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KEITHLEY

Model 428 Current Amplifier  
Quick Reference Guide

The tagline "A GREATER MEASURE OF CONFIDENCE" is written in a red, uppercase, sans-serif font. It is positioned at the bottom of the page, partially overlaid by a large, faint, light gray graphic of a handprint.

A GREATER MEASURE OF CONFIDENCE

# **INTRODUCTION**

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**This quick reference guide includes information on front panel operation for both the Model 428-MAN and the Model 428-PROG, as well as IEEE-488 operation information for the Model 428-PROG.**

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# **SAFETY PRECAUTIONS**

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- 1. Before operation, ground the Model 428 through a properly-grounded power receptacle.**
- 2. Before servicing, disconnect the instrument from line power and all other equipment, and consult the Model 428 Instruction Manual.**
- 3. Do not touch any exposed terminals, cables, or wires while the instrument is turned on or connected to other test equipment.**
- 4. Do not exceed the maximum input levels as defined in the specifications (see Figure 1 of this guide and the Model 428 Instruction Manual).**
- 5. Exercise caution when a shock hazard is present. Voltage levels greater than 30V RMS, 42.4V peak are considered hazardous.**
- 6. Instrumentation and accessories should not be connected to humans.**

# **CONTROL SUMMARY**

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**DISPLAY INTENSITY:** Selects normal/dim/off display.

**LOCAL:** Places unit in local and restores front panel key operation (428-PROG only).

**MENU:** Allows selection of firmware revision display, IEEE-488 primary address (428-PROG), autofilter on/off, save/recall configuration, and self-test.

**SHIFT EXIT:** Exits MENU.

**ZERO CHECK:** Allows check of offsets, and must be disabled to obtain normal output signal.

**SHIFT CORRECT:** Performs automatic zero correction to null instrument offsets.

**SETUP GAIN:** Use knob or cursor keys to set gain ( $10^3\text{V/A}$ – $10^{10}\text{V/A}$ , with X10 gain off,  $10^4\text{V/A}$ – $10^{11}\text{V/A}$ , with X10 gain on).

**SETUP FILTER RISE TIME:** Use knob or cursor keys to select filter rise time (10 $\mu\text{sec}$ –300msec),

**SETUP CURRENT SUPPRESS:** Use cursor keys to select suppress range and cursor position; use knob to adjust digit value ( $\pm 0.001\text{nA}$  to  $\pm 5\text{mA}$ ).

**SETUP VOLTAGE BIAS:** Use cursor keys to select digit; rotate knob to select digit value ( $\pm 2.5\text{mV}$  to  $\pm 5\text{V}$ ).

**SHIFT AUTO:** Performs automatic current suppression.

**ENABLE keys:** Enable/disable respective function (integral LED indicates when function is enabled).

# FACTORY DEFAULT CONDITIONS

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Mode	Default State
DISPLAY INTENSITY	Normal
CURRENT SUPPRESS	0.000mA, off
GAIN	10 <sup>3</sup> V/A
GAIN X10	Off
FILTER	Off
FILTER RISE TIME	10μsec
IEEE-488 Address*	22
VOLTAGE BIAS	0.000V, off
ZERO CHECK	On
AUTO FILTER	On

\*428-PROG only



# DISPLAY MESSAGES

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## Error Messages

Message	Type	Description
CONFLICT*	Momentary	Suppress value too large for suppress range
CORRECT ERR	Latching	Input offset too large for zero correct
IDDC*	Momentary	Invalid Device-dependent Command
IDDCO*	Momentary	Invalid Device-dependent Command Option
NO DFLTS	Latching	EEPROM checksum error during power up or device clear
NO REMOTE*	Momentary	X received while not in remote
OUT OF RNG	Momentary	Input current too large for auto suppress
OVERLOAD	Latching	Input or output overload (message flashes while overload exists)
RAM ERROR	Latching	RAM error during self-test
ROM ERROR	Latching	ROM error during self-test
Z CHECK ON	Momentary	Auto suppress attempt with zero check on

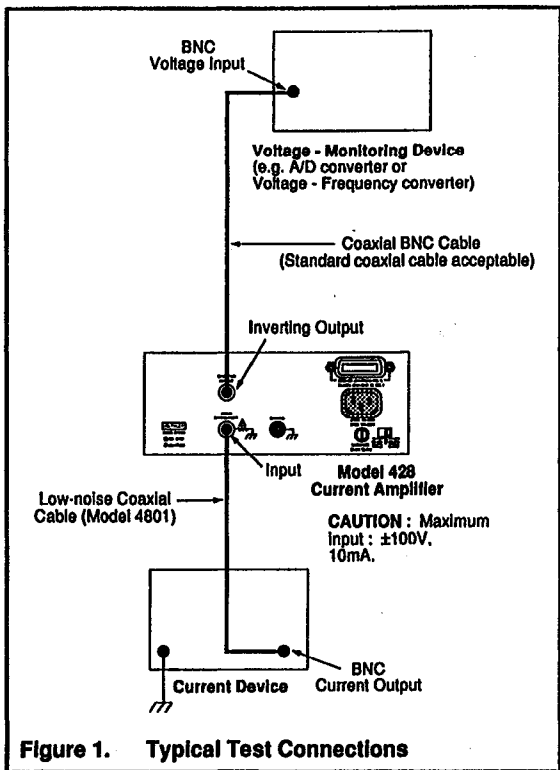
\*IEEE-488 messages for Model 428-PROG only

## Display Messages

Message*	Description
SHIFT	SHIFT key pressed
CORRECTING	Unit performing zero correct
SUPRESSING	Unit auto suppressing
1E03 V/A	GAIN display
10μsec	FILTER RISE TIME display
0.000mA	CURRENT SUPPRESS display
0.0000V	VOLTAGE BIAS DISPLAY
REV A01**	MENU software revision
IEEE 22***	MENU IEEE-488 address
AUTOFILT Y	MENU auto filter on
AUTOFILT N	MENU disable auto filter
DFLT OK	MENU no action on configuration
DFLT SAVE	MENU save configuration
DFLT RCL	MENU recall saved configuration
DFLT FCTRY	MENU restore factory defaults
SELFTEST N	MENU do not perform self-test
SELFTEST Y	MENU perform self-test
CHANGED	MENU item changed
NO CHANGE	MENU exit without change

- \* Numeric values depend on settings; factory defaults shown.
- \*\* Revision level may vary
- \*\*\* 428-PROG only

# TEST CONNECTIONS



# DEVICE-DEPENDENT COMMANDS

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## Display Intensity

A0	Normal
A1	Dim
A2	Off

## Voltage Bias On/Off

B0	Turn voltage bias off
B1	Turn voltage bias on

## Zero Check/Zero Correct

C0	Turn zero check off
C1	Turn zero check on
C2	Perform auto zero correct

## Display

DaaaaX	Display string aaaa (10 max.)
Dx	Return to normal display

**Hlt Key**

H1	DISPLAY INTENSITY
H2	LOCAL
H3	SHIFT
H4	MENU
H5	ZERO CHECK
H6	SETUP GAIN
H7	SETUP FILTER RISE TIME
H8	SETUP CURRENT SUPPRESS
H9	SETUP VOLTAGE BIAS
H10	ENABLE GAIN X10
H11	ENABLE FILTER
H12	ENABLE CURRENT SUPPRESS
H13	ENABLE VOLTAGE BIAS
H14	◀
H15	▶
H16	Knob rotation counterclockwise
H17	Knob rotation clockwise

**Self-test**

J0	Test ROM and RAM only
J1	Test ROM, RAM, and display

**EOI, Hold-off on X**

K0	Enable EOI, enable holdoff on X
K1	Disable EOI, enable holdoff on X
K2	Enable EOI, disable holdoff on X
K3	Disable EOI, disable holdoff on X

**Save/recall**

L0	Restore factory defaults and save
L1	Save configuration as power on
L2	Restore power-on conditions

**SRQ Mask**

M1	Overload
M2	Front panel key press
M4	Not used
M8	Not used
M16	Ready for command
M32	U1 error

**Suppression**

N0	Turn suppression off
N1	Turn suppression on
N2	Automatic suppress

**Filter**

P0	Turn filter off
P1	Turn filter on

<b>Gain</b>	
R0	10 <sup>3</sup> V/A gain
R1	10 <sup>3</sup> V/A gain
R2	10 <sup>3</sup> V/A gain
R3	10 <sup>3</sup> V/A gain
R4	10 <sup>4</sup> V/A gain
R5	10 <sup>5</sup> V/A gain
R6	10 <sup>6</sup> V/A gain
R7	10 <sup>7</sup> V/A gain
R8	10 <sup>8</sup> V/A gain
R9	10 <sup>9</sup> V/A gain
R10	10 <sup>10</sup> V/A gain

<b>Suppress Range and Value</b>	
S,0	Enable auto ranging
Sn,1	n = value, ±5nA range
Sn,2	n = value, ±50nA range
Sn,3	n = value, ±500nA range
Sn,4	n = value, ±5µA range
Sn,5	n = value, ±50µA range
Sn,6	n = value, ±500µA range
Sn,7	n = value, ±5mA range
Sn,8	IDDCO
Sn,9	IDDCO
Sn,10	Disable auto ranging

**Rlse Time**

T0	10 $\mu$ sec
T1	30 $\mu$ sec
T2	100 $\mu$ sec
T3	300 $\mu$ sec
T4	1msec
T5	3msec
T6	10msec
T7	30msec
T8	100msec
T9	300msec

**Alternate Output (Status Words)**

U0	Send machine status word
U1	Send error status word
U2	Send bias value
U3	Send total gain
U4	Send model number, revision

**Voltage Bias Value**

Vn	$-5 \leq n \leq +5V$ , 2.5mV resolution
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**X10 Gain On/Off**

W0	Turn X10 gain off
W1	Turn X10 gain on



**Execute**

X	Execute DDCs previously sent
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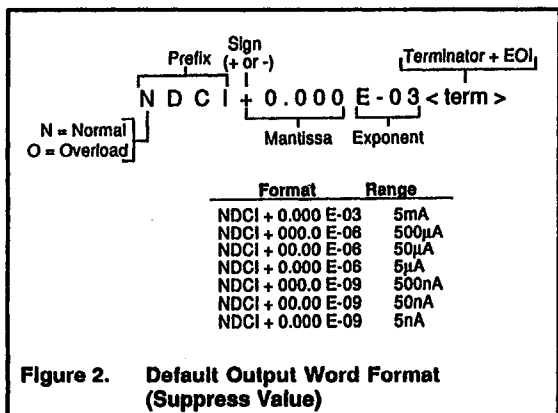
**Terminator**

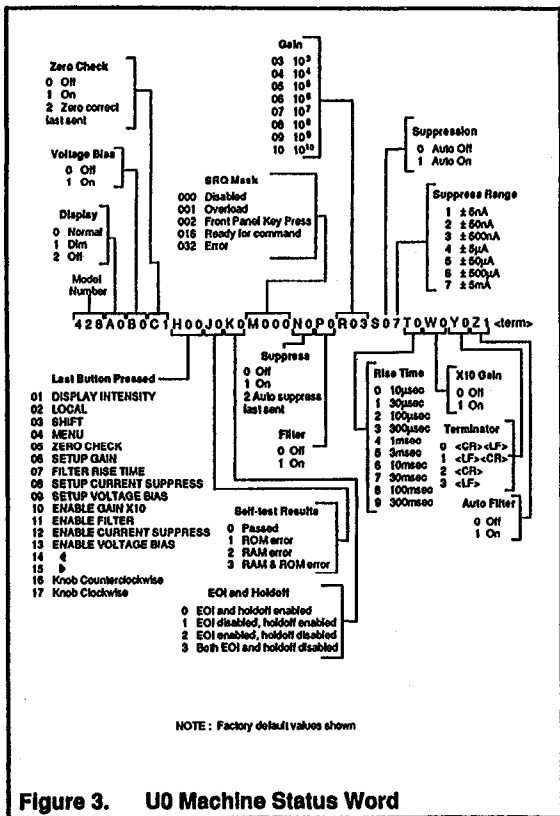
Y0	<CR><LF>
Y1	<LF><CR>
Y2	<CR>
Y3	<LF>

**Auto Filter**

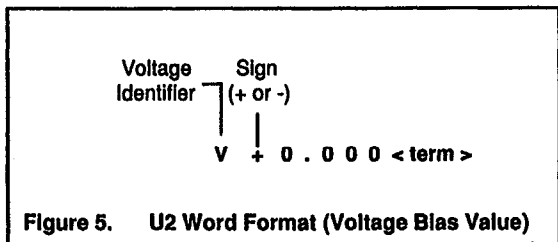
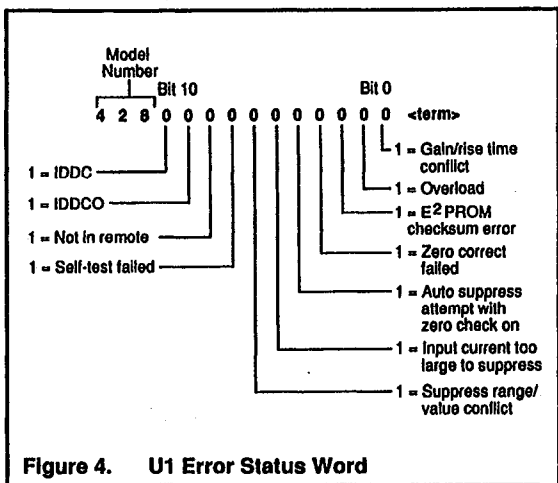
Z0	Turn auto filter off
Z1	Turn auto filter on

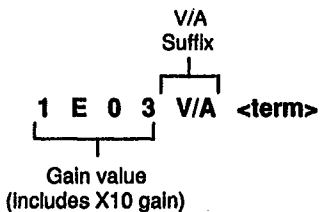
# DEFAULT/ALTERNATE OUTPUT WORD FORMATS



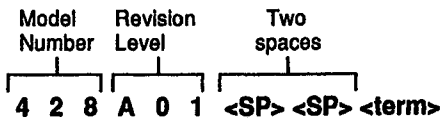


**Figure 3. U0 Machine Status Word**





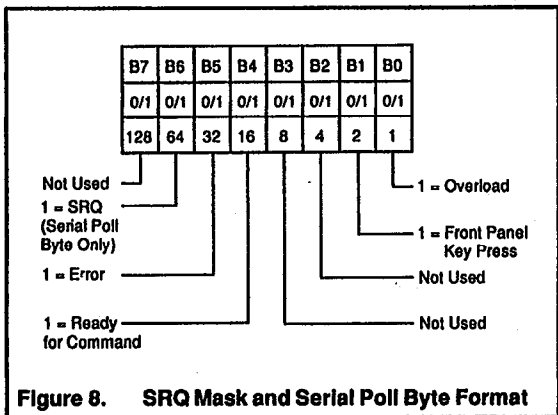
**Figure 6. U3 Word Format (Total Gain)**



**Figure 7. U4 Word Format (Model Number and Firmware Revision)**

# SRQ MASK AND SERIAL POLL BYTE

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28775 Aurora Road • Cleveland, Ohio 44139 • 440-248-0400 • Fax: 440-248-6168  
1-888-KEITHLEY (534-8453) [www.keithley.com](http://www.keithley.com)

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