> format.

COMMENTS

- The parameter and the query response value, when rounded to an integer value and expressed in base 2 (binary), represent the bit values of the negative transition filter.
- The value of unused bits is zero when queried and is ignored when set.
- A TRUE bit in the negative transition filter specifies that a negative (TRUE to FALSE) transition of the corresponding bit in the Operation Condition Status Register generates the corresponding event in the Operation Event Status Register.
- At power-on and STAT:PRES, the negative transition filter is preset such that each bit is a 0 (FALSE).
- This value is unaffected by *RST, *CLS, and *SAV/*RCL.

RELATED FRONT-PANEL KEYS None

3

COMMAND **:STATus:OPERation:PTRansition . . . <non-decimal numeric> | <NRf>**

Sets or queries the positive transition filter for the Operation status reporting structure.

RANGE The range of the <non-decimal numeric> or <NRf> parameters is 0 to 32,7670 to 32,767.

QUERY RESPONSE Numeric data transferred as ASCII bytes in <NR1> format.

COMMENTS

- The parameter and the query response value, when rounded to an integer value and expressed in base 2 (binary), represent the bit values of the positive transition filter.
- The value of unused bits is zero when queried and is ignored when set.
- A TRUE bit in the positive transition filter specifies that a positive (FALSE to TRUE) transition of the corresponding bit in the Operation Condition Status Register generates the corresponding event in the Operation Event Status Register.
- At power-on and STAT:PRES, the positive transition filter is preset such that each bit is a 1 (TRUE).
- This value is unaffected by *RST, *CLS, and *SAV/*RCL.

RELATED FRONT-PANEL KEYS None

COMMAND **:STATus:PRESet**

This event command presets the enable registers and transition filters associated with the Operation and Questionable status reporting structures. The enable registers and negative transition filters are preset such that each bit is a 0 (FALSE). The positive transition filters are preset such that each bit is a 1 (TRUE).

:STATus:QUEStionable Subtree

The :STATus:QUEStionable subtree commands allow you to examine the status of the instrument monitored by the Questionable Data/Signal Status Register Group, shown in Figure 4-3. The Questionable Status Group consists of a condition register, two transition registers, an event register, and an enable register. The commands in this subtree allow you to control and monitor these registers.

See the sections titled “Operation Status Register Group” and “Questionable Data Status Register Group” on pages 3-63 and 3-65 for a detailed description of the Questionable Data/Signal Status Register Group.

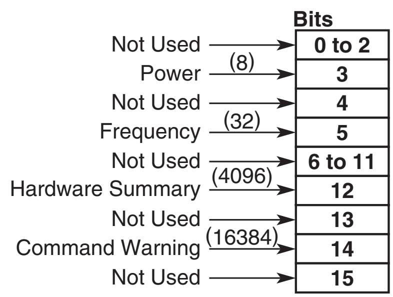

Figure 3-19. The Questionable Data/Signal Status Register Group

COMMAND **:STATus:QUEStionable:CONDition?**

Queries the status of the Questionable Data Condition Status Register.

QUERY RESPONSE

- Numeric data transferred as ASCII bytes in <NR1> format.
- Range is 0 to 32,767.
- The query response value is an integer formed by the binary weighting of the bits. The value of unused bits is zero.

COMMENTS

- The Questionable Data Condition Status Register is cleared at power-on.
- Bits are not cleared when read.

RELATED FRONT-PANEL KEYS None

COMMAND **:STATus:QUEStionable:ENABle . . . <non-decimal_numeric> | <NRf>**

Sets or queries the Questionable Data Event Status Enable Register.

RANGE The range of the <non-decimal numeric> or <NRf> parameter is 0 to 32,767.

QUERY RESPONSE Numeric data transferred as ASCII bytes in <NR1> format.

COMMENTS
- The parameter and the query response value, when rounded to an integer value and expressed in base 2 (binary), represent the bit values of the Questionable Data Event Status Enable Register.
- The value of unused bits is zero when queried and ignored when set.
- This register is used to enable a single or inclusive OR group of Questionable Data Event Status Register events to be summarized in the Status Byte Register (bit 3).
- At power-on and :STAT:PRES, the Questionable Data Event Status Enable Register is cleared (value is 0).
- This value is unaffected by *RST, *CLS, and *SAV/*RCL.

RELATED FRONT-PANEL KEYS None

COMMAND **:STATus:QUEStionable[:EVENt]?**

Queries the status of the Questionable Data Event Status Register.

QUERY RESPONSE
- Numeric data transferred as ASCII bytes in <NR1> format.
- Range is 0 to 32,767.
- The query response value is an integer formed by the binary weighting of bits. The value of unused bits is zero.

COMMENTS
- Each event bit in the Questionable Data Event Status Register corresponds to a specific condition bit in the Questionable Data Condition Status Register; this allows the Questionable Data Status Register to detect changes in conditions.
- An event becomes TRUE when the associated condition makes the transition specified by the transition filters.

3

- The event bits, once set, are “sticky”—i.e., they cannot be cleared until they are read, even if they do not reflect the current status of a related condition.
- The Questionable Data Event Status Register is cleared by *CLS, by :STAT:QUES[:EVEN]?, and at power-on.

RELATED FRONT-PANEL KEYS

None

3

:SYSTem Subsystem

This subsystem collects together the capabilities that are not related to instrument performance.

:SYSTem:COMMunicate Subtree

The :SYSTem:COMMunicate subtree collects together the configuration of the control/communication interfaces.

The :SYSTem:COMMunicate:SERial subtree controls the physical configuration of the RS-232C port. Any command to change the settings takes effect immediately upon receipt of the “program message termination.” These settings are stored in non-volatile memory, and are unaffected by power-on, *RST, and *SAV/*RCL.

The :SYSTem:COMMunicate:SERial:TRANsmit subtree controls parameters associated with transmission.

The instrument always uses eight data bits, one stop bit, and no parity.

COMMAND **:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess . . . <numeric_value>**

Sets the GPIB address that the instrument uses.

REPLY FORMAT <NR1>

COMMENTS

- The range for <numeric_value> is 0 through 30.
- The default setting is address 19.
- This value is unaffected by *RST.
- To change the GPIB address used at power-on, save the instrument settings using the *SAV 0 command after changing the GPIB address.

RELATED FRONT-PANEL KEYS **Shift + Menu** (GPIB ADDR > 0 - 30)

3

COMMAND **:SYSTem:COMMunicate:SERial:BAUD . . . <numeric_value>**

Sets or queries the baud rate.

<NUMERIC_VALUE> RANGE: The possible BAUD rate values that can be entered for the <numeric_value> parameter are: 1200, 2400, 4800, 9600, 14400, and 19200.

QUERY RESPONSE: Numeric data transferred as ASCII bytes in <NR1> format.

COMMENTS:

- This value is unaffected by *RST.
- To change the Baud rate used at power-on, save the instrument settings using the *SAV 0 command after changing the Baud rate.

RELATED FRONT-PANEL KEYS: **Shift + Menu** (BAUD > 19200 | 14400 | 9600 | 4800 | 2400 | 1200)

COMMAND **:SYSTem:ERRor?**

Queries the oldest error in the Error Queue and removes that error from the queue (first in, first out).

See the section titled “Errors” on page 3-150 for detailed error information

QUERY RESPONSE:

- The response is in the following form: <error_number>,“<error_description>”
- The <error_number> is an integer in the range [-32768, 32767]. The negative error numbers are defined by the SCPI standard; positive error numbers are particular to this instrument. An error number value of zero indicates that the Error Queue is empty.
- The maximum length of the <error_description> is 255 characters.

COMMENTS

- The queue is cleared (emptied) on *CLS, power-on, or upon reading the last error from queue.
- If the Error Queue overflows, the last error in the queue is replaced with the error -350, “Queue overflow”. Any time the queue overflows, the least recent errors remain in the queue and the most recent error is discarded. The maximum length of the Error Queue is 30.
- The Error Queue is unaffected by *RST and *SAV/RCL.
  It is cleared by *CLS.

RELATED FRONT-PANEL KEYS

None

COMMAND **:SYSTem:VERSion?**

Queries the SCPI version number with which the instrument complies.

QUERY RESPONSE

- Numeric data transferred as ASCII bytes in <NR2> format.
- The response is an <NR2> formatted numeric value which has the form YYYY.V, where YYYY represents the year, and V represents an approved version for that year.

RELATED FRONT-PANEL KEYS

None

3

:TRIGger Subsystem

COMMAND **:TRIGger[SEQuence | STARt]:HOLDoff . . . <numeric_value>**

When INIT:CONT is ON, this command determines the rate at which measurements are made by setting a delay between measurements. Its setting corresponds to the front-panel rate setting as follows:

<NUMERIC_VALUE> RATE: 0.0 = FAST; 0.5 = MEDium; 1.0 = SLOW

COMMENTS

- *RST: 0.0
- The only settings that are accepted are the three listed above.
- The measurement rate is also affected by the Resolution setting.
- When INIT:CONT is OFF, the holdoff has no effect.
- There is no setting for this command that corresponds to the front-panel rate setting of HOLD. The HOLD mode is entered through *RST or INIT:CONT OFF. The instrument then stops making measurements until it is triggered or until it receives INIT:CONT ON.

RELATED FRONT-PANEL KEYS: **Shift + Rate**

3

:UNIT Subsystem

COMMAND **:UNIT:POWer . . . <character_program_data>**

The UNIT subsystem sets the Power-Meter measurement units to Watts and % (linear) or dBm and dB (logarithmic).

COMMENT The UNIT:POWer and UNIT:POWer:RATio commands are coupled. Therefore, if:

- UNIT:POWer is set to DBM, then UNIT:POWer:RATio is dB.
- UNIT:POWer is set to W then UNIT:POWer:RATio is %.

RELATED FRONT-PANEL KEYS **Shift** + **dBm/W**

Common Commands

The IEEE 488.2 Common Commands are general-purpose commands that are common to all instruments (as defined in IEEE 488.2). These commands are generally not related to measurement configuration. They are used for functions like resetting the instrument, identification, or synchronization.

*CLS (Clear Status Command)

COMMAND ***CLS**

Clears all event registers summarized in the status byte (Standard Event Status Register, Operation Event Status Register, and Questionable Data Event Status Register) and clears the Error Queue.

COMMENTS

- The *CLS command does not clear data memories or any other settings.
- *CLS places the instrument in "Operation Complete Idle State" and "Operation Complete Query Idle State" (IEEE 488.2). This results in the disabling of any prior *OPC command.
- If *CLS immediately follows a program message terminator, the output queue and the MAV bit are cleared, since any new program message after a program-message terminator clears the output queue.
- This command clears any displayed error message from the front panel.
- If the front panel is displaying any menu when *CLS is received, the menu is abandoned (equivalent to pressing the **Clear** key).

RELATED FRONT-PANEL KEYS **Clear**

*DDT <arbitrary block> (Define Device Trigger Command) *DDT? (Define Device Trigger Query)

COMMAND

***DDT**
***DDT?**

Sets or queries the action that the device executes when it receives the IEEE 488.1 Group Execute Trigger (GET) interface message (page 3-97) or a *TRG common command.

QUERY RESPONSE

- Definite length block
- The query response is one of the following terminated with a new line and EOI:

  #14INIT
  #216INIT:*WAI;:DATA?
  #0
  #15FETC?
  #15READ?

COMMENTS

- *RST: #14INIT
- If a zero-length <arbitrary block> is specified as the parameter, the instrument does nothing when it receives a GET or *TRG command.

RELATED FRONT-PANEL KEYS

None

3

*ESE (Standard Event Status Enable Command)
*ESE? (Standard Event Status Enable Query)

COMMAND ***ESE <NRf> | <non-decimal numeric>**
***ESE?**

Sets or queries the Standard Event Status Enable Register, shown in Figure 3-20.

The parameter and query response value, when rounded to an integer value and expressed in base 2 (binary), represents the bit values of the Standard Event Status Enable Register. The value of unused bits is zero when queried and ignored when set.

This register is used to enable a single or inclusive OR group of Standard Event Status Register events to be summarized in the Status Byte Register (bit 5).

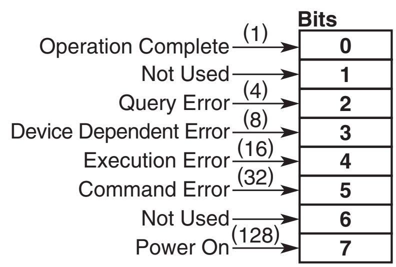

Figure 3-20. The Standard Event Status Enable Register

See the section titled “Standard Event Status Register” on page 3-56 for a detailed description of the Standard Event Status Register.

<NRF> RANGE	0 to 255
<NRF> RESOLUTION	1
QUERY RESPONSE	Numeric data transferred as ASCII bytes in <NR1> format.
COMMENTS	• At power-on, the Standard Event Status Enable Register is cleared (value is 0). • This value is unaffected by *RST and *SAV/*RCL. • Values for *ESE may be entered as decimal, hexadecimal, octal, or binary numbers.
RELATED FRONT-PANEL KEYS	None

3

*ESR? (Event Status Register Query)

COMMAND ***ESR?**

Queries the Standard Event Status Register, shown in Figure 3-21.

This event register captures changes in conditions, by having each event bit correspond to a specific condition in the instrument. An event becomes TRUE when the associated condition makes the defined transition. The event bits, once set, are "sticky"—i.e., they cannot be cleared until they are read, even if they do not reflect the current status of a related condition.

This register is cleared by *CLS, by *ESR?, and at power-on. Note that the instrument's power-on sequence initially clears the register, but then records any subsequent events during the power-on sequence including setting the PON (power on) bit.

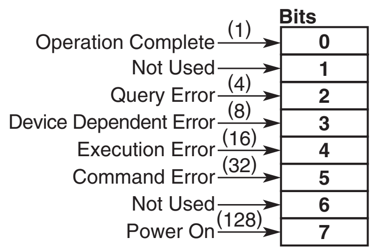

Figure 3-21. Standard Event Status Register

See the section titled "Standard Event Status Register" on page 3-56 for a detailed description of the Standard Event Status Register.

QUERY RESPONSE

- Numeric data transferred as ASCII bytes in <NR1> format.
- Range is 0 to 255.
- The query response is an integer formed by the binary-weighting of the bits. The value of any unused bit is zero.

*IDN? (Identification Query)

COMMAND ***IDN?**

Queries the instrument identification.

QUERY RESPONSE A sequence of ASCII-encoded bytes:

AGILENT, <Model Number>, <Serial Number>, <Firmware ID>

COMMENTS

- This query should be the last query in a terminated program message; if it is not the last query, an error -440 is generated.
- The model number is either 53147A, 53148A, or 53149A.
- The number of digits in the serial number is not fixed.
- The format for the firmware ID is: H0-nnn, where nnn is a three-digit number. This is followed by the date and time of the firmware release.

RELATED FRONT-PANEL KEYS **Shift + Menu**

*IST? (Instrument Status)

COMMAND ***IST?**

Queries the current state of the parallel poll response (Instrument Status).

QUERY RESPONSE <NR1>

RANGE 0-1

RELATED FRONT-PANEL KEYS None

3

*OPC (Operation Complete Command)

COMMAND ***OPC**

This event command enables the OPC bit (bit 0) in the Standard Event Status Register to be set when a triggered action is complete. See the section titled "Standard Event Status Register" on page 3-56 for a detailed description of the Standard Event Status Register's Operation Complete bit.

This event command is "disabled" by *CLS, *RST, power-on, or upon the transition of the measurement cycle from measuring to idle.

This event command has no query form.

See the section titled "Using the *OPC Command to Assert SRQ" on page 3-76 for an example that uses this command.

RELATED FRONT-PANEL KEYS None

*OPC? (Operation Complete Query)

COMMAND ***OPC?**

This query causes the instrument to place a response in the output queue when a triggered action is complete. This allows synchronization between a controller and the instrument using the MAV bit in the Status Byte Register. (Note that this query does not actually "read" a state, as most queries do.)

See the section titled "Using the *OPC? Command" on page 3-76 for an example that uses this command.

QUERY RESPONSE Single ASCII-encoded byte, 1.

RELATED FRONT-PANEL KEYS None

NOTE The *OPC? query does not in any way affect the OPC bit in the Standard Event Status Register.

*PRE (Parallel Poll Enable Register)
*PRE? (Parallel Poll Enable Register Query)

COMMAND ***PRE<NRf>**
***PRE?**

Sets or queries the value of the parallel poll enable register.

QUERY RESPONSE <NRf>

RANGE 0-255

COMMENTS
- The parallel poll enable register is eight bits wide and has the same bit definitions as the status byte.
- The status byte and parallel poll enable registers are anded together; the result determines the value of *IST (TRUE or FALSE).

RELATED FRONT-PANEL KEYS None

*RCL (Recall Command)

COMMAND ***RCL <NRf> | <non-decimal numeric>**

This command restores the state of the instrument from a copy stored in local non-volatile memory. Before the recall occurs, the current state of the instrument is automatically saved to register 0.

<NRF> RANGE 0 to 8

<NRF> RESOLUTION 1

RELATED FRONT-PANEL KEYS **Shift + Menu** (RECALL > 0 through 8)

3

*RST (Reset Command)

COMMAND ***RST**

This event command performs an instrument reset.

The reset performs the following:

- sets instrument settings to their *RST states, and
- places the instrument in "Operation Complete Idle State" and "Operation Complete Query Idle State."

COMMENTS

- See the section titled "*RST Response" on page 3-28 for a complete listing of the *RST state.
- Each command description in this section includes the *RST state in the "Comment" portion of the definition.

RELATED FRONT-PANEL KEYS **Reset/Local**

*SAV (Save Command)

COMMAND **<NRf> | <non-decimal numeric>** — ***SAV <NRf> | <non-decimal numeric>**

This command stores the current state of the instrument in register 0 of local non-volatile memory when *RCL or is executed or Recall is selected from the menu using the front-panel controls.

<NRF> RANGE: 0 to 8

<NRF> RESOLUTION: 1

COMMENTS

- The following states are saved:

:DISPlay[:WINDow]:BACKground:[:STATe]
:INITiate:CONTinous
[:SENSe]:AVERage[:STATe]
[:SENSe]:AVERage:COUNt
[:SENSe]:CORRection:CSET:SELect
[:SENSe]:CORRection:CSET:STATe
[:SENSe]:FILTer:FM:AUTO
[:SENSe]:FREQuency:OFFset:STATe
[:SENSe]:FREQuency:RESolution
[:SENSe]:FREQuency:TRACking
[:SENSe]:FUNCtion[:ON]
[:SENSe]:POWer:AC:REFerence
[:SENSe]:POWer:AC:REFerence:STATe
[:SENSe]:ROSCillator:SOURce
:TRIGger:[:SEQuence]:HOLDoff
*DDT

- The following front-panel settings are saved (these settings have no command equivalents):

Rel Pwr (Relative Power) valueRel Freq (Relative Frequency) value
Rel Pwr (Relative Power) stateRel Freq (Relative Frequency) state
Power Display Units

RELATED FRONT-PANEL KEYS: **Shift + Menu** (SAVE > 0 through 8)

*SRE (Service Request Enable Command)
*SRE? (Service Request Enable Query)

COMMAND ***SRE <NRf> | <non-decimal numeric>**
***SRE?**

Sets or queries the Service Request Enable Register, which is shown in Figure 3-22.

The parameter and query response value, when rounded to an integer value and expressed in base 2 (binary), represents the bit values of the Service Request Enable Register.

This register is used to enable a single or inclusive OR group of Status Byte Register events to generate an SRQ.

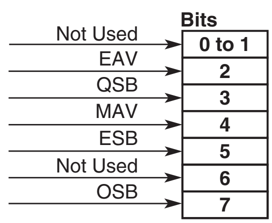

Figure 3-22. The Service Request Enable Register

See the section titled “Status Byte Register and Service Request Enable Register” starting on page 3-53 for a detailed description of the Service Request Enable Register.

<NRF> RANGE
- 0 to 255
- The value of bit 6 is ignored.

<NRF> RESOLUTION 1

QUERY RESPONSE
- Numeric data transferred as ACSII bytes in <NR1> format.
- The value of bit 6 is zero when queried.

COMMENTS
- At power-on, this value is cleared (set to 0).
- This value is unaffected by *RST, *CLS, and *SAV/*RCL.

RELATED FRONT-PANEL KEYS
None

*STB? (Status Byte Query)

COMMAND ***STB?**

Queries the Status Byte Register, shown in Figure 3-23.

This register is cleared at power-on.

This query does not directly alter the Status Byte Register (including the MSS/RQS bit) or anything related to the generation of SRQ.

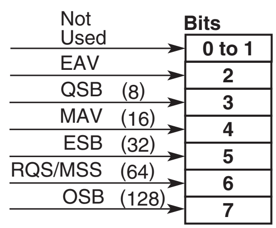

Figure 3-23. The Status Byte Register

See the section titled “Status Byte Register and Service Request Enable Register” starting on page 3-53 for a detailed description of the Status Byte Register.

QUERY RESPONSE
- Numeric data transferred as ASCII bytes in <NR1> format.
- Range is 0 to 255.
- The response value when rounded to an integer value and expressed in base 2 (binary), represents the bit values of the Status Byte Register.
- The value of unused bits is zero when queried.

- The Master Summary Status, not the RQS message, is reported on bit 6. Master Summary Status indicates that the instrument has at least one reason for requesting service. (The Master Summary Status is not sent in response to a serial poll; the IEEE 488.1 RQS message is sent instead.) It is the inclusive OR of the bitwise combination (excluding bit 6) of the Status Byte Register and the Service Request Enable Register.

*TRG (Trigger Command)

COMMAND ***TRG**

This command is the device-specific analog of the IEEE 488.1 Group Execute Trigger (GET) interface message (page 3-97), and has exactly the same effect.

The *TRG command performs the action defined by the *DDT command (page 3-28).

RELATED FRONT-PANEL KEYS None

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*TST? (Self-Test Query)

COMMAND ***TST?**

This query causes an internal self-test; the response indicates whether any errors were detected.

When the self-test fails, error -330 is generated, and other messages indicating specific failures are also placed in the error/event queue.

QUERY RESPONSE

- Numeric data transferred as ACSII bytes in <NR1> format.
- A response value of zero indicates the self-test has completed with no errors detected, while a non-zero value indicates the self-test was not completed or was completed with errors detected. The test failures that can be detected and their corresponding bit numbers are shown below:

Table 3-15. Self-Test Error Values

Bit	Test Failed	Bit	Test Failed
0	Band 1 Signal Path	19	ROM
1	Band 1 Threshold	20	Unused
2	Band 2 RF Threshold	21	Front Panel Hardware
3	Band 2 IF Through Threshold	22	GPIB
4	Band 2 IF Heterodyne Threshold	23	EEPROM Instrument Configuration Data
5	Heterodyne Path	24	EEPROM Service Data
6	Through Path	25	EEPROM Saved User Settings Data
7	VCO	26	EEPROM Power Calibration Data
8	Counter Control FPGA	27	EEPROM Write
9	Power Measurement Hardware	28	EEPROM Power Correction Data
10-15	Unused	29	ADC
16	–12 V	30	Over Temperature
17	–5 V	31	Unused
18	+12 V		

- The decimal weight of each bit is 2^n, where n is the bit number.

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COMMENTS The following are tested:

CPU	EEPROM
Front-panel components	Measurement hardware
ROM	Power supply outputs

RELATED FRONT-PANEL KEYS **Shift + Menu** (DO SELF TEST)

*WAI (Wait-to-Continue Command)

COMMENTS ***WAI**

This command prevents the instrument from executing any further commands or queries until all pending operations are complete. The only way to cancel this "holdoff" is by device clear, power-on, *RST, or *CLS.

See the section titled "Using the *WAI Command" on page 3-75 for an example that uses this command.

RELATED FRONT-PANEL KEYS None

Errors

This section explains how to read error messages from the instrument, discusses the types of errors, and provides a table of all of the Instrument’s error messages and their probable causes.

Reading an Error

Executing the :SYSTem:ERRor? command reads the oldest error from the error queue and erases that error from the queue. The :SYST:ERR? response has the form:

<error number>, <error string>

An example response is:

-113,”Undefined header”

All errors set a corresponding bit in the Standard Event Status Register (see the section titled “Standard Event Status Register Group” on page 3-56).

The following short program reads all errors (one at a time, oldest to newest) from the error queue. As each error is read, it is automatically erased from the error queue. When the error queue becomes empty (that is, when all errors have been read from the queue), further queries return the **+0, ”No error”** response.

```
10  ASSIGN @Cntr TO 703
20  !Assign path name
30  DIM Err_string$[255]
40  !Creates array for error string
50  REPEAT
60  !Repeats until error queue is empty
70  OUTPUT @Cntr;"SYST:ERR?"
80  !Read error number and string
90  ENTER @Cntr;Err_num,Err_string$
100 !Enter error number and string
110 PRINT Err_num,Err_string$
120 !Print error number and string
130 UNTIL Err_num = 0
140 END
```

Error Queue

As errors are detected, they are placed in an error queue. The error queue is a first in, first out queue. That is, if more than one error has occurred, the first error in the queue is read out with :SYST:ERR?. Subsequent responses to :SYST:ERR? continue until the queue is empty.

If the error queue overflows, the last error in the queue is replaced with error –350, “Queue overflow”. Any time the queue overflows, the least recent errors remain in the queue, and the most recent error is discarded. The length of the Instrument’s error queue is 10 (9 positions for the error messages, and 1 position for the “Queue overflow” error). Reading an error from the head of the queue removes that error from the queue, and opens a position at the tail of the queue for a new error, if one is subsequently detected. When all errors have been read from the queue, further error queries return **+0, “No error”**.

The error queue is cleared when any of the following events occur:

- Power-on.
- Receipt of a *CLS command.
- The last item is read from the queue.

Error Types

Error numbers are categorized by type as shown in Table 3-16. The error codes that can be generated by the Agilent 53147A, 53148A, and 53149A are listed in Table 3-17.

Table 3-16. Error Types

Error Number	Error Type
+0	No Error
–100 to –199	Command Errors
–200 to –299	Execution Errors
–300 to –350	Device-Specific Errors
–400 to –499	Query Errors

The first error described in each class (for example, –100, –200, –300, –400) is a “generic” error.

No Error

The :SYST:ERR? response **+0, “No error”** indicates that there are no errors in the instrument’s error queue. The error queue is empty when every error in the queue has been read (:SYST:ERR? query) or the queue was cleared by power-on or *CLS.

Command Error

An <error number> in the range [–100 to –199] indicates that an IEEE 488.2 syntax error was detected by the instrument’s parser. The occurrence of any error in this class causes the command error bit (bit 5) in the Event Status Register to be set. This happens when one of the following occurs:

- An IEEE 488.2 syntax error is detected by the instrument’s parser. That is, a controller-to-instrument message was received that is in violation of the IEEE 488.2 Standard. Possible violations include a data element that violates the instrument’s listening formats or whose type is unacceptable to the instrument.

- An unrecognized header was received. Unrecognized headers include incorrect instrument-specific headers and incorrect or unimplemented IEEE 488.2 Common Commands.
- A Group Execute Trigger (GET) was entered into the input buffer inside of an IEEE 488.2 program message.

Events that generate command errors do not generate execution errors, device-specific errors, or query errors.

Execution Error

An <error number> in the range [–200 to –299] indicates that an error has been detected by the instrument's execution control block. The occurrence of any error in this class causes the execution error bit (bit 4) in the Event Status Register to be set. One of the following events has occurred:

- A <PROGRAM DATA> element following a header was evaluated by the instrument as outside of its legal input range or is otherwise inconsistent with the instrument's capabilities.
- A valid program message could not be properly executed due to some instrument condition.

Execution errors are reported by the instrument after rounding and expression evaluation operations have been taken place. Rounding a numeric data element, for example, is not reported as an execution error. Events that generate execution errors do not generate command errors, device-specific errors, or query errors.

Device-Specific or Instrument-Specific Error

An <error number> in the range [–300 to –399] or [+1 to +32767] indicates that the instrument has detected an error that is not a command error, a query error, or an execution error; some instrument operations did not properly complete, possibly due to an abnormal hardware or firmware condition. These codes are also used for self-test response errors. The occurrence of any error in this class causes the device-specific error bit (bit 3) in the Event Status Register to be set.

Query Error

An <error number> in the range [–400 to –499] indicates that the output queue control of the instrument has detected a problem with the message exchange protocol. The occurrence of any error in this class causes the query-error bit (bit 2) in the Event Status Register to be set. This means that one of the following conditions exists:

- An attempt is being made to read data from the output queue when no output is either present or pending.
- Data in the output queue was lost.

Error List

Table 3-17 lists and describes the error messages generated by the Agilent 53147A, 53148A, and 53149A.

Table 3-17. Errors

Number	Error String	Cause
+0	No error	The error queue is empty. Every error in the queue has been read (:SYSTem:ERRor? query) or the queue was cleared by power-on or *CLS.
-100	Command error	This is the generic syntax error used if the instrument cannot detect more specific errors.
-101	Invalid character	A syntactic element contains a character that is invalid for that type. For example, a header containing an ampersand, :INP:COUP& AC.
-102	Syntax error	An unrecognized command or data type was encountered.
-103	Invalid separator	The parser was expecting a separator and encountered an illegal character.
-104	Data type error	The parser recognized a data element different than one allowed. For example, numeric or string data was expected, but block data was received.
-105	GET not allowed	A Group Execute Trigger was received within a program message.
-108	Parameter not allowed	More parameters were received than expected for the header.
-109	Missing parameter	Fewer parameters were received than required for the header.
-110	Command header error	An unspecified error was detected in the header.
-111	Header separator error	A character that is not a legal header separator was encountered while parsing the header.
-112	Program mnemonic too long	The header or character data element contains more than twelve characters.
-113	Undefined header	The header is syntactically correct, but it is undefined for the instrument. For example, *XYZ is not defined for the instrument.
-114	Header suffix out of range	The value of a numeric suffix attached to a program mnemonic makes the header invalid.
-120	Numeric data error	This error, as well as errors -121 through -129, are generated when parsing a data element which appears to be numeric, including the non-decimal numeric types. This particular error message is used when the instrument cannot detect a more specific error.
-121	Invalid character in number	An invalid character for the data type being parsed was encountered. For example, a “9” in octal data.
-123	Exponent too large	Numeric overflow.
-124	Too many digits	The mantissa of a decimal numeric data element contained more than 255 digits excluding leading zeros.
-128	Numeric data not allowed	A legal numeric data element was received, but the instrument does not accept one in this position for the header.
-130	Suffix error	This error can be generated when parsing a suffix. This particular error message is used if the instrument cannot detect a more specific error (errors -131 through -139).

Table 3-17. Errors (continued)

Number	Error String	Cause
-131	Invalid suffix	The suffix does not follow the syntax described in IEEE 488.2 or the suffix is inappropriate for the instrument.
-134	Suffix too long	The suffix contained more than 12 characters.
-138	Suffix not allowed	A suffix was encountered after a numeric element that does not allow suffixes.
-140	Character data error	This error can be generated when parsing a character data element. This particular error message is used if the instrument cannot detect a more specific error (errors -141 through -149).
-141	Invalid character data	The character data element contains an invalid character.
-144	Character data too long	The character data element contains more than twelve characters.
-148	Character data not allowed	A legal character data element was encountered where prohibited by the instrument.
-150	String data error	This error can be generated when parsing a string data element. This particular error message is used if the instrument cannot detect a more specific error.
-151	Invalid string data	A string data element was expected but was invalid for some reason. For example, an END message was received before the terminal quote character.
-158	String data not allowed	A string data element was encountered but was not allowed by the instrument at this point in parsing.
-160	Block data error	This error can be generated when parsing a block data element. This particular error message is used if the instrument cannot detect a more specific error (errors -161 through -169).
-161	Invalid block data	A block data element was expected, but it was not allowed by the instrument at this point in parsing.
-168	Block data not allowed	A legal block data element was encountered but was not allowed by the instrument at this point in parsing.
-170	Expression error	This error can be generated when parsing an expression data element. It is used if the instrument cannot detect a more specific error.
-171	Invalid expression	The expression data element was invalid (see IEEE 488.2). For example, unmatched parentheses or an illegal character.
-178	Expression data not allowed	Expression data was encountered but was not allowed by the instrument at this point in parsing.
-181	Invalid outside macro definition	Indicates that a macro parameter placeholder ($<number>) was encountered outside of a macro definition.
-200	Execution error	This is the generic syntax error if the instrument cannot detect more specific errors. This code indicates only that an Execution Error has occurred.
-210	Trigger error	Used if the instrument cannot detect a more specific error from the :INIT,:TRIG, or :ABOR subsystems.

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Table 3-17. Errors (continued)

Number	Error String	Cause
-211	Trigger ignored	Indicates that a GET or *TRG was received and recognized by the instrument but was ignored.
-213	Init ignored	Indicates that a request for a measurement initiation was ignored as another measurement was in progress.
-220	Parameter error	Indicates that a program data element related error occurred. This error is used when the instrument cannot detect more specific errors.
-221	Settings conflict	Indicates that a legal program data element was parsed but could not be executed due to the current instrument state.
-222	Data out of range	Indicates that a legal program data element was parsed but could not be executed because the interpreted value is outside the legal range defined by the instrument. Typically, the value is clipped to legal limit.
-223	Too much data	Indicates that a legal program data element of block, expression, or string type was received that contained more data than the instrument could handle due to memory or related instrument-specific requirements.
-224	Illegal parameter value	Used where exact value, from a list of possible values, was expected.
-230	Data corrupt or stale	No valid data available. New measurement started but not completed.
-240	Hardware error	Indicates that a legal program command or query could not be executed because of a hardware problem in the instrument.
-241	Hardware missing	Indicates that a legal program command or query could not be executed because of missing instrument hardware.
-300	Device-specific error	This is the generic device-dependent error.
-310	System error	Indicates that a system error occurred.
-321	Out of memory	Indicates that the instrument has detected that insufficient memory is available.
-330	Self-test failed	Indicates at least one failure occurred when *TST? was executed.
	Queue overflow	Indicates that there is no room in the error queue and an error occurred but was not recorded.
	Query error	This is the generic query error.
	Query INTERRUPTED	Indicates that a condition causing an INTERRUPTED Query error occurred. For example, a query followed by DAB or GET before a response was completely sent.
-340	Data Qestionable: ZERO ERROR I CAL ERROR	The zeroing (ZERO ERROR) or calibration (CAL ERROR) process failed.
-350	Queue Overflow	Indicates that there is no room in the error queue, and that an error occurred but was not recorded.
-400	Query error	This is the generic query error.
-410	Query INTERRUPTED	Indicates that a condition causing an INTERRUPTED Query error occurred. For example, a query followed by a DAB or GET before a

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Table 3-17. Errors (continued)

Number	Error String	Cause
-420	Query UNTERMINATED	Indicates that a condition causing an UNTERMINATED Query error occurred. For example, the instrument was addressed to talk and an incomplete program message was received.
-430	Query DEADLOCKED	Indicates that a condition causing a DEADLOCKED Query error occurred. For example, both input buffer and output buffer are full and the instrument cannot continue.
-440	Query UNTERMINATED after indefinite response	Indicates that a query was received in the same program message after a query requesting an indefinite response (for example, *IDN? or *OPT?) was executed.

4

Specifications

Introduction

The specifications for the Agilent 53147A, 53148A, and 53149A are provided in this chapter.

Measurement Specifications and Characteristics

All measurement specifications are over the full signal and temperature ranges unless otherwise noted. All specifications are warranted. Those items labeled "typical" or "nominal" are characteristics and are not warranted.

Input Characteristics	53147A	53148A	53149A
Frequency Range			
Channel 1 (Normal mode)	10 Hz–125 MHz	10 Hz–125 MHz	10 Hz–125 MHz
(Low pass filter enabled)	10 Hz–50 kHz	10 Hz–50 kHz	10 Hz–50 kHz
Channel 2	50 MHz–20 GHz	50 MHz–26.5 GHz	50 MHz–46 GHz
Sensitivity			
Channel 1			
10–30 Hz	40 mV rms	40 mV rms	40 mV rms
30 Hz–125 MHz	25 mV rms	25 mV rms	25 mV rms
Channel 2			
50–300 MHz	–20 dBm	–20 dBm	–20 dBm
0.3–12.4 GHz	–33 dBm	–33 dBm	–33 dBm
12.4–18 GHz	–33 dBm	–33 dBm	–30 dBm
18–20 GHz	–29 dBm	–29 dBm	–27 dBm
20–26.5 GHz	N/A	–25 dBm	–27 dBm
26.5–40 GHz	N/A	N/A	–23 dBm
40–46 GHz	N/A	N/A	–17 dBm
Maximum Input			
Channel 1	2 Vrms	2 Vrms	2 Vrms
Channel 2			
50 MHz–2 GHz	+5 dBm	+5 dBm	+5 dBm
2–46 GHz	+13 dBm	+13 dBm	+13 dBm
Damage Level			
Channel 1	120 V (dc + ac pk) linearly derated to 5 Vrms at 125 MHz	120 V (dc + ac pk) linearly derated to 5 Vrms at 125 MHz	120 V (dc + ac pk) linearly derated to 5 Vrms at 125 MHz
Channel 2	+27 dBm	+27 dBm	+27 dBm
Impedance (Nominal)			
Channel 1	1 MΩ/ 60 pF	1 MΩ/ 60 pF	1 MΩ/ 60 pF
Channel 2	50 Ω	50 Ω	50 Ω
Connector			
Channel 1	BNC female	BNC female	BNC female
Channel 2	SMA/APC-3.5 compatible female	SMA/APC-3.5 compatible female	2.92 mm removable, SMA/APC-3.5 compatible female
SWR			
Channel 2			
50–300 MHz	1.5:1 typical	1.5:1 typical	1.5:1 typical
0.3–10 GHz	2.0:1 typical	2.0:1 typical	2.0:1 typical
10–20 GHz	3.0:1 typical	3.0:1 typical	3.0:1 typical
20–26.5 GHz	N/A	3.0:1 typical	2.5:1 typical
26.5–46 GHz	N/A	N/A	2.5:1 typical
Coupling			
Channel 1	ac	ac	ac
Channel 2	ac	ac	ac

Input Characteristics (continued)	53147A	53148A	53149A
Emissions (typical) ("kickback noise") Channel 1 Channel 2 (measuring/no input)	N/A –40 dBm/<–70 dBm	N/A –40 dBm/<–70 dBm	N/A –40 dBm/<–70 dBm
Resolution selection Channel 1/Channel 2	1 Hz to 1 MHz	1 Hz to 1 MHz	1 Hz to 1 MHz
Accuracy Channel 1/Channel 2 (LSD=Resolution selected)	±1 LSD ± residual stability ± timebase error x frequency	±1 LSD ± residual stability ± timebase error x frequency	±1 LSD ± residual stability ± timebase error x frequency
Residual Stability* Channel 1 Channel 2 *Counter and source tied to same timebase	N/A 0.6 LSD rms	N/A 0.8 LSD rms	N/A 1.25 LSD rms
Measurement Time (typical) Channel 1 Channel 2	1/Resolution +30 ms 1/Resolution + Acquisition time + 30 ms	1/Resolution +30 ms 1/Resolution + Acquisition time + 30 ms	1/Resolution + 30 ms 1/Resolution + Acquisition time + 30 ms
Acquisition Time (typical) (1 MHz FM rate, power meter off) Channel 1 Channel 2 (FM Auto/FM Off)	N/A 150 ms/125 ms	N/A 150 ms/125 ms	N/A 165 ms/140 ms
FM Tolerance Channel 1 Channel 2 (FM Auto) (FM Off)	N/A 20 MHz p-p max @ 10 MHz rate 1 MHz p-p @ 10 MHz rate	N/A 20 MHz p-p max @ 10 MHz rate 1 MHz p-p @ 10 MHz rate	N/A 20 MHz p-p max to 26.5 GHz, 12 MHz p-p max above 26.5 GHz @ 10 MHz rate 1 MHz p-p @ 10 MHz rate
AM Tolerance Channel 1, Channel 2	Any index provided minimum signal level is not less than sensitivity	Any index provided minimum signal level is not less than sensitivity	Any index provided minimum signal level is not less than sensitivity
Amplitude Discrimination Channel 1 Channel 2 below 300 MHz above 300 MHz	N/A N/A Automatically measures the largest signal present provided signal is >10 dB (typical) above any signal separated by less than 75 MHz; >20 dB (typical) above any signal separated by more than 75 MHz	N/A N/A Automatically measures the largest signal present provided signal is >10 dB (typical) above any signal separated by less than 75 MHz; >20 dB (typical) above any signal separated by more than 75 MHz	N/A N/A Automatically measures the largest signal present provided signal is >10 dB (typical) above any signal separated by less than 75 MHz; >20 dB (typical) above any signal separated by more than 75 MHz
Timebase Frequency Output External timebase input Connector	10 MHz 10 MHz sine wave, 1 Vrms into 50Ω 1, 2, 5, 10 MHz, 1 to 5 Vrms into 50Ω BNC female located on rear panel		
Internal timebase stability	**TCXO** (standard)	**Oven** (Option 001)	
Aging rate per day	N/A	$<5 \times 10^{-10}$	
Aging rate per month	$<1 \times 10^{-7}$	$<1.5 \times 10^{-8}$	
Short term (1 sec. average time)	$<1 \times 10^{-9}$	$<2 \times 10^{-10}$	
Line variation (± 10%)	$<1 \times 10^{-7}$	$<1 \times 10^{-10}$	
Warm-up	N/A	$<1 \times 10^{-8}$ within 5 min. after turn-on at 25ºC	
Temperature stability (0-55ºC)	$<1 \times 10^{-6}$	$<1 \times 10^{-8}$	

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Power Meter Specifications	53147A, 53148A, and 53149A
Frequency range	100 kHz to 50 GHz, sensor dependent
Power range	-70 to +44 dBm, sensor dependent
Power sensors supported	8480 series (8487A, 8485A, 8482A, 8481D, 8481A, 8481B, 8482B, 8481H, 8482H, 8485D, 8487D)
Resolution	0.01 dB in log mode, 0.1% of full scale in linear mode
Display units	
Absolute	dBm or Watts
Relative	dB or %
Accuracy	
Instrumentation	± 0.02 dB or ± 0.5%, add power sensor linearity specification for overall system accuracy
Zero set (digital setting capability of zero)	Sensor dependent (see “Available Sensors” table on page 4-6)
Power reference	
Power output	1.00 mW, factory set to ± 0.7%, traceable to NIST
Accuracy	± 1.2% worst case (± 0.9 RSS) for one year
Frequency	50 MHz (nominal)
Connector	N (f)

DVM Specifications	53147A, 53148A, and 53149A
Function	DC volts
Range	± 50 Vdc
Resolution	2 mV
Accuracy	± 0.25% of reading ± 10 mV
Damage level	± 60 Vdc
Input resistance	0.5 MΩ (nominal)
Connector	4 mm banana sockets
Display	Replaces frequency display when DVM is activated

General Information	53147A, 53148A, and 53149A
Save and recall	Up to 9 complete instrument setups may be saved and later recalled. These setups are retained when power is removed
Sample rate	User-selectable fast (nominally 20 ms between readings), medium (nominally 250 ms between readings), slow (nominally 1 s between readings) and hold
Counter gate time	1/Resolution selected
Math functions	
Offset (relative/fixed)	Last reading and/or entered offset to reading for either power or frequency
Averaging	1 to 99 measurement running average
Display	Backlit LCD. Backlight can be turned on or off via front panel control
Sleep mode (Option 002 only)	Backlight automatically shuts off if no input signal and power sensor present, and no keys pressed, for 5 minutes (nominal)
Self test	Counter and power-meter circuitry and internal memory automatically tested at startup, via menu selection, or remotely. Error messages displayed to indicate failed tests.
Programming	
Interface	GPIB (IEEE-488.1-1987, IEEE 488.2-1987) and RS-232
Language	SCPI-1992.0 (Standard Commands for Programmable Instruments)
RS-232 Rates	User selectable 2400 to 19200 baud

General Information (continued)	53147A, 53148A, and 53149A
Power Supply	
ac	90-132 Vac; 47.5-66 Hz or 360-440 Hz 216-264 Vac; 47.5-66 Hz
Line selection	automatic
Power requirements	80 VA max. (32 W typical)
dc (Option 002 only)	11-18 Vdc; 2A max.
Battery (Option 002)	
Type	VHS camcorder, lead acid (2 each)
Charge Time	8 hours in unit (typical)
Capacity	2 hours min. at 25° C
Size	330 mm W x 156 mm H x 376 mm D with bumpers and handles. Rack panel is full EIA width and 3U ISO height.
Operating temperature	0-55° C, 0-40° C with battery option
Weight (nominal)	4.5 kg without battery option, 6.6 kg with battery option
Safety	Designed in compliance with IEC-1010, CAN/CSA 1010.1
EMC	Designed in compliance with IEC-11, EN50082-1, IEC801-2, -3, -4
Accessories	
Supplied	Power sensor cable (11730A); DVM test leads (34132B); operating/programming and service manuals; ac power cord
Available	
Power sensors	8480 series (see table below)
Spare battery	53150-80010
DC power input cable	53150-60214

Available Sensors	Frequency Range	Connector	Zero Set
25 Watt sensors 1 mW to 25 W (0 to +44 dBm)			
8481B	10 MHz to 18 GHz	N (m)	±50 μW
8482B	100 kHz to 4.2 GHz	N (m)	±50 μW
3 Watt sensors 100 μW to 3 W (-10 to +35 dBm)			
8481H	10 MHz to 18 GHz	N (m)	±5 μW
8482H	100 kHz to 4.2 GHz	N (m)	±5 μW
100 mW sensors 1 μW to 100 mW (-30 to +20 dBm)			
8485A	50 MHz to 26.5 GHz	APC-3.5 mm (m)	±50 nW
8485A Option 033	50 MHz to 33 GHz	APC-3.5 mm (m)	±50 nW
8481A	10 MHz to 18 GHz	N (m)	±50 nW
8482A	100 kHz to 4.2 GHz	N (m)	±50 nW
8487A	50 MHz to 50 GHz	2.4 mm (m)	±50 nW
High sensitivity sensors 100 pW to 10 μW (-70 to -20 dBm)			
8481D	10 MHz to 18 GHz	N (m)	±20 pW
8485D	50 MHz to 26.5 GHz	APC-3.5 mm (m)	±20 pW
8485D Option 033	50 MHz to 33 GHz	APC-3.5 mm (m)	±20 pW
8487D	50 MHz to 50 GHz	2.4 mm (m)	±20 pW

A

Rack Mounting the Instrument

A

Rack Mounting the Instrument

You can mount the Agilent 53147A, 53148A or 53149A in a standard 19-inch rack using the optional Rack Mounting Kit (53147-67001) available from Agilent.

To rack-mount the instrument, you must first remove the front bumper, the front bumper retainers, and the carrying handle. Use the following procedure to prepare the instrument for rack-mounting:

NOTE Unlike the hardware used elsewhere in this instrument, all hardware used to attach the handle pivots and the rack mounts to the instrument is metric.

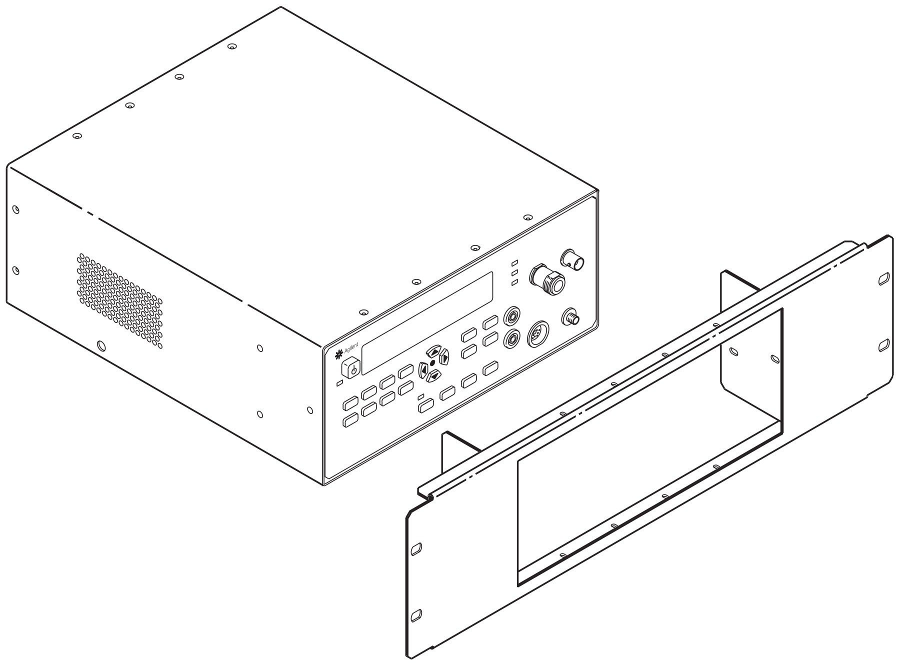
1 Remove the front bumper by lifting the inner edge of the bumper away from the shroud near one corner at the top and one side and pulling that corner away from the instrument. Repeat the process with the remaining corners until the bumper is free of the instrument.

2 Pull out on both sides of the handle at the handle pivots, and rotate the handle towards the top of the instrument until the handle is touching the top of the shroud.

3 Use a T15 Torx™ tool to remove the three screws that attach each of the handle pivots to the sides of the instrument, and remove the handle.

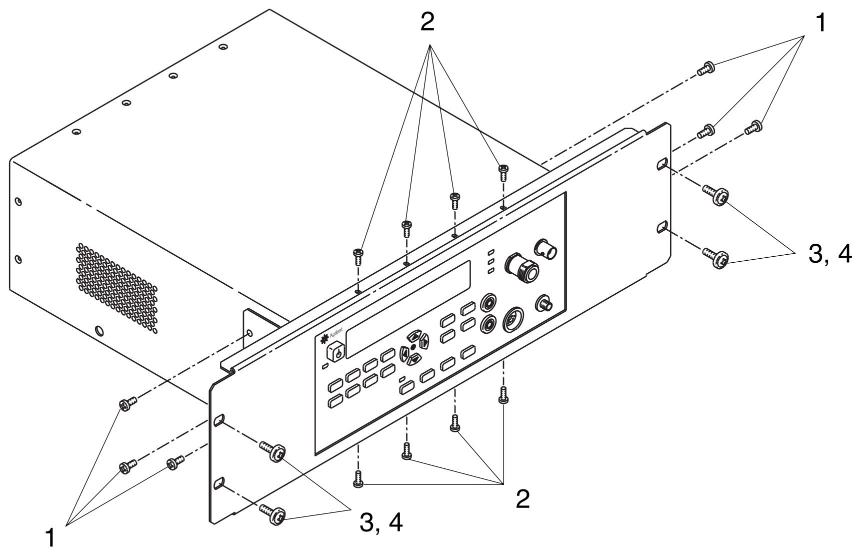
4 Use a #1 Phillips™ screwdriver to remove the two screws that attach each of the front bumper retainers to the top and bottom of the instrument (there are four front bumper retainers—two each on the top and bottom).

5 Position the rack-mount panel (53147-60211) on the front of the instrument so that the four holes in the top and bottom of the rack-mount panel are aligned with the four threaded holes in the top and bottom of the instrument (the holes that were used to mount the front bumper retainers).



A

6 Insert the eight 3/8-inch x 4-40, pan-head Phillips screws (2) supplied in the Rack Mount Kit through the holes in the top and bottom of the rack-mount panel into the threaded holes in the top and bottom of the instrument. Start the screws, but do not tighten them at this time.



7 Insert the six 10mm long, 4 mm x .7, pan-head Torx screws (1) supplied in the Rack Mount Kit through the holes in the side flanges of the rack-mount panel and tighten them fully.

8 Tighten the eight screws you inserted in Step 6.

NOTE You can use angle brackets to help support the instrument in the rack and to make it easier to mount the instrument.

9 Place the four Nylon washers supplied in the Rack Mount Kit over the four 10-32 screws (3, 4).

10 Inspect the holes in the rack to determine if they are threaded. If the holes are threaded, skip Step 11.

11 Insert the four sheet-metal U-nuts provided in the Rack Mount Kit in the rack flange behind the four holes you intend to use to mount the instrument.

12 While holding the instrument in position in the rack, insert one of the 10-32 screws with the Nylon washer on it (3,4) through one of the upper holes in the rack-mount panel into the threaded hole in the rack (or into the U-nut you installed in Step 11 if the hole is not threaded).

13 Repeat the procedure in Step 12 for the remaining upper rack-mount hole and the two lower rack-mount holes.

14 Tighten all four rack-mount screws.

15 Connect the power cord to the Main ~ Power input connector on the instrument's rear panel.

16 Connect the other end of the power cord to an appropriate AC power source.

Rack Mounting the Instrument

B

Messages

Overview

The Agilent 53147A/148A/149A provides two types of messages that are displayed on the instrument's front panel and/or sent over the RS-232 serial interface. The first type is status messages, which are displayed during normal operation. The second type is error messages, which are sent via RS-232 and/or displayed when the instrument detects an error during the Self-Test procedure or during normal operation.

NOTE All messages sent over the RS-232 interface are also available via GPIB. However, these messages are not automatically sent over the GPIB interface. For information on retrieving messages over the GPIB interface, see Chapter 3.

Status Messages

Table B-1 lists and describes the status messages that are displayed on the instrument's front panel.

Table B-1. Status Messages

Message	Description
TESTING	The instrument is performing its Self-Test.
SELF TEST OK	No critical errors were detected during the self-test.
MEASURING	The instrument is sampling the signal and computing a measurement.
AVERAGING	The instrument is taking measurements and computing the number of averages determined by the Averages setting.
CH 1 NO SIGNAL CH 2 NO SIGNAL	The instrument is operational, but no signal can be detected on the selected input.
CHANNEL 1 CHANNEL 2	Identifies the currently selected channel after you press the **Chan Select** key to switch channels. CHANNEL 1 or CHANNEL 2 is displayed until the Counter can display a measurement or determine that no signal is present.
NO PM SENSOR	The Power Meter was activated without a power head connected to the input connector, or the power head is not connected properly or is defective.

Self-Test Messages

Table B-2 lists and describes messages that are generated by the instrument during Self-Test to indicate whether a component passed or failed its test. These messages are sent via the RS-232 serial output only—they do not appear on the instrument's front-panel display.

Table B-2. Self-Test Messages

Message	Description
ROM TEST FAIL ROM TEST OK	ROM failed read test. ROM passed read test.
RAM DATA LINES OK RAM DATA ERROR RAM ADDR LINES OK RAM ADDR ERROR RAM TEST OK	RAM data lines passed test. RAM data lines failed test. RAM address lines passed test. RAM address lines failed test. RAM tests completed with no errors detected.
EEPROM FAIL - CONFIGURATION DATA	The configuration data saved in EEPROM memory is defective.
ROM FAIL; Computed checkbyte does not match the value stored in EEPROM.	The checksum of the ROM data does not match the value stored in EEPROM.
EEPROM FAIL - CONFIGURATION DATA; Needs to be (re)initialized.	The EEPROM org code does not verify with current revision of ROM code.
EEPROM FAIL - POWER CAL DATA; Using default data	The checksum of the EEPROM power-calibration table is bad. Factory default calibration data will be used.
EEPROM FAIL - SAVED SETTINGS; Using default data	The checksum of the user settings stored in EEPROM is bad. Factory default settings will be used.
EEPROM FAIL - SAVED SETTINGS; Invalid EEPROM SAV n Data.	The checksum of one set of user settings (1 – 9) stored in EEPROM is bad.
GPIB FAIL; Conf. Test	The GPIB hardware failed its confidence test.

Error Messages

Table B-3 lists and describes messages that are generated by the instrument during Self-Test or during operation to indicate that a problem has been detected. These messages are displayed on the instrument's front-panel display and are also sent via the RS-232 serial output (note that, in many cases, the exact message text that is displayed on the front panel is a condensed form of the message that is sent via the RS-232 interface).

Table B-3. Error Messages

Message	Display	RS-232	Description
12V FAIL	X	X	The +12 VDC output from the power supply is not within specifications.
–12V FAIL	X	X	The –12 VDC output from the power supply is not within specifications.
–5V FAIL	X	X	The –5 VDC output from the power supply is not within specifications.
ADC FAIL	X	X	A failure was detected in the ADC.
B1 SIGNAL PATH FAIL		X	A failure was detected in the Channel 1 signal path.
PATH FAIL	X		
B1 THRESHOLD FAIL		X	A failure was detected in the Channel 1 threshold circuit.
THRS FAIL	X		
B2 RF THRESHOLD FAIL		X	A failure was detected in the Channel 2 RF threshold circuit.
THRS FAIL	X		
B2 THROUGH-PATH THRESHOLD FAIL		X	A failure was detected in the Channel 2 through-path threshold circuit.
THRS THRU	X		
B2 HETERODYNE PATH THRESHOLD FAIL		X	A failure was detected in the Channel 2 heterodyne-path threshold circuit.
THRS HET	X		
EEPROM FAIL - WRITE		X	A failure was detected while writing to EEPROM.
EEP WRT FAIL	X		

Table B-3. Error Messages (continued)

Message	Display	RS-232	Description
FRONT PANEL FAIL		X	The front panel or its interconnecting cable are defective or not properly connected.
FPANEL FAIL	X		
FPGA FAIL	X	X	A failure was detected in the FPGA (Field Programmable Gate Array).
GPIB FAIL	X	X	A failure was detected in the GPIB hardware.
HETERODYNE PATH FAIL		X	A failure was detected in the heterodyne-path circuit.
HET PATH FAIL	X		
IIC FAIL	X	X	An attempt to write to the LCD display failed.
INSTCFG FAIL	X	X	The instrument's configuration data is missing or has become corrupted.
OVER TEMPERATURE		X	The instrument's internal temperature is above the acceptable limit.
OVERTEMP	X		
PWR CAL FAIL	X	X	The instrument's power-calibration data is missing or has become corrupted.
POWER METER FAIL		X	A failure was detected in the Channel 2 power-measurement circuit.
PWR CKT FAIL	X		
RAM FAIL	X	X	A failure was detected in RAM.
ROM FAIL	X	X	A failure was detected in ROM.
SAV SET FAIL	X	X	One or more of the sets of user settings is missing or has become corrupted.
SERVICE FAIL	X	X	The instrument's service data is missing or has become corrupted.
THRU PATH FAIL		X	A failure was detected in the through-path circuit of Channel 2.
THRU FAIL	X		
VCO/COUNT CHAIN FAIL		X	A failure was detected in the VCO or the Count Chain.
VCO/CNT FAIL	X		

B

C

Using the Battery Option

Overview

The Battery option (Option 002) allows you to operate the instrument away from a source of AC power using internal rechargeable batteries or the external DC (EXT DC) power connector on the rear panel. You can charge the batteries inside the instrument when you are not using it, if an AC power source is available. (To charge the batteries inside the instrument, it must be in Standby mode.)

Operating the Instrument from the Batteries

When the instrument is powered from the internal batteries, it operates in the same manner as it does when it is powered from an external AC or DC source, except that the cooling fan does not operate. Whenever a battery-equipped instrument is on (not in Standby), the battery annunciator in the lower-right corner of the front-panel display (see Figure C-1) indicates the approximate charge level remaining in the batteries. This allows you to estimate the amount of time you can continue to operate from battery power before recharging the batteries or replacing them with fully charged batteries.

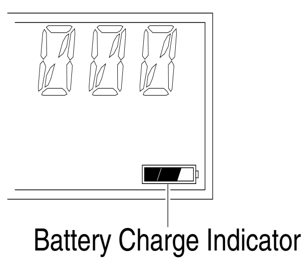


Figure C-1. Battery Charge Level Indicator

When all three segments of the battery annunciator are activated, the battery charge level is at 83% or more. When only two segments are activated, the charge level is approximately 50%, and when only the first segment is activated, the charge level is approximately 17%.

A pair of fully charged batteries in good condition provides enough power to operate the instrument for approximately two hours at 25º C. Various conditions, such as ambient temperature and the measurement configuration, can affect the length of time the instrument can operate from a fully charged set of batteries.

A battery that reads approximately 13.6 VDC when measured with a voltmeter (or the Battery Voltage reading in the menu display) is fully charged. A battery that reads 11 VDC or less is at or near the minimum effective charge level.

NOTE

Operating the instrument with the display backlight turned off lengthens the time the instrument can operate from the batteries. When operating from battery power, the instrument automatically turns the backlight off after five minutes if no front-panel keys are pushed, no GPIB commands are received, no power-sensor head is connected, and/or no signal is applied to any input during that period.

C

Operating the Instrument from a DC Power Source

Instruments that have the Battery option can operate from an external DC power source (with or without batteries in the instrument).

The external DC power source must supply +11 to +18 VDC at 2.0 A (min.). It must use a 2.1 mm coaxial plug, and its DC output plug must be wired so the inner connector is positive and the outer connector is negative.

To use an external DC power source, disconnect the AC power cord, make sure the Battery switch on the back panel is set to 0 (off), insert the coaxial plug into the EXT DC connector on the back panel (see Figure C-2), and turn the instrument on by setting the Battery switch to 1 and then pressing the POWER button on the front panel in the normal manner.

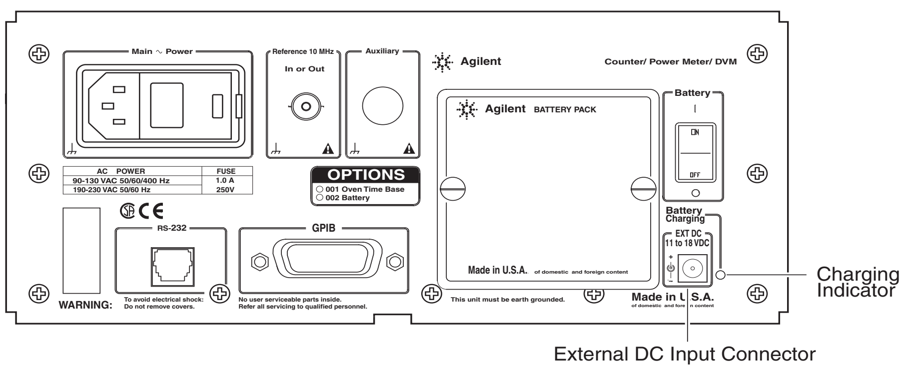


Figure C-2. External DC Power Connector

Replacing the Batteries

Instruments equipped with the Battery option use sealed lead-acid VHS camcorder batteries. You can obtain additional batteries of this type from Agilent (Agilent P/N 53150-80010) and from other suppliers who carry test-equipment and/or video-camera accessories.

Removing the Batteries

To remove the batteries, use the following procedure:

1. Turn off the instrument, and disconnect all external cables (including the power cord).
2. Turn the two thumb screws that secure the battery sled to the instrument's back panel counterclockwise until both thumb screws are completely out of the threaded holes in the back panel (see Figure C-3).

NOTE The thumbscrews require a considerable amount of turning force, since they pull the battery sled partially out of the instrument and also extract the battery terminals from the battery connector as you turn them. To prevent the battery sled from binding and increasing the force necessary to turn the thumbscrews, either turn both thumbscrews simultaneously, or alternately turn the thumbscrews one-half turn each, until both thumbscrews are fully out of the threaded holes in the back panel.

3. Slide the battery sled out the back of the instrument.

CAUTION Avoid placing the battery sled and/or the batteries where the battery terminals could contact any conductive surfaces.

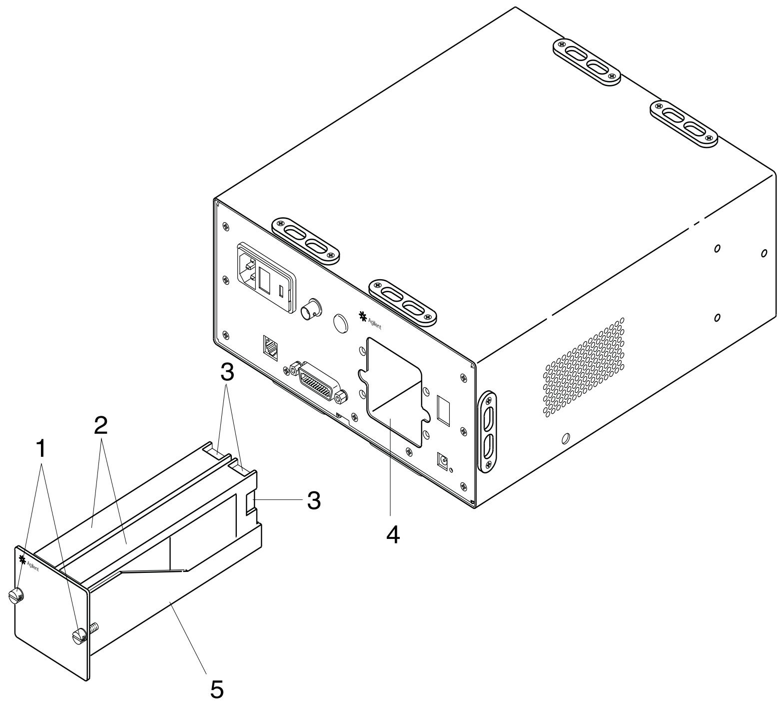
4. Lift the terminal end of either or both batteries up out of the battery sled, and then pull the battery(ies) out of the sled.

Installing Batteries

To install batteries in the instrument, use the following procedure:

1 If you have not previously removed the battery sled from the instrument and the batteries from the sled, do so now (see “Removing the Batteries” on the previous page).

2 Position the battery sled so that the back (taller) end is to your left as shown in Figure C-3.



1 Thumbscrews
2 Batteries
3 Battery terminals
4 Battery chamber
5 Battery sled

Figure C-3. Removing and Installing Batteries

3 Holding one of the batteries so the battery terminals are to your right and the plus sign at the terminal end is facing away from you, insert the left-hand end of the battery into the taller end of the battery sled with the far side of the battery against the far side of the sled. Lower the right end of the battery into the sled, and push down on the battery until it is down as far as it can go. Insert the second battery next to the first one in the same manner.

NOTE The batteries fit snugly into the sled, so it is important to keep them aligned with the sides of the sled. If you attempt to insert a battery, and it is not parallel with the sides of the sled, it will bind.

4 When both batteries are fully inserted in the sled, insert the sled into the battery-chamber opening in the instrument's back panel (terminal end first).

5 Slide the sled into the battery chamber until you can start the thumb-screws into the threaded holes in the instrument's back panel (turn the thumbscrews clockwise). You may have to push against the back end of the battery sled to insert it far enough for the thumb screws to contact the back panel.

6 Tighten the two thumb screws on the battery sled until both thumbscrews are fully hand tight and the back cover of the battery sled is flush against the instrument's back panel.

NOTE The thumbscrews require a considerable amount of turning force, since they push the battery sled into the instrument and also insert the battery terminals into the battery connectors as you turn them. To prevent the battery sled or the terminals from binding or jamming, either turn both thumbscrews simultaneously, or alternately turn the thumbscrews one-half turn each, until the battery sled is fully inserted.

Charging the Batteries

The batteries are charged automatically whenever the instrument is connected to an AC power source and is in Standby mode. The amount of time required to fully charge the batteries is dependent on several factors, including the current charge level, the condition of the batteries, the ambient temperature, and the power source used for charging. In general, it takes approximately eight hours to charge two batteries inside the instrument.

The Agilent part numbers for the batteries are provided in the section titled “Accessories Supplied and Available” on page xviii.

Precautions

Observe the following precautions when handling and charging the batteries:

- Do not attempt to use or charge the batteries when they are exposed to temperatures below –10º C (15º F) or above 40º C (105º F). (Most batteries of this type have an internal safety device that prevents them from operating outside of this temperature range.)
- Charge the batteries only with a charger intended for this type of battery or inside the instrument.
- Do not allow the battery terminals to contact any conductive surfaces.
- Avoid discharging the batteries completely.
- Recharge the batteries as soon as possible after use.
- Handle the batteries carefully to avoid internal damage and/or damage to the casings. Do not drop or throw the batteries or otherwise expose them to strong physical shock.
- Do not incinerate the batteries or subject them to extremely high temperatures.

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Agilent Technologies

Service and Support

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For more information about Agilent test and measurement products, applications, and services, visit our web site at http://www.agilent.com/services/English/index.html.

Agilent's Test and Measurement Fax Service for United States and Canada:

Technical information for test and measurement products and services is available 24 hours a day, 7 days a week, by calling **1-800-800-5281**.

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If you need technical assistance with an Agilent test and measurement product or application, you can find a list of local service representatives on the web site listed above. If you do not have access to the Internet, one of the following centers can direct you to your nearest representative:

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Fax: (852) 2506-9284

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Tel: 1-800-629-485 (Australia)
Tel: 0-800-738-378 (New Zealand)
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Fax: (905) 206-4700

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Continued from front matter. . .

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Agilent does not warrant that the operation of Agilent products will be uninterrupted or error free. If Agilent is unable, within a reasonable time, to repair or replace any product to a condition as warranted, customer will be entitled to a refund of the purchase price upon prompt return of the product.

Agilent products may contain remanufactured parts equivalent to new in performance or may have been subjected to incidental use.

The warranty period begins on the date of delivery or on the date of installation if installed by Agilent. If customer schedules or delays Agilent installation more than 30 days after delivery, warranty begins on the 31st day from delivery.

Warranty does not apply to defects resulting from
(a) improper or inadequate maintenance or calibration,
(b) software, interfacing, parts or supplies not supplied by Agilent, (c) unauthorized modification or misuse,
(d) operation outside of the published environmental specifications for the product, or
(e) improper site preparation or maintenance.

TO THE EXTENT ALLOWED BY LOCAL LAW, THE ABOVE WARRANTIES ARE EXCLUSIVE AND NO OTHER WARRANTY OR CONDITION, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED AND AGILENT SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY, SATISFACTORY QUALITY, AND FITNESS FOR A PARTICULAR PURPOSE.

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Safety Considerations (cont'd)

WARNING

INSTRUCTIONS FOR ADJUSTMENTS WHILE COVERS ARE REMOVED AND FOR SERVICING ARE FOR USE BY SERVICE-TRAINED PERSONNEL ONLY. TO AVOID DANGEROUS ELECTRIC SHOCK, DO NOT PERFORM SUCH ADJUSTMENTS OR SERVICING UNLESS QUALIFIED TO DO SO.

WARNING

ANY INTERRUPTION OF THE PROTECTIVE GROUNDING CONDUCTOR (INSIDE OR OUTSIDE THE PRODUCT'S CIRCUITRY) OR DISCONNECTING THE PROTECTIVE EARTH TERMINAL WILL CAUSE A POTENTIAL SHOCK HAZARD THAT COULD RESULT IN PERSONAL INJURY. (GROUNDING ONE CONDUCTOR OF A TWO CONDUCTOR OUTLET IS NOT SUFFICEIENT PROTECTION.)

Whenever it is likely that the protection has been impaired, the instrument must be made inpoerative and be secured against any unintended operation.

If this instrument is to be energized via an autotransformer (for voltage reduction), make sure the common terminal is connected to the earthed pole terminal (neutral) of the power source.

Instructions for adjustments while covers are removed and for servicing are for use by trained personnel only. To avoid dangerous electric shock, do not perform such ajdustments or servicing unless qualified to do so.

For continued protection against fire, replace the line fuse(s) with fuses of the same current rating and type (for example, normal blow, time delay). Do not use repaired fuses or short-circuited fuseholders.

Acoustic Noise Emissions

LpA<47 dB at operator position, at normal operation, tested per EN 27779. All data are the results from type test.

Geräuschemission

LpA<47 dB am Arbeits platz, normaler Betrieb, geprüft nach EN 27779.
Die Angagen beruhen auf Ergebnissen von Typenprüfungen.

Electrostatic Discharge Immunity Testing

When the product is tested with 8kV AD, 4kV CD and 4kV ID according to IEC801-2, a system error may occur that may affect measurement data made during these disturbances. After these occurrences, the system self-recovers without user intervention.

7.C.NL.07.31.00.R1.M.CW6FC

Agilent Technologies

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

CE

Manufacturer's Name: Agilent Technologies, Inc.

Manufacturer's Address: 5301 Stevens Creek Blvd
Santa Clara, California 95051
U.S.A.

Declares, that the product

Product Name: Microwave Counter / Power Meter / DVM

Model Number: 53147A, 53148A, and 53149A

Product Options: This declaration covers all options of the above product.

Conforms with the following European Directives:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) and carries the CE Marking accordingly.

Conforms with the following product standards:

EMC	Standard	Limit
	IEC 61326-1:1997+A1:1998 / EN 61326-1:1997+A1:1998	*Group 1 Class A [1]*
	CISPR 11:1990 / EN 55011:1991	*4kV CD, 8kV AD*
	IEC 61000-4-2:1995+A1:1998 / EN 61000-4-2:1995	*3 V/m, 80-1000 MHz*
	IEC 61000-4-3:1995 / EN 61000-4-3:1995	*0.5kV signal lines, 1kV power lines*
	IEC 61000-4-4:1995 / EN 61000-4-4:1995	*0.5 kV line-line, 1 kV line-ground*
	IEC 61000-4-5:1995 / EN 61000-4-5:1995	*3V, 0.15-80 MHz I cycle, 100%*
	IEC 61000-4-6:1996 / EN 61000-4-6:1996	
	IEC 61000-4-11:1994 / EN 61000-4-11:1994	
	Canada: ICES-001:1998	
	Australia/New Zealand: AS/NZS 2064.1	

[1] The product was tested in a typical configuration with Agilent Technologies test systems.

Safety *IEC 61010-1:1990+A1:1992+A2:1995 / EN 61010-1:1993+A2:1995*
Canada: CSA C22.2 No. 1010.1:1992

July 31, 2001

Date

Art Nanawa

Art Nanawa
Product Regulations Manager

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