

# 7526A Precision Process Calibrator

**Users Manual** 

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# Chapter 1 Introduction

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# Introduction

The Fluke 7526A Precision Process Calibrator (the "Product" or "Calibrator") is an accurate, full-featured temperature, pressure, and DC calibrator. The Calibrator is meant for research and development, manufacturing, and calibration lab procedures. The Product operation is easy and you will quickly understand its operations and features.

Some time-saving features let you:

- Save, recall, and automatically move through setpoints for each output range
- Record user-defined RTD curves
- Remotely interface with the Product

# **Contact Fluke Calibration**

To contact Fluke Calibration, call one of the subsequent telephone numbers:

- Technical Support USA: 1-877-355-3225
- Calibration/Repair USA: 1-877-355-3225
- Canada: 1-800-36-FLUKE (1-800-363-5853)
- Europe: +31-40-2675-200
- Japan: +81-3-6714-3114
- Singapore: +65-6799-5566
- China: +86-400-810-3435
- Brazil: +55-11-3759-7600
- Anywhere in the world: +1-425-446-6110

To see product information and download the latest manual supplements, visit Fluke Calibration's website at <u>www.flukecal.com.</u>

To register your product, visit http://flukecal.com/register-product.

# **Safety Information**

A **Warning** identifies conditions and procedures that are dangerous to the user; A **Caution** identifies conditions and procedures that could cause Product damage, equipment under test damage, or permanent loss of data.

## <u>∧</u>∧Warnings

To prevent possible electrical shock, fire, or personal injury:

- Read all safety Information before you use the Product.
- Carefully read all instructions.
- Use the Product only as specified, or the protection supplied by the Product can be compromised.
- Use this Product indoors only.
- Examine the case before you use the Product. Look for cracks or missing plastic. Carefully look at the insulation around the terminals.
- Use only the mains power cord and connector approved for the voltage and plug configuration in your country and rated for the Product.
- Replace the mains power cord if the insulation is damaged or if the insulation shows signs of wear.
- Make sure the ground conductor in the mains power cord is connected to a protective earth ground. Disruption of the protective earth could put voltage on the chassis that could cause death.
- Do not put the Product where access to the mains power cord is blocked.
- Do not touch voltages > 30 V ac rms, 42 V ac peak, or 60 V dc.
- Use only cables with correct voltage ratings.
- Do not apply more than the rated voltage, between the terminals or between each terminal and earth ground.
- Do not use the Product around explosive gas, vapor, or in damp or wet environments.
- Remove all probes, test leads, and accessories that are not necessary for the measurement.
- Do not use the Product if it operates incorrectly.
- Do not use and disable the Product if it is damaged.

Table 1-1 shows the symbols used on the Product and in this manual.

Symbol	Definition	Symbol	Definition
	Risk of Danger. Important information. See Manual.	<u>X</u>	This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste. Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as category 9 "Monitoring and Control Instrumentation" product. Do not dispose of this product as unsorted municipal waste. Go to Fluke's website for recycling information.
	Hazardous voltage. Risk of electric shock.	₽	Fuse
~	AC (Alternating Current)		Protective Earth Ground
Ŧ	Earth ground	C€	Conforms to European Union directives.
~	AC (Alternating Current) and DC (Direct Current)		DC (Direct Current)
c∰ ® ∪s	This product has been tested to the requirements of CAN/CSA-C22.2 No. 61010-1, third edition.	0#	Pressure

# **Unpack the Product**

When you receive the Product, examine the container and equipment for signs of damage. Note indications of damage while in transit. Immediately report damage to the shipping agent.

Note

The carrier will not honor claims unless all shipment material is kept for their inspection.

After you examine and remove the contents, keep the package material and carton in the case that shipment is necessary.

Remove the Package List and make sure that all of the shown equipment is received. If there are questions about the shipment, contact Fluke. See the "Contact Fluke Calibration" section.

# **Standard Equipment**

Make sure the basic Calibrator package is complete. It includes:

- The Calibrator
- Users Manual CD-ROM
- Getting Started
- AC Mains Cord
- Thermocouple Shorting Jumper
- NIST Traceable Calibration Report
- USB to Serial Adapter Cable.

# **Options and Accessories**

For more information about these accessories and their prices, contact your Fluke representative.

- 5520A-525A Leads kit
- Y7526A Rack Mount kit
- Fluke 700 and 525A-P series pressure modules
- MET/CAL with 7526A Function Select Code (FSC)
- MET/CAL 7526A calibration procedure

# **Product Description**

This section is a general description of the Product.

#### **Front-Panel Overview**

Figure 1-1 shows the layout of the front panel. Each of the three primary divisions is given in the subsequent sections.



Figure 1-1. Front Panel

riešenia na presné meranie ${}^{{ \rm TM}}$ 

Elso Philips Service; tel: +421 32 6582410 email: elso@elso.sk; web: www.elso.sk

#### **Primary Input/Output Terminals**

Figure 1-2 shows the primary input/output terminals.



Figure 1-2. Primary Input/Output Terminals

#### Primary Input/Output Display and Controls

Figure 1-3 shows the primary input/output display and controls.



Figure 1-3. Primary Input/Output Display and Controls

ltem	Description				
	Numeric and Secondary Function Keys: Output value data entry keys. Secondary function selection per the text printed above the numeric key. Push select the function.				
	SHIFT	C/°F 6	Select Celsius or Fahrenheit units for RTD and Thermocouple temperature measurements.		
	SHIFT	ET 1	Set a new value for a preset output setpoint as given in Chapter 3, "Output Setpoints".		
2		CALL 2	Recall a preset output setpoint as given in Chapter 3, "Output Setpoints".		
		OSET 3	Start automatic stepping of preset output setpoints as given in Chapter 3, "Output Setpoints".		
	SHIFT RNG	LOCK	Select Auto-range or Range Lock for voltage output.		
	SHIFT	CAL 0	Push to regain local control of the Product after the remote command REMOTE is received. In this case, all keys but this one are ignored. When the remote command LOCKOUT is received, all keys are ignored. This includes this key. The remote command LOCAL must be received to regain local control.		
	SHIFT	ХР •	Push during entry of a RTD custom curve coefficient to start entry of the exponent.		
	Function Keys				
	VOLTS mA		Select dc voltage or current output mode, and toggle between them.		
	TC RTD		Select Thermocouple or RTD/Ohms input/output mode, and toggle between them.		
(3)	Select Pressure input mode		Select Pressure input mode.		
	TYPE UNITS		In Thermocouple mode, move through the thermocouple types, this includes millivolts. In RTD/Ohms mode, move through the RTD types, this includes ohms in Pressure mode, move through the pressure units.		

Figure 1-3. Primary Input/Output Display and Controls (cont.)

	Function Keys			
	STBY OPR	For all but Thermocouple output modes, toggle between Standby and Operate modes. In Standby mode, changes to the output value in the display is not applied to the terminals until you select the Operate mode. In Operate mode, each change to the output value in the display is applied to the terminals immediately. Voltages more than 30 V are not applied to the terminals and the mode automatically reverts to Standby for your safety.		
3	ENTER	Changes the Product output or parameter to the numeric value typed into the keypad.		
	CE	Erases a partial keypad entry and reverts the Product output or parameter to its last known value.		
	SHIFT	Prepares for selection of a secondary function with the numeric keypad. The secondary function is shown above each numeric key. The display changes to SHIFT ENABLED until a numeric key is pushed. To cancel the selection, push were again.		
4	Cursor Controls	<ul> <li>Push () or () to put the cursor below the digit in an output value that is to be increased or decreased.</li> <li>Push () to increment the digit in the output value where the cursor is.</li> <li>Push () to decrement the digit in the output value where the cursor is.</li> <li>The () and () keys are also used to adjust LCD Contrast level LCD Backlight level, and Remote Interface</li> </ul>		
		Configuration selections as given in Chapter 5, "LCD and Remote Interface Setup Procedure".		

Figure 1-3. Primary Input/Output Display and Controls (cont.)

#### Isolated Input Display, Controls, and Terminals

Figure 1-4 shows the isolated input display, controls, and terminals.

	10V RANGE -0.	gwp04.eps
Item	Name	Description
(1)	Display	A two-line, 16-character display gives all visual user feedback for the isolated input operations. See the "Display Layouts" section of this chapter for layout information, and the "Error Messages" section of this chapter for possible error messages.
	F	Function Keys
	WULTS/mA SW TEST	<ul> <li>This key is used for multiple functions. In normal operation it is used to move through the 50 mA, 10 V and 100 V ranges.</li> <li>If held for 3 seconds it will change the Product into or out of switchtest mode. In switchtest recall mode it will move through the stored switch test data.</li> </ul>
(2)	(2) LOOP PWR HART	When you use 24 mA mode to verify a two-wire loop powered transmitter, disconnect it from its wires and push [work]. This turns on an internal 24 V power supply in series with the current measurement circuit. Push the key again to turn off the 24 V supply. In all switch test modes, push this key to start or stop a test.
		When you use 50 mA mode to verify a HART configuration device, push this key to turn on an internal 250 $\Omega$ resistor in series. Push the key again to turn off the resistor. Note that when you turn on this resistor, the maximum load-driving functionality drops from 1000 $\Omega$ at 20 mA to 750 $\Omega$ at 20 mA.

Figure 1-4. Isolated Input Display, Controls, and Terminals

Item	Name	Description				
2	<b>.</b>	Selects Pressure input mode. Subsequent pushes of this key cycle through the pressure units. Pressure input mode uses the pressure module connector on the primary input/output side. Each side can use pressure mode at the same time and can be set to show the same pressure measurement in different units if necessary.				
3	Input Terminals <sup>[1,2]</sup>	Common input terminals for dc voltage and current.				
[1] Th Dis du	[1] These terminal binding posts are made of a special copper alloy to decrease thermal EMF's. Discreet wires or standard banana plugs can be used, and the HI/LO pairs are distanced for standard dual banana plugs.					
[2] 🛕 ma	A Marning: To prevent possible electrical shock, fire, or personal injury Do not exceed a maximum of 100 V peak to chassis ground.					

#### Figure 1-4. Isolated Input Display, Controls, and Terminals (cont.)

#### Rear Panel

Figure 1-5 shows the rear-panel layout.



Figure 1-5. Rear Panel

#### **Display Layouts**

Figure 1-6 shows the primary voltage and current display.

	1	2
	AUT Stb	0: 0.1 VDC 9 0.000000 V
	3	gwp006.eps
ltem		Description
	Operation mod	le:
	AUTO	Auto-range
1	LOCK	Range lock
	rem	Remote operation
	SP #	Automatic stepping of preset setpoints
(2)	Current range a	and output mode
	Output condition	on:
3	Stby	Standby, terminals inactive
٢		Operating, terminals are active with output that refers to the shown value.
4	Output value	
5	Units	

Figure 1-6. Primary Voltage and Current Display

	RTD Stł	о OUT P100-385 оч 0.00 °F						
	4	5						
ltem		Description						
1	Output mode	e selection: RTD, TC, or rem for remote operation						
2	Input or output selection							
3	RTD or thermocouple type selection							
	Output condition for RTD outputs:							
	Stby	Standby, terminals inactive						
	Opr Operating, terminals are active with output per the shown value Blank for RTD inputs							
	Cold junctior	selection for thermocouple inputs and outputs:						
(4)	XCJC	External cold junction compensation. The Product automatic cold junction compensation is turned off, for example, 0 mV is always 0 °C.						
	Blank	Internal cold junction compensation. The Product automatically measures the ambient temperature at the thermocouple terminals and adjusts the measurement, for example, 0 mV is ambient temperature.						
5	Input or outp	ut value						
6	Units							

Figure 1-7 shows the primary thermocouple and RTD display.

Figure 1-7. Primary Thermocouple and RTD Display



Figure 1-8 shows the primary and isolated pressure display.



Figure 1-9 shows the isolated voltage and current display.



Figure 1-9. Isolated Voltage and Current Display

#### **Error Messages**

Table 1-2 shows the error messages that can appear on the displays.

Message	Description
OVER RANGE	The numeric keypad value is larger than the range of the output mode selected.
OVER LOAD	For dc voltage output mode, the current necessary to make the output is larger than the Product specifications. For dc current mode, the resistance of the circuit is larger than the Product specifications.
OL	For input modes, the measured value is larger than the top limit of the selected input mode range. For output modes, when the range is locked, the current automatically recalled preset setpoint is larger than the maximum limit of the locked range. The output is set to zero for the time of this setpoint.
-OL	For input modes, the measured value is less than the lower limit of the selected input mode range.

#### Table 1-2. Error Messages

# Set Up

Follow the subsequent steps to set up the Product:

#### ▲ Caution

#### Before you connect the mains power cord to the rear connector, make sure that the line voltage selector is in the correct position for your location.

The Product is shipped from the factory with the line voltage set for the country of purchase. To make sure the line voltage is correctly set, examine the indicator on the power line voltage selector and fuse compartment cover. See the "Rear Panel" section of this chapter.

1. See Table 1-3 to set the correct line voltage.

Table	1-3.	Line-	Voltage	Settings
-------	------	-------	---------	----------

Line Voltage (50/60Hz)	Selector Position
100 V ac to 120 V ac	120 V ac position
220 V ac to 240 V ac	240 V ac position

2. If the line voltage is not correctly set, follow the instructions in "Changing the Line Voltage" in Chapter 7.

- 3. When the line voltage is correctly set, make sure that the power switch is off and connect the mains power cord to the Product. See the "Rear Panel" section of this chapter, for the location.
- 4. Turn on the Product with the rear-panel rocker switch. The Product will power up in a few seconds. It briefly shows the model number and firmware version in the primary display before it changes to the correct input/output display.

Note

If a correct power-up display does not occur in 30 seconds, turn off the power. Turn on the unit after a few seconds. If the problem continues, report the problem to Fluke immediately.

Warmup time is two times the time since its last warmup, to a maximum of 30 minutes. To keep the Product stable, it is best to keep the Product on all the time.

# **Specifications**

#### **General Specifications**

Warm-up Time	Twice the time since last warmed up, to a maximum of 30 minutes
Settling Time	Less than 5 seconds for all functions and ranges except as noted
Standard Interfaces	RS-232
	IEEE-488 (GPIB)
Temperature Performance	
Operating	0 °C to 50 °C
Calibration (tcal)	18 °C to 28 °C
Storage	20 °C to 70 °C
Electromagnetic Compatibility	CE: Conforms to EN61326; operation in controlled EM environments
Temperature Coefficient	Temperature coefficient for temperatures outside tcal 5 °C is 10 % of the 90-day specification (or 1 year if applicable) per °C
Relative Humidity	
Operating	<80 % to 30 °C
	<70 % to 40 °C
	<40 % to 50 °C
Altitude	
Operating	3,000 m (9,800 ft) maximum
Non-operating	12,200 m (40,000 ft) maximum
Safety	EN/IEC 61010-1:2010 3 <sup>rd</sup> Edition, UL 61010-1:2012,
	CAN/CSA 22.2 No. 61010-1-12
Analog Low Isolation	20 V
Line Power Line Voltage (selectable)	
120 V~	100 V to 120 V
240 V~	220 V to 240 V
Line Frequency	47 to 63 Hz
Line Voltage Variation	±10 % about setting
Power Consumption	15 VA maximum
Dimensions	
Height	14.6 cm (5.75 inch)
Width	44.5 cm (17.5 inch)
Depth	29.8 cm (11.75 inch) overall
Weight (without options)	4.24 kg (9.35 lb)

DC Voltage Specifications, Outpu
----------------------------------

<b>D</b> [1]	Absolute Uncertainty tcal ± 5°C, ±(ppm of output +µV)				Stability	Deschafter	Maximum
Ranges	90 Days		1 Year		24 hours, ±1 °C ±(ppm of output +μV)	Resolution	Burden <sup>[2]</sup>
0 mV to 100.000 mV	25	3	30	3	5 ppm + 2 μV	1 μV	10 mA
0 V to 1.00000 V	25	10	30	10	4 ppm + 10 μV	10 μV	10 mA
0 V to 10.0000 V	25	100	30	100	4 ppm + 100 μV	100 μV	10 mA
0 V to 100.000 V	25	1 mV	30	1 mV	5 ppm + 1 mV	1 mV	1 mA
	TC Output and Input						
-10 to 75.000 mV	25	2 μV	30	2 μV	5 ppm + 2 μV	1 μV	10 Ω
<ul> <li>[1] All outputs are positive only, unless otherwise noted.</li> <li>[2] Remote sensing is not provided. Output resistance is &lt;1 Ω</li> </ul>							

[2] Remote sensing is not provided. Output resistance is <1  $\Omega$ 

Noise							
Ranges	Bandwidth 0.1 to 10 Hz p-p ±(ppm of output +µV)	Bandwidth 10 Hz to 10 kHz rms μV					
0 mV to 100.000 mV	1 μV	6 μV					
0 V to 1.00000 V	10 µV	60 µV					
0 V to 10.0000 V	100 μV	600 μV					
0 V to 100.000 V	10 ppm+1 mV	20 mV					

#### DC Voltage Specifications, Isolated Input

Ranges	Absolute Unc ±(ppm of	ertainty, tcal ±5 °C, reading + mV)	Resolution	
0 V to 10.0000 V	50	0.2	100 μV	
0 V to 100.000 V	50	2.0	1 mV	

#### DC Current Specifications, Output

Ranges <sup>[1]</sup>	Absolute Uncertainty, tcal ±5 °C ± (ppm of output +μA)				Resolution	Maximum Compliance	Maximum Inductive
	90 E	Days	s 1 Year			Voltage	2000
0 mA to 100.000 mA	40 [2]	1	50 <sup>[2]</sup>	1	1 µA	12 V	100 mH
[1] All outputs are positive only.							

[2] For line voltages less than 95 V (±100 ppm of reading).

Pangos	Noise		
Ranges	Bandwidth 0.1 to 10 Hz p-p	Bandwidth 10 Hz to 10 kHz rms $\mu$ V	
0 mA to 100.000 mA	2000 nA	20 μA	

#### DC Current Specifications, Isolated Input

Ranges	Absolute Uncertainty, tcal ±5 °C, ±(ppm of reading + μA)		Resolution
0 mA to 50.0000 mA	100	1	0.1 μΑ
0 mA to 24.0000 mA (Loop Power) [1][2]	100	1	0.1 μΑ
[1] Loop Power: 24 V ±10 %			
[2] HART Resistor: 250 $\Omega \pm 3 \%$			

#### Resistance Specifications, Output

Ranges	Absolute Uncertainty, tcal ±5 °C, ± Ohms		Resolution	Nominal Current <sup>[1]</sup>
	90 Days	1 Year		
$5\Omega$ to 400.000 $\Omega$	0.012	0.015	0.001 Ω	1 to 3 mA
5 k $\Omega$ to 4.00000 k $\Omega$	0.25	0.3	0.01 Ω	100 µA to 1 mA
<ul> <li>[1] For currents lower than shown, the specification becomes New Spec. = Stated Spec. x Imin/lactual.</li> <li>For example, a 500 μA stimulus that measures 100 Ω has a specification of: 0.015 Ω x 1 mA/500 μA=0.03 Ω</li> </ul>				

#### **Resistance Specifications, Input**

Ranges	Absolute Uncertainty, tcal ±5 °C ±(ppm of reading + Ω)		Resolution	Stimulus Current
	90 Days	1 Year		
0 $\Omega$ to 400.000 $\Omega$	$\pm 20$ ppm + 0.0035 $\Omega$	$\pm$ 20 ppm + 0.004 $\Omega$	0.001 Ω	1 mA
0 k $\Omega$ to 4.00000 k $\Omega$	$\pm$ 20 ppm + 0.035 $\Omega$	$\pm$ 20 ppm + 0.04 $\Omega$	0.01 Ω	0.1 mA

	Range (°C)		Absolute Uncertainty, tcal ±5 °C, ±(°C) <sup>[1]</sup>	
ТС Туре			Outpu	ıt/Input
	Minimum	Maximum	90 days	1 Year
	600 °C	800 °C	0.35 °C	0.35 °C
В	800 °C	1550 °C	0.28 °C	0.28 °C
	1550 °C	1820 °C	0.21 °C	0.22 °C
	0 °C	1000 °C	0.15 °C	0.16 °C
0	1000 °C	1800 °C	0.22 °C	0.23 °C
C	1800 °C	2000 °C	0.24 °C	0.26 °C
	2000 °C	2316 °C	0.32 °C	0.35 °C
	-250 °C	-200 °C	0.24 °C	0.25 °C
	-200 °C	-100 °C	0.10 °C	0.12 °C
E	-100 °C	0°C	0.07 °C	0.09 °C
		600 °C	0.06 °C	0.08 °C
	600 °C	1000 °C	0.08 °C	0.10 °C
	-210 °C	-100 °C	0.13 °C	0.14 °C
J	-100 °C	800 °C	0.07 °C	0.09 °C
	800 °C	1200 °C	0.08 °C	0.10 °C
	-250 °C	-200 °C	0.45 °C	0.46 °C
	-200 °C	-100 °C	0.15 °C	0.16 °C
K	-100 °C	500 °C	0.08 °C	0.10 °C
	500 °C	800 °C	0.09 °C	0.10 °C
	800 °C	1372 °C	0.11 °C	0.13 °C
L	-200 °C	-100 °C	0.08 °C	0.10 °C
	-100 °C	900 °C	0.07 °C	0.09 °C
	-250 °C	-200 °C	0.72 °C	0.73 °C
	-200 °C	-100 °C	0.22 °C	0.23 °C
N	-100 °C	0°C	0.11 °C	0.12 °C
		100 °C	0.09 °C	0.11 °C
	100 °C	800 °C	0.08 °C	0.10 °C
	800 °C	1300 °C	0.10 °C	0.12 °C
	-50 °C	-25 °C	0.54 °C	0.55 °C
	-25 °C	0°C	0.44 °C	0.45 °C
		100 °C	0.38 °C	0.39 °C
R	100 °C	400 °C	0.27 °C	0.28 °C
i v	400 °C	1000 °C	0.21 °C	0.22 °C
	1000 °C	1600 °C	0.19 C	0.21 C
	1600 °C	1767 °C	0.10°C	0.13 °C
			0.21 0	0.20 0
	-50 °C	-25 °C	0.51 °C	0.51 °C
	-25 °C	0°C	0.43 °C	0.43 °C
	0°C	100 °C	0.37 °C	0.38 °C
s	100 °C	400 °C	0.28 °C	0.29 °C
Ĭ	400 °C	000 °C	0.22 °C	0.23 °C
		1000 °C		0.22 °C
	1600 °C	1767 °C	0.20 °C	0.22 °C 0.26 °C
			0.24 0	0.20 C

## Thermocouple Specification, Output and Input

	Banga (%C)		Absolute Uncerta	ainty, tcal ±5 °C, ±(°C) <sup>[1]</sup>
ТС Туре	Kang	e (°C)	Output	/Input
	Minimum	Maximum	90 days	1 Year
	-250 °C	-200 °C	0.34 °C	0.35 °C
	-200 °C	-100 °C	0.14 °C	0.16 °C
Т	-100 °C	0 °C	0.09 °C	0.11 °C
	0 °C	200 °C	0.07 °C	0.09 °C
	200 °C	400 °C	0.06 °C	0.09 °C
	-200 °C	0 °C	0.15 °C	0.16 °C
U	0 °C	200 °C	0.08 °C	0.10 °C
	200 °C	600 °C	0.07 °C	0.10 °C
	-200 °C	-100 °C	0.10 °C	0.11 °C
	-100 °C	0 °C	0.07 °C	0.09 °C
ХК	0 °C	600 °C	0.06 °C	0.08 °C
	600 °C	800 °C	0.07 °C	0.09 °C
	0 °C	200 °C	0.17 °C	0.18°C
	200 °C	600 °C	0.14 °C	0.16 °C
	600 °C	800 °C	0.15 °C	0.17 °C
BP	800 °C	1600 °C	0.22 °C	0.23 °C
	1600 °C	2000 °C	0.26 °C	0.28 °C
	2000 °C	2500 °C	0.38 °C	0.40 °C
		600 °C	800 °C	
[1] Does not incl	ude thermocouple wire error	r.		
Type B, E, J	K, N, R, S and T are based	on ITS-90		
Type L and L	lara based on DIN 12710 1	005		

Type B, E, J ,K, N, R, S and T are based on ITS-90 Type L and U are based on DIN 43710-1985 Type C is based on ASTM standard E 988-96 Type XK and BP are based on GOST R 8.585-2001

#### RTD and Thermistor Specification, Output

	Range °C		Absolute Uncertaint	Absolute Uncertainty, tcal ±5 °C ±(°C) <sup>[1]</sup>	
RID Types	Minimum	1 Year	90 Days	1 Year	
Pt 385, 100 Ω	-200 °C	-800 °C	0.04 °C	0.05 °C	
Pt 3926, 100 Ω	-200 °C	630 °C	0.04 °C	0.05 °C	
Pt 3916, 100 Ω	-200 °C	630 °C	0.04 °C	0.05 °C	
Dt 385, 200 O	-200 °C	400 °C	0.35 °C	0.40 °C	
Ρί 385, 200 Ω	400 °C	630 °C	0.42 °C	0.50 °C	
Pt 385, 500 Ω	-200 °C	630 °C	0.15 °C	0.17 °C	
Pt 385, 1000 $\Omega$	-200 °C	630 °C	0.07 °C	0.09 °C	
Ni 120, 120 Ω	-80 °C	260 °C	0.02 °C	0.02 °C	
Cu 427, 10 $\Omega$ $^{[2]}$	-100 °C	260 °C	0.30 °C	0.38 °C	
YSI 400	15 °C	50 °C	0.005 °C	0.007 °C	
[1] 2-wire output	t				
[2] Based on MI	NCO Application Aid No. 18				

	Range (°C)		Absolute Uncertain	Absolute Uncertainty, tcal ±5 °C, ±(°C) <sup>[1]</sup>	
RTD Type			Outpu	it/Input	
	Minimum	Maximum	90 Days	1 Year	
	-200 °C	-80 °C	0.012 °C	0.013 °C	
	-80 °C	100 °C	0.018 °C	0.020 °C	
	100 °C	300 °C	0.022 °C	0.024 °C	
Pt 385, 100 Ω	300 °C	400 °C	0.025 °C	0.026 °C	
	400 °C	630 °C	0.031 °C	0.033 °C	
	630 °C	800 °C	0.037 °C	0.038 °C	
	-200 °C	-80 °C	0.012 °C	0.013 °C	
	-80 °C	0 °C	0.014 °C	0.015 °C	
	0 °C	100 °C	0.016 °C	0.017 °C	
Pt 3926, 100 Ω	100 °C	300 °C	0.022 °C	0.022 °C	
	200 °C	400 °C	0.022 °C	0.026 °C	
	400 °C	630 °C	0.024 °C	0.032 °C	
	-200 °C	-190 °C	0.009 °C	0.010 °C	
	-190 °C	-80 °C	0.012 °C	0.013 °C	
	-80 °C	0 °C	0.014 °C	0.015 °C	
	0 °C	100 °C	0.016 °C	0.017 °C	
Pt 3916, 100 $\Omega$	100 °C	300 °C	0.021 °C	0.022 °C	
	300 °C	400 °C	0.024 °C	0.026 °C	
	400 °C	600 °C	0.030 °C	0.031 °C	
	600 °C	630 °C	0.031 °C	0.033 °C	
	-200 °C	-80 °C	0.047 °C	0.053 °C	
	-80 °C	0 °C	0.050 °C	0.056 °C	
	0 °C	100 °C	0.053 °C	0.060 °C	
Pt 385, 200 Ω	100 °C	260 °C	0.054 °C	0.060 °C	
,	260 °C	300 °C	0.062 °C	0.069 °C	
	300 °C	400 °C	0.064 °C	0.071 °C	
	400 °C	630 °C	0.079 °C	0.088 °C	
	-80 °C		0.031 °C		
	-200 °C	0 °C	0.023 °C	0.025 °C	
	0°C	100 °C	0.026 °C	0.028 °C	
Pt 385, 500 Ω	100 °C	300 °C	0.031 °C	0.034 °C	
	300 °C	400 °C	0.035 °C	0.038 °C	
	400 °C	630 °C	0.041 °C	0.045 °C	
	-200 °C	0 °C	0.014 °C	0.015 °C	
	0 °C	100 °C	0.017 °C	0.018 °C	
Pt 385, 1000 Ω	100 °C	300 °C	0.022 °C	0.024 °C	
	300 °C	400 °C	0.024 °C	0.026 °C	
	400 °C	630 °C	0.031 °C	0.033 °C	
Ni 120, 120 Ω	-80 °C	260 °C	0.008 °C	0.009 °C	
Cu 427, 10 $\Omega$ <sup>[2]</sup>	-100 °C	260 °C	0.097 °C	0.110 °C	
YSI 400	15 °C	50 °C	0.005 °C	0.007 °C	
SPRT	-200 °C	660 °C	0.05 °C	0.06 °C	
[1] 4-wire mode [2] Based on MI	. Uncertainties shown do NCO Application Aid No.	not include probe uncertainties 18.	S.		

#### RTD and Thermistor Specification, Input

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#### **Pressure Measurement Specifications**

The Calibrator can accept the Fluke 700 or 525A-P Series pressure modules. Pressure modules connect directly into the front panel Lemo connector with the Calibrator firmware auto-detecting the type and value of the module you connect.

Range	Accuracy and Resolution	Units
Determined by the pressure module	Determined by the pressure module	PSI (pounds per square inch)
		in H2O 4 °C (inches of water at 4 degrees Celsius)
		in H2O 20 °C (inches of water at 20 degrees Celsius)
		in H2O 60 °C (inches of water at 60 degrees Fahrenheit)
		cm H2O 4 °C (centimeters of water at 4 degrees Celsius)
		cm H2O 20 °C (centimeters of water at 20 degrees Celsius)
		mm H2O 4 °C (millimeters of water at 4 degrees Celsius)
		mm H2O 20 °C (millimeters of water at 20 degrees Celsius)
		BAR (bars)
		mBAR (millibars)
		kPa (kilopascals)
		MPa (megapascals)
		in HG 0 °C (inches of mercury at 0 degrees Celsius)
		mm HG 0 °C (millimeters of mercury at 0 degrees Celsius)
		kg/cm2 (kilograms per square centimeter)

#### Switch Test Specifications, Isolated Input

Contact Closure Resistance	<1 kΩ
Excitation Current	27 mA Max

# Chapter 2 **Primary Inputs and Outputs**

#### Title

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DC Current Output	2-4
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Resistance Temperature Detector (RTD) with Custom Coefficients	2-7
Standard Platinum Resistance Thermometer (SPRT) Coefficients	2-8
Thermocouple (TC) Measure	2-9
Thermocouple (TC) Source	2-11
Pressure Measure	2-12
## Introduction

This chapter explains the main (primary) inputs and outputs of the Product. Connection figures are also shown so that you properly connect the Product to a unit under test (UUT).

## **DC Voltage Output**

The Product can source dc voltages from 0 V to 100 V and uses these four ranges for maximum accuracy:

- 0.1 V
- 1 V
- 10 V
- 100 V

For dc voltage output:

- 1. Disconnect test leads from external devices.
- 2. Push with to select dc voltage and current mode, if not already selected.
- 3. If dc current mode is shown, push the key again to go to dc voltage mode.
- 4. Connect the UUT to the voltage output terminals of the Product as shown in Figure 2-1.



Figure 2-1. DC Voltage Output Connections

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- 5. Use the numeric keypad to type the necessary output value and push ENTER.
- 6. As an alternative, use **◊** or **◊** to select a digit to change, followed by or to ramp the digit up or down. This method gives you a simple solution when small changes to an output value are necessary, or if is necessary to increment or decrement decades.
- 7. When dc voltage mode is first selected, the Product is put into standby (Stby) mode which puts the positive (+) output jack into a high-impedance condition (>100 k $\Omega$ ) for safety. To put the output into the active condition, push  $\Im$  to toggle between the standby and operate modes.
- 8. The standby mode is also started in these situations:
  - If a fault occurs during operation, such as an overload or short circuit condition.
  - As a safety feature for all new outputs larger than 30 V dc. Refer to the product specification section of this manual for maximum drive currents.

Notes

Scrolling the output when the output value is already larger than 30 V will not place the Calibrator in standby mode for each new value.

Automatic setpoints higher than 30 V will not put the Calibrator in standby mode for each new value.

9. The Product can be locked to a specified voltage range. Select a value in that range and then push shift and +/- to select the secondary RNG LOCK function.

## **DC Current Output**

The Product can source dc current from 0 mA to 100 mA.

- 1. Disconnect test leads from external devices.
- 2. Push Yours to select dc voltage and current mode, if not already selected.
- 3. If dc voltage mode is shown, push the key again to go to dc current mode.
- 4. Connect the UUT to the current output terminals of the Product as shown in Figure 2-2.



Figure 2-2. DC Current Output Connection

5. Use the numeric keypad to type the necessary output value and push ENTER.

As an alternative, use  $\mathbf{Q}$  or  $\mathbf{D}$  cursor key to select a digit to change, followed by  $\mathbf{\Phi}$  or  $\mathbf{\nabla}$  to move the digit up or down. This method gives you a simple solution when small changes to an output value are necessary, or if is necessary to increment or decrement decades.

6. When dc current mode is first selected, the Product is put into standby (Stby) mode which puts the positive (+) output jack into a high impedance condition (>100 k  $\Omega$ ) for safety. To put the output into the active condition, push  $\Im$  to toggle between the standby and operate modes.

The standby mode also operates in these situations:

- No connection made to the output terminals.
- The voltage compliance is larger than a given output current. The Product has a typical-voltage compliance of 10 V. This is so that the 4 mA-20 mA application loads to a maximum of 500  $\Omega$  can be driven. At maximum current of 100 mA, the maximum load is 100  $\Omega$ .

## Resistance Temperature Detector (RTD) and Ohms Measure

The Product can measure all common RTD types, 5 custom RTD curves, and a custom SPRT in °F or °C, plus basic resistance from 0  $\Omega$  to 4000  $\Omega$ . The Product uses these common RTD types:

- Pt 385 100 Ω, 200 Ω, 500 Ω, 1000 Ω
- Pt 3926 100 Ω
- Pt 3916 (JIS) 100 Ω
- Ni120 120 Ω
- Cu 427 (Minco) 10 Ω
- YSI 400

Disconnect test leads from external devices.

- 1. Push  $\mathbb{R}$  to select thermocouple and RTD/ $\Omega$  mode, if not already selected. If thermocouple mode is shown, push the key again to go to RTD/ $\Omega$  mode.
- 2. If output mode is shown, push shift and s to select input mode.
- 3. Push I to select the necessary RTD type, the custom curve, the SPRT, or the necessary ohms range. The setup and use of custom RTD coefficients is given in the "Resistance Temperature Detector (RTD) with Custom Coefficients" section of this chapter. The set up and use of SPRT coefficients is given in the "Standard Platinum Resistance Thermometer (SPRT) Coefficients" section of this chapter.
- 4. Connect the UUT to the 4-wire RTD/ $\Omega$  input terminals of the Product as shown in Figure 2-3.



Figure 2-3. RTD/ $\Omega$  Input Connection

- 5. Push  $[s_{HFT}]$  and [6] to toggle the RTD display between °F and °C.
- 6. For best accuracy, it is recommended to zero the RTD resistance circuit(s) daily, or if you will use the Product out of the ambient temperature range of 18 °C to 28 °C. The maximum offset from unit calibration that can be zeroed out is  $\pm 0.1 \Omega$  for the high range and  $\pm 0.01 \Omega$  for the low range.

To zero a RTD resistance circuit:

- Select the RTD measure function as in the "Resistance Temperature Detector (RTD) and Ohms Measure" and "Resistance Temperature Detector (RTD) and Ohms Source" sections of this chapter and push I until the low or high ohms range is selected.
- Short the RTD/ $\Omega$  terminals with the test leads normally used for RTD/ $\Omega$  measurements.
- It is necessary for the test leads and terminals to stabilize to the same temperature. They are stable in approximately 3 minutes.
- Push shift and 9 to zero the ohms range.

### **Resistance Temperature Detector (RTD) and Ohms Source**

The Product can source all common RTD types and 5 custom RTD curves in °F or °C, plus basic resistance from 5  $\Omega$  to 4000  $\Omega$ .

The Product uses these common RTD types:

- Pt 385 100 Ω, 200 Ω, 500 Ω, 1000 Ω
- Pt 3926 100 Ω
- Pt 3916 (JIS) 100 Ω
- Ni120 120 Ω
- Cu 427 (Minco) 10 Ω
- YSI 400
- 1. Disconnect test leads from external devices.
- 2. Push  $\mathbb{H}$  to select thermocouple and RTD/ $\Omega$  mode, if not already selected. If thermocouple mode is shown, push the key again to go to RTD/ $\Omega$  mode.
- 3. If input mode is shown, push shift and 7 to select output.
- 4. Push K to select the necessary RTD curve or ohms range. The set up and use of custom RTD coefficients is given in the "Resistance Temperature Detector (RTD) with Custom Coefficients" section of this chapter.
- 5. Connect the UUT to the RTD/ $\Omega$  output terminals of the Product as shown in Figure 2-4.



Figure 2-4. RTD/Ω Output Connection

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- 6. Push shift and **6** to toggle the RTD display between °F and °C.
- 7. Use the numeric keypad to type the necessary output value and push ENTER.
- 10. As an alternative, use **Q** or **D** to select a digit to change, followed by **●** or **●** to ramp the digit up or down. This method gives you a simple solution when small changes to an output value are necessary, or if is necessary to increment or decrement decades.

When RTD/ $\Omega$  mode is first selected, the Product is put into standby (Stby) mode which puts the positive (+) output jack into a high-impedance condition (>100 k  $\Omega$ ) for safety. To put the output into the active condition, push with to toggle between the standby and operate modes.

#### **Resistance Temperature Detector (RTD) with Custom Coefficients**

The Product can store coefficients for a maximum of five custom RTD curves. To key in the coefficients for a custom RTD curve:

- 1. Select RTD measure or source mode as given in the "Resistance Temperature Detector (RTD) and Ohms Measure" or "Resistance Temperature Detector (RTD) and Ohms Source" sections of this chapter.
- 2. Push the USR\_DEF type is selected.
- 3. Push ENTER to show the curve selection prompt "RTD CUSTOM (1-5)".
- 4. Push the numeric key that goes with the custom RTD curve to be keyed in.
- 5. At the "SET(1)/RECALL(2)" prompt, push 1 to select custom RTD curve data entry.
- 6. At the "ENTER MIN TEMP" prompt, key in the minimum temperature limit for the custom RTD curve, and push ENTER.
- 7. At the "ENTER MAX TEMP" prompt, key in the maximum temperature limit for the custom RTD curve, and push ENTER.
- 8. At the "ENTER R0" prompt, key in the nominal resistance value (R0) for the custom RTD curve, and push ENTER .
- At the "ENTER COEFF A" prompt, key in the first (A) coefficient for the custom RTD curve, and push ENTER. To key in a coefficient that includes an exponent, key in the mantissa, push SHIFT and • to select the EXP function, key in the exponent, and push ENTER.
- 10. When prompted, key in the second (B) and third (C) coefficients in the same manner.
- 11. To abort the curve entry without stored changes, push  $\mathbb{H}_{0}^{\mathbb{C}}$ .

To use a custom RTD curve:

- 1. Select RTD measure or source mode as given in the "Resistance Temperature Detector (RTD) and Ohms Measure" or "Resistance Temperature Detector (RTD) and Ohms Source" sections of this chapter.
- 2. Push **TYPE** until the USR\_DEF type is selected.
- 3. Push ENTER to show the curve selection prompt "RTD CUSTOM (1-5)".
- 4. Push the numeric key that goes with the custom RTD curve to be used.
- 5. At the "SET(1)/RECALL(2)" prompt, push 2 to recall the custom RTD curve coefficients.

6. To use a different custom RTD curve, push selection prompt.

The USR\_DEF function of the Product uses the Callendar-Van Dusen equation to source and measure custom RTD's. The C coefficient is only used for the subrange -260 °C to 0 °C. Only the A and B coefficients are necessary for the subrange 0 °C to 630 °C. The R0 value is the resistance of the probe at 0 °C.

All five of the custom RTD curves are set to PT385 at the factory, as shown in Table 2-1.

Curve	Subrange	R0	Coefficient A	Coefficient B	Coefficient C
1	0 to 630	100	3.9083e10-3	-5.775e10-7	0
2	-260 to 0	100	3.9083e10-3	-5.775e10-7	-4.183e10-12
3	0 to 630	100	3.9083e10-3	-5.775e10-7	0
4	-260 to 0	100	3.9083e10-3	-5.775e10-7	-4.183e10-12
5	0 to 630	100	3.9083e10-3	-5.775e10-7	0

Table 2-1. Default Custom RTD Coefficients

Table 2-2 shows the coefficients for RTD types PT391 and PT392. The C coefficient is only used for temperatures less than 0  $^{\circ}$ C.

Table 2-2.	Other	Common	RTD	Coefficients
------------	-------	--------	-----	--------------

RTD Type	R0	Coefficient A	Coefficient B	Coefficient C
PT392	100	3.9848e10-3	-5.87e10-7	-4.0e10-12
PT391	100	3.9692e10-3	-5.8495e10-7	-4.2325e10-12

## Standard Platinum Resistance Thermometer (SPRT) Coefficients

The SPRT function of the Product uses ITS-90 standard coefficients as a basis to measure a SPRT. The five custom coefficients are keyed in as deviations from the standard coefficients, and as such, all of them are set to zero at the factory.

The coefficients A- and B- refer to the A4 and B4 coefficient. These are received when the SPRT is calibrated at the triple points of argon, mercury, and water. This includes the 83.8058 K to 273.16 K subrange. Coefficients A, B, and C refer to different coefficients based on which subranges of the SPRT were calibrated. For example, if the 273.15 K to 933.473 K subrange was used, A, B, and C would refer to A7, B7, and C7 whereas if the 273.15 K to 692.67 K subrange was used, A and B would refer to A8 and B8 and C=0.

To key in the deviation coefficients for a custom SPRT:

- 1. Select RTD measure mode as given in the "Resistance Temperature Detector (RTD) and Ohms Measure" section of this chapter.
- 2. Push the SPRT type is selected.
- 3. Push ENTER to show the prompt "SET(1)/RECALL(2)".
- 4. Push 1 to select custom SPRT data entry.
- 5. At the "ENTER MIN TEMP" prompt, key in the minimum temperature limit for the custom SPRT, and push [ENTER].
- 6. At the "ENTER MAX TEMP" prompt, key in the maximum temperature limit for the

custom SPRT, and push ENTER .

- 7. At the "ENTER RTPW" prompt, key in the nominal resistance value (RTPW) for the custom SPRT, and push ENTER.
- 8. At the "ENTER COEFF A" prompt, key in the first (A) deviation coefficient for the custom SPRT, and push ENTER . To key in a coefficient that includes an exponent, key in the mantissa, push ENTER and to select the EXP function, key in the exponent, and push ENTER.
- 9. When prompted, use the same method to key in the second (B), third (C), fourth (A-), and fifth (B-) deviation coefficients.
- 10. To abort the SPRT entry without stored changes, push **F**.

To use a custom SPRT:

- 1. Select RTD measure mode as given in the "Resistance Temperature Detector (RTD) and Ohms Measure" section of this chapter.
- 2. Push the SPRT type is selected.
- 3. Push ENTER to show the prompt "SET(1)/RECALL(2)".
- 4. Push **2** to recall the custom SPRT curve coefficients.
- 5. To use a different custom SPRT, push 📅 two times to show the SPRT selection prompt.

#### Thermocouple (TC) Measure

The Product can measure all common thermocouple types in °F or °C, plus basic millivolts from -10.0 to 75.0 mV.

The Product uses these common thermocouple types:

- B
- C
- E
- J
- K
- L
- N
- R
- S
- T
- U
- XK
- BP
- 1. Disconnect test leads from external devices.
- 2. Push  $\mathbb{H}$  to select thermocouple and RTD/ $\Omega$  mode, if not already selected. If RTD/ $\Omega$  mode is shown, push the key again to go to thermocouple mode.
- 3. If output mode is shown, push shift and s to select input.

- 4. Push to select the necessary thermocouple type or the millivolt range.
- 5. Connect the UUT to the thermocouple terminals of the Product with a standard TC miniplug as shown in Figure 2-5. One pin is wider than the other. Do not push the plug into the incorrect polarization. The TC wire used for the connection must agree with the thermocouple type selected for correct cold junction compensation. It is necessary for the miniplug and terminals to stabilize to the same temperature. They are stable in approximately 3 minutes.



Figure 2-5. Thermocouple Input Connection

- 6. Push shift and 6 to toggle the thermocouple display between °F and °C.
- 7. Push shift and 5 to toggle the cold junction compensation between the internal temperature sensor and an external reference.
- 8. For best accuracy, it is recommended to zero the TC millivolt circuit daily, or if the Product is used out of its ambient temperature range of 18 °C to 28 °C. The maximum offset from unit calibration that can be zeroed out is ±1 mV.

To zero the TC millivolt circuit:

- 1. Select the thermocouple measure function and push the millivolt range is selected.
- 2. Put the supplied thermocouple shorting jumper into the thermocouple terminals.
- 3. It is necessary for the jumper and terminals to stabilize to the same temperature. They are stable in approximately 3 minutes.
- 4. Push shift and 9 to zero the TC millivolt circuit.

## Thermocouple (TC) Source

The Product can source all common thermocouple types in °F or °C, plus basic millivolts from -10.0 mV to 75.0 mV.

The following common thermocouple types are supported:

- B
- C
- E
- J
- K
- L
- N
- R
- S
- T
- U
- XK
- BP
- 1. Disconnect test leads from external devices.
- 2. Push  $\mathbb{H}_{\mathcal{D}}$  to select thermocouple and RTD/ $\Omega$  mode, if not already selected. If RTD/ $\Omega$  mode is shown, push the key again to go to thermocouple mode.
- 3. If input mode is shown, push shirt and 7 to select output mode.
- 4. Push **TYPE** to select the necessary thermocouple type or the millivolt range.
- 5. Connect the UUT to the thermocouple terminals of the Product with a standard TC miniplug as shown in Figure 2-6. One pin is wider than the other. Do not push the plug into the incorrect polarization. The TC wire used for the connection must agree with the thermocouple type selected for correct cold junction compensation. It is necessary for the miniplug and terminals to become stabile to the same temperature. They are stable in approximately 3 minutes.



Figure 2-6. Thermocouple Output Connection

- 6. Push shift and 6 to toggle the thermocouple display between °F and °C.
- 7. Push shift and 5 to toggle the cold junction compensation between the internal temperature sensor and an external reference.
- 8. Use the numeric keypad to type the necessary output value and push ENTER.
- 9. As an alternative, use **◊** or **◊** to select a digit to change, followed by or to ramp the digit up or down. This method gives you a simple solution when small changes to an output value are necessary, or if is necessary to increment or decrement decades.
- 10. For best accuracy, it is recommended to zero the TC millivolt circuit daily, or if the Product is used out of the ambient temperature range of 18 °C to 28 °C. This procedure is given in the "Thermocouple (T/C) Measure" section of this chapter.

#### **Pressure Measure**

Many ranges and types of pressure modules are available from Fluke. The Product can use the Fluke Model 700 Series Modules. Before you use a pressure module, read its instruction sheet. Pressure modules vary in use, media, and accuracy.

1. Connect the pressure module to the Product as shown in Figure 2-7.



Figure 2-7. Pressure Module Connection

- 2. Push 2. The Product automatically senses which pressure module is attached and sets its range accordingly.
- 3. Push **EXPE** to select the necessary pressure units to show.
- Before you attach the module to the pressure source, zero the module as given in the instruction sheet that came with the module. Procedures can be different, but all use shirt and 9.
- 5. Attach the module to the pressure source. Refer to the instruction sheet that came with the module. Follow all safety precautions when you do work with high pressures.

Pressure modules that can be used with the Product are listed in Tables 2-3 and 2-4.

Fluke Model Number	Range	Type and Media
Fluke-700P00	0 to 1 inH <sub>2</sub> 0	differential, dry
Fluke-700P01	0 to 10 inH <sub>2</sub> 0	differential, dry
Fluke-700P02	0 to 1 psi	differential, dry
Fluke-700P22	0 to 1 psi	differential, wet
Fluke-700P03	0 to 5 psi	differential, dry
Fluke-700P23	0 to 5 psi	differential, wet
Fluke-700P04	0 to 15 psi	differential, dry
Fluke-700P24	0 to 15 psi	differential, wet
Fluke-700P05	0 to 30 psi	gage, wet
Fluke-700P06	0 to 100 psi	gage, wet
Fluke-700P07	0 to 500 psi	gage, wet
Fluke-700P08	0 to 1,000 psi	gage, wet
Fluke-700P09	0 to 1,500 psi	gage, wet
Fluke-700P27	0 to 300 psi	gage, wet
Fluke-700P29	0 to 3,000 psi	gage, wet
Fluke-700P30	0 to 5,000 psi	gage, wet
Fluke-700P31	0 to 10,000 psi	gage, wet
Fluke-700PA3	0 to 5 psi	absolute, wet
Fluke-700PA4	0 to 15 psi	absolute, wet
Fluke-700PA5	0 to 30 psi	absolute, wet
Fluke-700PA6	0 to 100 psi	absolute, wet
Fluke-700PV3	0 to -5 psi	vacuum, dry
Fluke-700PV4	0 to -15 psi	vacuum, dry
Fluke-700PD2	±1 psi	dual range, dry
Fluke-700PD3	±5 psi	dual range, dry
Fluke-700PD4	±15 psi	dual range, dry
Fluke-700PD5	-15 / +30 psi	dual range, wet
Fluke-700PD6	-15 / +100 psi	dual range, wet
Fluke-700PD7	-15 / +200 psi	dual range, wet

Table 2-3. Fluke 700 Series Pressure Modules

_	<u>.</u>	_
Fluke Model Number	Range	Type and Media
Fluke-525A-P02	0 to 1 psi	differential, dry
Fluke-525A-P03	0 to 5 psi	gage, wet
Fluke-525A-P04	0 to 15 psi	gage, wet
Fluke-525A-P05	0 to 30 psi	gage, wet
Fluke-525A-P06	0 to 100 psi	gage, wet
Fluke-525A-P07	0 to 500 psi	gage, wet
Fluke-525A-P08	0 to 1000 psi	gage, wet
Fluke-525A-P29	0 to 3000 psi	gage, wet
Fluke-525A-PA4	0 to 15 psia	absolute, wet
Fluke-525A-PA5	0 to 30 psia	absolute, wet
Fluke-525A-PA6	0 to 100 psia	absolute, wet
Fluke-525A-PA7	0 to 500 psia	absolute, wet
Fluke-525A-PA8	0 to 1000 psia	absolute, wet
Fluke-525A-PV4	-15 to 0 psi	vacuum, dry

Table 2-4. Fluke 525A-P Series Pressure Modules

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## Voltage Input

The Product can measure dc voltages from 0 V to 100 V. Use these ranges for maximum accuracy: 10 V and 100 V.

- 1. Disconnect test leads from external devices.
- 2. Push with to select isolated dc voltage and current input mode, if not already selected. If the necessary dc voltage mode is not shown, push with again to cycle to the necessary dc voltage mode.
- 3. Connect the unit under test (UUT) to the isolated voltage/current input terminals of the Product as in Figure 3-1.



Figure 3-1. Isolated DC Voltage Input Connection

## **Current Input**

The Product can measure dc current from 0 mA to 50 mA.

- 1. Disconnect test leads from external devices.
- 2. Push with to select isolated dc voltage and current input mode, if not already selected. If the dc current mode is not shown, push the key again to go to it.
- 3. Connect the UUT to the isolated voltage/current input terminals of the Product as in Figure 3-2.



Figure 3-2. Isolated DC Current Input Connection

4. If the UUT is a 2-wire loop powered transmitter that is disconnected from the wiring,

push  $\begin{bmatrix} 100PP \\ PWR \end{bmatrix}$  to turn on the Product internal 24 V supply in series with the current measuring circuit. The top line changes to 24mA LPWR to show that the supply is on. Push  $\begin{bmatrix} 100P \\ PWR \end{bmatrix}$  again to turn off the supply and the top line reverts to 50mA RANGE.

5. If a 250  $\Omega$  resistor is necessary during a HART calibration procedure, push  $\frac{1}{MART}$  to switch in the Product internal 250  $\Omega$  resistor. HART is added to the top line of the display to show that the resistor is turned on in the circuit. Push  $\frac{1}{MART}$  again to turn off the resistor and the display changes to its previous condition. This resistor lowers the maximum-load driving function from 1000  $\Omega$  at 20 mA to 750  $\Omega$  at 20 mA.

## **Pressure Input**

The isolated pressure display uses the same physical pressure connector as the primary display. It is possible to have the displays set to show pressure at the same time. The same source can be shown in different pressure units. See the "Pressure Measure" in Chapter 2 for a discussion on pressure module selection.

1. Connect the pressure module to the Product as shown in Figure 3-3.



Figure 3-3. Isolated Pressure Module Connection

- 2. Push 2. The Product automatically senses which pressure module is connected and sets its range accordingly.
- 3. If necessary, push again to cycle through the pressure units until the necessary unit is shown.
- Before you attach the module to the pressure source, zero the module as given in the instruction sheet that came with the module. Procedures can be different, but all end with SHIFT and 9.
- 5. Attach the module to the pressure source. Refer to the instruction sheet that came with the module, and make sure to follow all safety precautions when dealing with high pressures.

## Switch Test

When in Switch Test mode the Calibrator can sense a contact transition (closed or opened). At the time of the transition the Calibrator records the value and units shown on the primary display. This means that a switch test can be done in all modes, read or source. After two transitions the Calibrator changes to recall mode. In recall mode, the value of the first transition, second transition, and the calculated deadband of the switch can be seen on the display. See Figure 3-4 for connections.



Figure 3-4. Swich Test and Pressure Module Connections

1. To go to switch test mode, push and hold with for three seconds.

When in switch test mode, the Calibrator shows the status of the switch contacts, in this instance, you can see the contact status of a normally open temperature switch:



gwp036.eps

At the first transition, the switch contact closes:



gwp037.eps

After the second contact transition, the switch opens. After the second contact transition, the Calibrator enters the recall mode:

		SWITCH	CLOSED AT 100.0	•C	gwp035.eps
2.	$Push_{\text{SWTEST}}^{\text{VOLTS/MA}}.$				
		SWITCH	OPEN AT 105.0	•0	
3.	Push wuisma .				gwp038.ep
		SWITCH	DEADBAND 5.0	•0	aug 020 agu

When necessary, push  $\begin{bmatrix} LOOP \\ PWR \end{bmatrix}$  to reset the switch test. Hold down  $\begin{bmatrix} WISHNY \\ WWR \end{bmatrix}$  for 3 seconds to put the Calibrator into the isolated input mode that was selected before.

#### **Output Setpoints**

Nine preset output setpoints can be stored and recalled for each of these output modes:

- Voltage
- Current
- Each thermocouple type, this includes millivolts
- Each RTD type, this includes each of the five custom curves

They can be recalled on an individual basis or as an automatic up and down cycle with a configurable dwell time between each setpoint. The automatic cycle feature starts at setpoint number 1 and steps to a user-specified end setpoint number. It then goes back down in reverse sequence and cycles through the sequence again.

To set a setpoint:

- 1. Select the output mode.
- 2. Type the output value for the setpoint.
- 3. Push shift and 1 to select the SET function.
- 4. At the setpoint number selection prompt "SET POINT#", push the numeric key, 1 to 9, for the setpoint to be set.
- 5. If the automatic cycle feature is to be used, make sure to correctly sequence the setpoint values. It always cycles between setpoint number 1 and a user-specified end setpoint number. The values in the cycled group of setpoints must be keyed in with this in mind. Random setpoints used for individual checks can then be found after the usual end setpoint number.

To recall a setpoint:

- 1. Select the output mode.
- 2. Push shift and 2 to select the RECALL function.
- 3. At the setpoint number selection prompt "RECALL SPT#", push the numeric key, 1 to 9, for the setpoint to be recalled.

To start an automatic setpoint cycle:

- 1. Select the output mode.
- 2. Push shift and 3 to select the AUTOSET function.
- 3. At the end setpoint number selection prompt "AUTO SET POINT", push the numeric key, 1 to 9, for the end setpoint number for the cycle.
- 4. At the dwell time prompt "DWELL TIME", "5-500?", record the number of seconds, 5 to 500, to dwell at each setpoint value, followed by ENTER.
- 5. **STRY** can be used at any time during the cycle without stopping it.
- 6. Push the other Product keys to stop the cycle.

# Chapter 4 Application Notes

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## Introduction

This chapter includes application notes that will help you to understand how to better use the Product under different situations.

## **P/I Transmitter**

- 1. Disconnect test leads from external devices.
- 2. Select pressure input on the primary display as given in the "Pressure Measure" section of Chapter 4.
- 3. Select current input on the isolated display as given in the "Current Input" section of Chapter 5. Select isolated loop power. If a HART communicator is used for set up of the transmitter, select HART.
- 4. Connect the transmitter as shown in Figure 4-1.
- 5. To verify and calibrate the transmitter, refer to the transmitter documentation.



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Figure 4-1. P/I Transmitter Application

## **I/P Transmitter**

- 1. Disconnect test leads from external devices.
- 2. Select current output on the primary display as given in the "DC Current Output" section of Chapter 4.
- 3. Select pressure input on the isolated display as given in the "Pressure Input" section of Chapter 5.
- 4. Connect the transmitter as shown in Figure 4-2.
- 5. To verify and calibrate the transmitter, refer to the transmitter documentation.



Figure 4-2. I/P Transmitter Application

## V/I Transmitter

- 1. Disconnect test leads from external devices.
- 2. Select voltage output on the primary display as given in the "DC Voltage Output" section of Chapter 4.
- 3. Select current input on the isolated display as given in the "Current Input" section of Chapter 5. Select the isolated loop power option.
- 4. Connect the transmitter as shown in Figure 4-3.
- 5. To verify and calibrate the transmitter, refer to the transmitter documentation.

VOLTS VO	24 mA LPWR 12.0000 mA
- - - - - - - - - - - - - - - - - - -	

Figure 4-3. V/I Transmitter Application

## **RTD Test**

- 1. Disconnect test leads from external devices.
- 2. Select RTD input on the primary display as given in the "Resistance Temperature Detector (RTD) and Ohms Measure" section of Chapter 4.
- 3. Select the correct RTD type.
- 4. Connect the RTD as shown in Figure 4-4.
- 5. To verify the RTD, refer to the RTD documentation.



Figure 4-4. RTD Test Application

## **RTD Transmitter**

- 1. Disconnect test leads from external devices.
- 2. Select RTD output on the primary display as given in the "Resistance Temperature Detector (RTD) and Ohms Source" section of Chapter 4.
- 3. Select the correct RTD type.
- 4. Select current input on the isolated display as given in the "Current Input" section in Chapter 5.
- 5. Select the isolated loop power option. If a HART communicator will be used for setup of the transmitter, select HART.
- 6. Connect the transmitter as shown in Figure 4-5.
- 7. To verify and calibrate the transmitter, refer to the transmitter documentation.



Figure 4-5. RTD Transmitter Application

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## **Thermocouple Test**

- 1. Disconnect test leads from external devices.
- 2. Select thermocouple input on the primary display as given in the "Thermocouple (TC) Measure" section in Chapter 4.
- 3. Select the correct thermocouple type.
- 4. Connect the thermocouple as shown in Figure 4-6.
- 5. To verify the thermocouple, refer to the thermocouple documentation.



Figure 4-6. Thermocouple Test Application

## Thermocouple Transmitter

- 1. Disconnect test leads from external devices.
- 2. Select thermocouple output on the primary display as given in the "Thermocouple (TC) Source" section of Chapter 4.
- 3. Select the correct thermocouple type for the transmitter.
- 4. Select current input on the isolated display as given in the "Current Input" section of Chapter 5.
- 5. Select the isolated loop power option. If a HART communicator is necessary for set up of the transmitter, select HART.
- 6. Connect the transmitter as shown in Figure 4-7.
- 7. To verify and calibrate the transmitter, refer to the transmitter documentation.



Figure 4-7. Thermocouple Transmitter Application

#### **RTD** Indicator

- 1. Disconnect test leads from external devices.
- 2. Select RTD output on the primary display as given in the "Resistance Temperature Detector (RTD) and Ohms Source" section of Chapter 4.
- 3. Select the correct RTD type for the indicator.
- 4. Connect the indicator as shown in Figure 4-8.
- 5. To verify and calibrate the indicator, refer to the indicator documentation.



Figure 4-8. RTD Indicator Application

#### **Precision Current Trip**

- 1. Disconnect test leads from external devices.
- 2. Select current output on the primary display as given in the "DC Current Output" section of Chapter 4.
- 3. Select voltage input on the isolated display as given in the "Voltage Input" section in Chapter 5.
- 4. Connect the trip as shown in Figure 4-9.
- 5. To verify and calibrate the trip, refer to the trip documentation.



Figure 4-9. Precision Current Trip Application

#### I/I Isolator/Transmitter

- 1. Disconnect test leads from external devices.
- 2. Select current output on the primary display as given in the "DC Current Output" section of Chapter 4.
- 3. Select current input on the isolated display as given in the "Current Input" section of Chapter 5.
- 4. Select the isolated loop power option.
- 5. Connect the transmitter as shown in Figure 4-10.
- 6. To verify and calibrate the transmitter, refer to the transmitter documentation.



Figure 4-10. I/I Isolator/Transmitter Application

#### Precision Temperature Measurement with Probe

- 1. With the probe and the custom coefficients that go with the probe, the total system error is  $0.03 \, ^{\circ}$ C.
- 2. Disconnect test leads from external devices.
- 3. Select RTD input on the primary given as given in the "Resistance Temperature Detector (RTD) and Ohms Measure" section of Chapter 4.
- 4. Select the user-defined curve with the custom coefficients for the probe. If custom coefficients have not been recorded for the probe, follow the instructions in the "Resistance Temperature Detector (RTD) with Custom Coefficients" section in Chapter 4.
- 5. Connect the probe as shown in Figure 4-11.



Figure 4-11. Precision Temperature Measurement with Probe

#### **Temperature Switch Test**

To do a temperature switch test, see Figure 4-12 for the necessary connections and do the subsequent steps.



Figure 4-12. Temperature Switch Test Connections

gwp062.eps

- 1. To go to the switch test mode, push and hold with for three seconds.
- 2. Connect the Calibrator to the switch with the isolated terminals. The polarity of the terminals is not important.
- 3. The top of the isolated display will read "CLOSE":



- 4. Increase the temperature slowly until the switch opens.
- 5. When the switch opens, "OPEN" will be shown. Decrease the temperature slowly until the switch closes:

|--|

6. At the top of the isolated display it will now read, "SW OPENED AT" and show the temperature that the switch opened at:



7. Push with to see when the switch closed and the deadband:



8. Push  $\begin{bmatrix} LOOP\\ PWR \end{bmatrix}$  to get to the main menu. Clear the data and do another test.

Note

The last example uses a normally closed switch. The basic procedure is the same for a normally open switch, but the display will read "OPEN" as an alternative to "CLOSE".

#### **Pressure Switch Test**

The connections for this test are shown in Figure 4-13.



Figure 4-13. Pressure Switch Test Connections
To do the pressure switch test:

- 1. To go to the switch test mode, push and hold with for 3 seconds.
- 2. Connect the Calibrator to the switch. Use the isolated terminals. The polarity of the terminals is not important.
- 3. Connect the pump to the Calibrator and the pressure switch. Make sure the vent on the pump is open.
- 4. Zero the Calibrator if necessary.
- 5. Close the vent after you zero the Calibrator.
- 6. The top of the isolated display will read "CLOSE".



gwp065.eps

7. Apply pressure with the pump slowly until the switch opens.

Note

When you pressurize the device under test, it must be done slowly to make sure the readings will be accurate.

8. When the switch is open, "OPEN" will be shown. Bleed the pump slowly until the pressure switch closes.



9. The top of the isolated display will now read, "SW OPENED AT" and show at what pressure that the switch opened.





10. Push the "NEXT" option to see when the switch closed, and the deadband.

Note

The previous example uses a normally closed switch.

The basic procedure is the same for a normally open switch but the display will show "OPEN" as an alternative to "CLOSE".

# Chapter 5 LCD and Remote Interface Setup Procedures

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# Introduction

This chapter tells you how to set up and use the Remote Interface. It also explains the IEEE-488 interface and gives a listing of remote commands and their functions.

# Access LCD and Remote Interface Setup Procedures

To access LCD and Remote Interface setup procedures:

- 1. Push shift and 4 to select the SETUP function.
- 3. Push ENTER.
- 4. At the "LCD BACKLIGHT" prompt, push rightarrow or rightarrow to adjust the LCD backlight.
- 5. Push ENTER.

# **Remote Interface**

The Product can be controlled remotely from a personal computer (PC). Use an RS-232 serial connection or an IEEE-488 parallel connection (also called a General Purpose Interface Bus, or GPIB connection). Individual commands can be typed into terminal emulator software applicable for the connection type. The Calibrator can also be controlled by PC software that uses the Product command set. You can write your own PC program or purchase applicable third-party software and configure it for the Product. MET/CAL, a compatible software for IEEE-488 operation, can be purchased from Fluke.

The RS-232 connection lets one Product be connected to one PC. The communication speed is slower than IEEE-488, but no other equipment is necessary other than a low-cost null modem cable.

The IEEE-488 connection lets you connect a maximum of 15 different calibrators, PCs, and items of test equipment together in a bus system. The communication speed is much faster than RS-232, but it is necessary to purchase and install special PC interface card(s) and cable(s).

This section gives the setup of the two types of connections, and the general operation of the command set. Chapter 6 gives the individual commands.

## Set Up the RS-232 Port for Remote Control

The Product is programmable with a standard RS-232 connection with a PC. The RS-232 cable for the port must be shorter than 15 meters (50 feet). Longer cables are permitted if the load capacitance measured at a connection point (including signal terminator) is not larger than 2500 pF.

The serial communications parameters in the Product are set at these values:

- 9600 baud
- 8 data bits
- 1 stop bit
- no parity
- Xon/Xoff
- EOL (end-of-line) character CR (Carriage Return)

A typical RS-232 connection is shown in Figure 5-1. Note that a null modem cable is used for the connection. See the "Rear Panel" section in Chapter 1 for the location of the RS-232 port on the rear panel of the Product.



Figure 5-1. RS-232 Remote Connection

## **Use with Computer USB Ports**

The Product can be used with a computer USB ports with a USB to serial converter. Fluke can supply the equipment for this connection:

- 80313, Cable, USB to serial adapter
- 80157, Cable, Null modem, RS-232

See Figure 5-2 for connections.



Figure 5-2. RS-232 Remote Connection

## Set Up the IEEE-488 Port for Remote Control

The Product is fully programmable for you to use on a standard IEEE-488 interface bus. The IEEE-488 interface is also in compliance with supplemental standard IEEE-488.2, which gives you more IEEE-488 features. Devices connected to the IEEE-488 bus are designated as talkers, listeners, talker/listeners, or controllers. The Product operates as a talker/listener when you use it by remote control from an instrument.

A PC with an IEEE-488 interface controls the Product. Compatible software for IEEE-488 operation, MET/CAL, can be purchased from Fluke Calibration.

When you use the IEEE-488 remote control interface, there are two restrictions:

- 1. A maximum of 15 devices can be connected in one IEEE-488 bus system.
- 2. The total length of IEEE-488 cables used in one IEEE-488 bus system is the smaller of 2 meters multiplied by the number of devices in the system or 20 meters (65 feet).

See Chapter 5 for instructions to configure the Product for IEEE-488 (GPIB) operation. These instructions include interface and bus address selection. A typical IEEE-488 (GPIB) connection is shown in Figure 5-3. See the "Rear Panel" section of Chapter 1 for the location of the IEE-488 (GPIB) port on the rear panel of the Product.



Figure 5-3. IEEE-488 (GPIB) Remote Connection

## **Change Between Local and Remote Operation**

With local mode (front-panel operation) and remote, the Product can be put into a local lockout condition by command of the controller. Mixed, the local, remote, and lockout conditions will give you four possible operation conditions as follows.

1. Local State

The Product answers to local and remote commands. This is usual front-panel operation. All remote commands received by the Product are processed.

2. Local with Lockout State

Local with lockout is the same to local, but the Product will go into the remote with lockout state as an alternative to the remote state when it receives a remote command. You can only go to this state with the IEEE-488 command GTL (Go To Local) when in the remote with lockout state.

3. Remote State

When the Product is put in remote, by RS-232 REMOTE command, or by IEEE-488 asserting the REN line, it goes to the remote state. The left-end of the top-line of the display changes to: rem.

Front-panel operation is stopped. This does not include the LOCAL (0) key. Push the LOCAL key, use RS-232 to send the LOCAL command, or use IEEE-488 to send the GTL (Go To Local) message. The Product goes to the local state.

4. Remote with Lockout State

When the Product is in lockout, by RS-232 LOCKOUT command, or by IEEE-488 message LLO (Local Lockout), the Product front-panel controls are locked out. The left-end of the top-line of the display changes to: rem.

To change the Product to the local with lockout state, send the RS-232 LOCAL command or the IEEE-488 GTL (Go To Local) message.

Table 5-1 gives the possible operation state transitions. For more information about IEEE-488 GPIB messages, see the "IEEE-488 Interface Overview" section of this chapter.

From	То	Front Panel	GPIB Message	Serial Command
Local	Remote Local with Lockout		MLA (REN True) LLO	REMOTE LOCKOUT
Remote	Local Remote with Lockout	Local 0 key	GTL or REN False LLO	LOCAL LOCKOUT
Local with Lockout	Local Remote with Lockout		REN False MLA (REN True)	LOCAL REMOTE
Remote with Lockout	Local Local with Lockout		REN False GTL	LOCAL

Table 5-1. Operating State Transitions

# **IEEE-488 Interface Overview**

The IEEE-488 parallel interface sends commands as data and receives measurements and messages as data. The maximum data exchange rate is 1 Mbyte per second, with a maximum distance of 20 meters for the full length of the cable connections. One cable must not be more than 4 meters.

Some commands are used only for RS-232 serial operation because these functions must be implemented as IEEE uniline (single control line) bus management messages per the IEEE Standards. For example, the command REMOTE can be sent as data over the IEEE-488 interface to put the Product into remote operation mode, but it is not because the IEEE Standards use the remote function to be sent to the device as the uniline message REN. This is also true for some other commands and functions, as shown in Table 5-2 with their RS-232 equivalents.

Table 5-2. RS-232 Emulation of IEEE-488 Messages
--

IEEE-488 Message	RS-232 Equivalent		
GTL	LOCAL command		
GTR	REMOTE command		
LLO	LOCKOUT command		
SDC, DCL	(not emulated on RS-232)		
GET	(not emulated on RS-232)		
SPE, SPD	(not emulated on RS-232)		
UNL, UNT	(not emulated on RS-232)		

The IEEE-488 interface uses the IEEE Standards 488.1 and 488.2 as its basis. For more information, refer to the IEEE-488.1 and IEEE-488.2 standards.

# **Command Use**

Communications between the controller and the Product use commands, queries, and interface messages. Although the commands use the 488.2 standard as their basis, they can be used on the IEEE-488 or RS-232 interface. There are some special RS-232 only commands as shown in the section "Commands for RS-232 Only".

For more information on IEEE command structures, see the IEEE 488.2 standard.

See Chapter 6 for more information about the commands referenced in this section.

All commands, units, and text data can be recorded in UPPER or lower-case letters. The Product changes all lower-case letters to upper case before they are used.

## **Types of Commands**

The commands for the Product can be put into these categories:

Device-Dependent Commands

Device-dependent commands are unique to the Product. An example of a device-dependent command is:

OUT 1 V

This command tells the Product to source 1 V dc

1. Common Commands

Common commands are specified by the IEEE 488.2 standard and are common to most bus devices. Common commands start with an asterisk (\*). Common commands are available if you use the IEEE-488 or RS-232 interface for remote control. An example of a common command is:

\*IDN?

This command tells the Product to show the instrument identification string.

2. Query Commands

Query commands requests for information, which can be shown as the command operates, or can be put in a buffer until it is necessary later. Query commands end with a question mark. An example of a query commands is:

RANGE?

This command tells the Product to show the current DC voltage output range.

3. Interface Messages (IEEE-488)

Interface messages control traffic on the IEEE-488 interface bus. Device addressing and clearing, data handshaking, and commands to put status bytes on the bus are all directed by interface messages. Some of the interface messages occur as state transitions of dedicated control lines. The remaining interface messages are sent through the data lines with the ATN signal true. All device-dependent and common commands are sent through the data lines with the ATN signal false.

An important thing about interface messages is that, unlike device-dependent and common commands, interface messages are not sent literally in a direct method. They are changed to parallel signal levels on the bus data and control lines.

IEEE-488 standards define interface messages which are managed automatically in most cases.

4. Compound Commands

A compound command is two or more commands put on one command line isolated from each other with semicolons. For example, the subsequent two individual commands:

OUT 1 V OPER

can be mixed into the compound command: OUT 1 V; OPER

These commands tell the Product to source 1 V dc, and then go into operate mode.

5. Overlapped Commands

Commands that start execution but take more time than the usual communication command/response interval to complete are overlapped commands. This is because they can be overlapped by receipt the command that follows before they are complete.

The detailed command descriptions in Chapter 6 show a check mark by Overlapped for overlapped commands.

Use the command \*WAI to stop until the overlapped command is complete before you do the command that follows. For example:

OUT 1 V; \*WAI

You can also use the status commands \*OPC and \*OPC? to find the overlapped commands that are complete.

6. Sequential Commands

Commands that operate immediately are sequential commands.

The command descriptions in Chapter 6 show a check mark by Sequential for sequential commands.

Most commands are sequential.

7. Commands for RS-232 Only

Some commands are used only for RS-232 serial operation because these functions must be done as IEEE uniline (single control line) bus management messages per the IEEE Standards. For example, the command REMOTE can be sent as data through the IEEE-488 interface to put the Product into remote operation mode, but it is not because the IEEE Standards tell you that the remote function to be sent to the device as the uniline message REN. This is also true for some other commands and functions, as shown in Table 5-3 with their RS-232 equivalents.

For these commands, the detailed command descriptions in Chapter 6 show a marked box beside RS-232, but no check marked box beside IEEE-488.

IEEE-488 Message	RS-232 Equivalent
GTL	LOCAL command
GTR	REMOTE command
LLO	LOCKOUT command

### Table 5-3. Commands for RS-232 Only

#### 8. Commands for IEEE-488

These are all of the commands but those used for RS-232 only, as shown above. All commands are moved through the IEEE-488 as data, but the commands LOCAL, REMOTE, and LOCKOUT, which are done per the IEEE Standards as uniline messages.

The detailed command descriptions in Chapter 6 show a check mark beside IEEE-488 for these commands.

## **Command Syntax**

The subsequent syntax rules are for all of the remote commands. Information about the syntax of response messages is also given.

1. Parameter Syntax Rules

Table 5-4 shows the units permitted in command parameters and used in responses. All commands and units can be recorded in upper or lower case.

Units	Meaning
μV	Volts in units of microvolts <sup>[1]</sup>
mV	Volts in units of millivolts <sup>[1]</sup>
V	Volts in units of volts
kV	Volts in units of kilovolts <sup>[1]</sup>
μA	Current in units of microamperes <sup>[1]</sup>
mA	Current in units of milliamps <sup>[1]</sup>
A	Current in units of amps
Ohm	Resistance in units of ohms
kOhm	Resistance in units of kilohms <sup>[1]</sup>
MOhm	Resistance in units of megohms <sup>[1]</sup>
cel	Temperature in degrees Celsius
far	Temperature in degrees Fahrenheit
psi	Pressure in pounds per square inch
mmHg	Pressure in millimeters of mercury at 0 °C
inHg	Pressure in inches of mercury at 0 °C
inH2O4C	Pressure in inches of water at 4 °C
inH2O20C	Pressure in inches of water at 20 °C
inH2O60F	Pressure in inches of water at 60 °F
cmH2O4C	Pressure in centimeters of water at 4 °C
cmH2O20C	Pressure in centimeters of water at 20 °C
mmH2O4C	Pressure in millimeters of water at 4 °C
mmH2O20C	Pressure in millimeters of water at 20 °C
bar	Pressure in bar
mbar	Pressure in millibar
kPa	Pressure in kilopascals
MPa	Pressure in megapascals
kg/cm2	Pressure in kilograms per square centimeter
[1] Parameter only	

#### Table 5-4. Units Accepted in Parameters and Used in Responses

2. General Rules

The general rules for parameter use are:

- Numeric parameters can have a maximum of 15 important digits and their value can be in the range +/-1.0E+/-20.
- You must include the correct number of parameters. This causes a command error.
- Null parameters cause an error, for example, the adjacent commas in OUT 1V,,; OPER.
- Expressions, for example 4+2\*13, cannot be used as parameters.

3. More Space or Tab Characters

In the command descriptions, parameters are shown isolated by spaces. One space after a command is necessary (unless no parameters are necessary). All other spaces are optional. Spaces are put in for clarity in the manual and can be left in or left out as necessary. You can put more spaces or tabs between parameters as necessary. More spaces in a parameter are typically not permitted. You can have more spaces between a number and its related multiplier or unit.

4. Terminators

Table 5-5 summarizes the terminator characters for both the IEEE-488 and the RS-232 remote interfaces.

Terminator	ASCII	Character	Control	Language Command Terminator			
Function	Number	Program	Command Terminator				
Carriage Return (CR)	13	Chr(13)	<cntl> M</cntl>	١n			
Line Feed (LF)	10	Chr(10)	<cntl> J</cntl>	١r			
Backspace (BS)	8	Chr(8)	<cntl> H</cntl>	\b			
Form Feed (FF)	12	Chr(12)	<cntl> L</cntl>	\f			
Examples:	Examples:						
RS-232 Mode, terminal: OUT 1 V <enter></enter>							
RS-232 Mode, program: Comm1.Output = "OUT 1 V" + Chr(10) IEEE-488 Mode: OUT 1 V							

Table 5-	5. Terminat	or Characters

IEEE-488 interface:

The Product sends the ASCII character Carriage Return with the EOI control line held high as the terminator for response messages. The Product recognizes the subsequent as terminators when found in incoming data:

- ASCII CR character
- All ASCII character sent with the EOI control line asserted

RS-232 interface:

The Product sends a Carriage Return (CR) character as the terminator for response messages. The Product recognizes the subsequent as terminators when found in incoming data:

- ASCII CR character
- ASCII LF character
- 5. Incoming Character Processing

The Product processes all incoming data as follows:

- The most significant data bit (DIO8) is ignored
- All data is read as 7-bit ASCII

• Lower case or upper case characters are accepted, with lower case changed to upper case before they are used.

6. Response Message Syntax

In the complete command descriptions in Chapter 6, the responses from the Product are given where applicable. To know what type of data to read in, refer to the start of the response description for the command.

## **Check Product Status**

Figure 5-4 shows the status registers, enable registers, and queues in the Product which show different conditions in the Product. Some registers and queues are specified by the IEEE-488.2 standard, while the others are only for the Product. With the status registers, the Service Request (SRQ) control line and a 16-element buffer (the Error Queue) also give status information.



Figure 5-4. Status Register Overview

gwp055.eps

Table 5-6 shows the status registers and gives the read/write commands and related mask registers to use them.

Table \$	5-6.	Status	Register	Summar	у
----------	------	--------	----------	--------	---

Status Register	Read Command	Write Command
Serial Poll Status Byte (STB)	*STB?	
Service Request Enable Register (SRE)	*SRE?	*SRE
Event Status Register (ESR)	*ESR?	_
Event Status Enable Register (ESE)	*ESE?	*ESE

Each status register and queue has a summary bit in the Serial Poll Status Byte. Enable registers are used to mask different bits in the status registers and to make summary bits in the Serial Poll Status Byte. For IEEE-488 interface operation, the Service Request Enable Register is used to assert the SRQ control line on detection of A status condition or conditions that the programmer chooses. For RS-232 interface operation, the SRQSTR string is sent through the serial interface when the SRQ line is set.

1. Serial Poll Status Byte (STB)

The Calibrator sends the serial poll status byte (STB) when it answers to a serial poll. This byte is set to 0 when the power is turned on. The STB byte structure is shown in Table 5-7. Refer to the \*STB? command in Chapter 6 for more information on how to read this register.

Table 5-7. Serial Poll Status Byte (STB) and Service Request Enable (SRE) Registers

7	6	5	4	3	2	1	0
0	RQS				0		
	MSS	ESB	WAV	EAV	0	0	0

RQS Requesting Service. The RQS bit is set to 1 when bits ESB, MAV, EAV, or ISCB change from 0 to 1 and are enabled (1) in the SRE. When RQS is 1, the Product asserts the SRQ control line on the IEEE-488 interface. You can do a serial poll to read this bit to see if the Product is the source of an SRQ.

MSS Master Summary Status. Set to 1 when bits ESB, MAV, EAV, or ISCB are 1 and enabled (1) in the SRE. This bit can be read with the \*STB? Remote command in in place of a serial poll. Set to 1 when one or more ESR bits are 1.

- MAV Message Available. The MAV bit is set to 1 when data is available in the IEEE-488 interface output buffer of the Product.
- EAV Error Available. An error has occurred and an error is available to be read from the error queue with the FAULT? query.
  - 2. Service Request (SRQ) Line

IEEE-488 Service Request (SRQ) is an IEEE-488.1 bus control line that the Product asserts to tell the controller that some type of service is necessary. Many instruments can be on the bus, but they all share one SRQ line. To find which instrument set SRQ, the Controller typically does a serial poll of each instrument. The calibrator asserts SRQ when the RQS bit in its Serial Poll Status Byte is 1. This bit tells the controller that the Product was the source of the SRQ.

The Product clears SRQ and RQS when the controller/host does a serial poll, sends \*CLS, or when the MSS bit is cleared. The MSS bit is cleared only when ESB and MAV are 0, or they are disabled when their related enable bits in the SRE register are set to 0.

3. Service Request Enable Register (SRE)

The Service Request Enable Register (SRE) enables or masks the bits of the Serial Poll Status Byte. The SRE is cleared at power up. Refer to Table 5-8 for the bit functions.

4. Programming the STB and SRE

When you reset (to 0) the bits in the SRE, you can mask (disable) related bits in the serial poll status byte. Bits set to 1 enable the related bit in the serial poll status byte.

5. Event Status Register (ESR)

The Event Status Register is a two-byte register in which the higher eight bits are always 0, and the lower eight bits show different conditions of the Product. The ESR is cleared (set to 0) when the power is turned on, and each time it is read.

Parameters are necessary for many of the remote commands. Incorrect parameter use causes command errors to occur. When a command error occurs, bit CME (5) in the Event Status Register (ESR) goes to 1 (if enabled in ESE register), and the error is logged in the error queue.

6. Event Status Enable (ESE) Register

A mask register named the Event Status Enable register (ESE) lets the controller enable or mask (disable) each bit in the ESR. When a bit in the ESE is 1, the related bit in the ESR is enabled. When an enabled bit in the ESR is 1, the ESB bit in the Serial Poll Status Byte also goes to 1. The ESR bit stays 1 until the controller reads the ESR, does a device clear, a selected device clear, or sends the reset or \*CLS command to the Product. The ESE is cleared (set to 0) when the power is turned on.

7. Bit Assignments for the ESR and ESE

The bits in the Event Status Register (ESR) and Event Status Enable register (ESE) are as shown in Table 5-8.

15	14	13	12	11	10	9	8
0	0	0	0	0	0	0	0
7	6	5	4	3	2	1	0
PON	0	CME	EXE	DDE	QYE	0	OPC
PON	Power on. This ESR was read.	bit is set to 1	if line power	has been tur	med off and o	on since the I	ast time the
CME	Command error command and p to fetch error co	. The IEEE-4 laced an erro des from the	88 interface of or code in the error queue,	of the Produc e error queue which is des	ct encountere . The comma cribed in moi	ed an incorrect and FAULT? re detail belo	ctly formed can be used w.
EXE	EXE Execution error. An error occurred when the Product tried to execute the last command an error code was placed into the error queue. This could be caused, for example, by a parameter being out of range. The command FAULT? can be used to fetch error codes from the error queue, which is described in more detail below.						
DDE	Device-dependent error. An error related to a device-dependent command has occurred.						
QYE	Query error. The Product was addressed to talk when no response data was available or appropriate, or when the controller failed to retrieve data from the output queue.						
OPC	Operation complete. All commands previous to reception of a *OPC command have been executed, and the interface is ready to accept another message.						

Table 5-8. Event Status Register (ESR) and Event Status Enable (ESE) Registers

8. Programming the ESR and ESE

To read the contents of the ESR, send the remote command, \*ESR?. The ESR is cleared (set to 0) each time it is read. To read the contents of the ESE, send the remote command, \*ESE?. The ESE is not cleared when it is read. When you read registers, the Product shows a decimal number that when changed to binary refers to bits 0 through 15.

9. Output Queue

The output queue is loaded when a query is processed, and holds a maximum of 250

characters. The controller reads it with a statement such as a BASIC INPUT statement. What is read is removed from the queue. If the queue is empty, the Product does not answer to the INPUT statement from the controller. The Message Available (MAV) bit in the Serial Poll Status Byte is 1 if there is something in the output queue and 0 if the output queue is empty.

10. Error Queue

When a command error, execution error, or device-dependent error occurs, its error code is put in the error queue where it can be read by the FAULT? command. If you read the first error with the FAULT? Command, this removes that error from the queue. A response of 0 means the error queue is empty. The error queue is cleared when you turn off the power, and when you use the \*CLS (Clear Status) common command. The error queue holds A maximum of 15 entries. If more than 15 errors occur, only the first 15 errors are kept in the queue. A 16th entry in the queue is always an "error queue overflow" error, and all new errors are discarded until part of the queue is read. The first errors are kept, because if many errors occur before the user can acknowledge and read them, the first errors are most likely to point to the problem. The newest errors are usually repetitions or consequences of the initial problem.

11. Input Buffer Operation

As the Product gets each data byte from the controller, it puts the byte in a part of memory named the input buffer. The input buffer holds a maximum of 250 data bytes and operates in a first in, first out procedure.

IEEE-488 interface:

The Product works with the IEEE-488 EOI control line as an isolated data byte and puts it into the input buffer if it is found as part of a message terminator. Input buffer operation is transparent to the program on the controller. If the controller sends commands faster than the Product can do them, the input buffer fills to capacity. When the input buffer is full, the Product holds off the IEEE-488 bus with the NRFD (Not Ready For Data) handshake line. When the Product has processed a data byte from the full input buffer, it then completes the handshake. This lets the controller send a different data byte. The calibrator clears the input buffer on power-up and when receiving the DCL (Device Clear) or SDC (Selected Device Clear) message from the controller.

RS-232 interface:

The Product uses the RS-232-C Xon/Xoff protocol to control buffer overflow. The Product sends a Xoff (Ctrl S) character when the input buffer becomes 80 % full, and sends a Xon (Ctrl Q) character when it has processed a sufficient part of the input buffer so that it is less than 40 % full

# Chapter 6 Remote Commands

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# Introduction

Remote commands duplicate actions that can be started from the front panel in local operation mode. After the summary table is a complete alphabetical list of all commands complete with protocol information. Headings in the alphabetical list give the parameters and responses, plus an example for each command. For information on how to use the commands, see Chapter 5.

# **Command Summary by Function**

See the subsequent tables for command summary function information.

Command	Description		
*CLS	Clear status. Clears the ESR, the error queue, and the RQS bit in the status byte. This command stops all pending operation complete commands, *OPC or *OPC?.		
*ESE	Puts a byte into the Event Status Enable register.		
*ESE?	Shows the contents of the Event Status Enable register.		
*ESR?	Shows the contents of the Event Status register and clears the register.		
*IDN?	Identification query. Shows the manufacturer, model number, serial number, and firmware revision level of the Calibrator.		
*OPC	Sets bit 0 (OPC for Operation Complete) in the Event Status Register to 1 when all pending device operations are complete.		
*OPC?	Shows a 1 after all subsequent operations are complete. This command causes program execution to pause until all operations are complete. See also the *WAI command.		
*OPT?	Shows a list of the installed hardware and software options.		
*RST	Resets the condition of the instrument to the power-up condition. This command holds off execution of subsequent commands until it is complete.		
*SRE	Puts a byte into the Service Request Enable register (SRE).		
*SRE?	Shows the byte from the Service Request Enable register.		
*STB?	Shows the status byte.		
*TST?	Does a series of self-tests and shows a "0" for pass or a "1" for fail. If faults are found, they are put into the fault queue where they can be read by the FAULT? query.		
*WAI	Stops subsequent remote commands from execution until all remote commands from before are complete.		

#### Table 6-1. Common Commands

Table 6-2.	External	Connection	Commands
------------	----------	------------	----------

Command	Description
FUNC?	Shows the current output, measurement, or calibration function selected on the isolated and primary displays, in that sequence.
HART?	Shows the HART resistor setting for the isolated milliamp range, ON or OFF.
HART_OFF	Turns off the HART resistor on the isolated milliamp range.
HART_ON	Turns on the HART resistor on the isolated milliamp range.
ISO_PRES_UNIT	Sets the isolated display pressure units.
ISO_PRES_UNIT?	Shows the isolated display pressure units.
LOOP_POWER?	Shows the 24V loop power setting for the isolated milliamp range, ON or OFF.
LOOP_POWER_OFF	Turns off the 24V loop power on the isolated milliamp range.
LOOP_POWER _ON	Turns on the 24V loop power on the isolated milliamp range.
PRES_UNIT	Sets the primary display pressure units.
PRES_UNIT?	Shows the primary display pressure units.
RTD_TYPE	Sets the Resistance Temperature Detector (RTD) type.
RTD_TYPE?	Shows the Resistance Temperature Detector (RTD) type.
TC_REF	Selects the internal temperature sensor or an external reference value for cold junction compensation of thermocouple (TC) source and measurement.
TC_REF?	Shows the source of the temperature that is used for cold junction compensation of thermocouple (TC) source and measurement.
TC_TYPE	Sets the thermocouple (TC) type.
TC_TYPE?	Shows the thermocouple (TC) type.
TSENS_TYPE	Sets temperature mode, RTD or TC.
TSENS_TYPE?	Shows the temperature mode.

### Table 6-3. Output Commands

Command	Description
OPER	Starts the Calibrator output if it is in standby mode.
OPER?	Shows the operate/standby mode setting.
OUT	Sets the output of the Calibrator.
OUT?	Shows the current output value of the Calibrator.
RANGE?	Shows the current output range, for voltage and current only.
RANGELCK	Locks the current output range, for voltage only.
RANGELCK?	Shows the RANGELOCK condition, for voltage only.
STBY	Stops the Calibrator output if it is in operate mode.

Command	Description
ISO_MEAS	Sets the isolated input measurement type.
PRES?	Queries the connected pressure module for its manufacturer and serial number.
PRES_MEAS	Changes the operation mode of the primary display to pressure measurement.
RTD_MEAS	Changes the operation mode to RTD measurement.
ST_START	Puts the Calibrator in switch test mode and/or starts a new switch test.
ST_CLOSE?	Shows the value at which the switch closed.
ST_OPEN?	Shows the value at which the switch opened.
ST_DEAD?	Shows the value of the dead band of the switch.
TC_MEAS	Changes the operation mode to thermocouple measurement.
VAL?	Shows the last values for the isolated and primary measurements, in that order.
ZERO_MEAS	Zeros the pressure module, TC mV, or RTD ohms.
ZERO_MEAS?	Shows the zero offset for the pressure module, TC mV, or RTD ohms.

### Table 6-4. Measurement Commands

## Table 6-5. RS-232 Operation Mode Commands

Command	Description
LOCAL	Puts the Calibrator into the local condition and disables lockout.
LOCKOUT	Puts the Calibrator into the lockout condition. This command duplicates the IEEE-488 LLO (Local Lockout) message.
REMOTE	Puts the Calibrator into the remote condition. This command duplicates the IEEE-488 REN (Remote Enable) message.

#### Table 6-6. Status Commands

Command	Description
FAULT?	Shows the most recent error code in the Calibrator error queue, and then removes that error code from the queue.

# **Error Code List**

Table 6-7 is list of error codes for the Product.

#### Table 6-7. Error Code List

Error Number	Message Class	Description	
1	DDE	Error queue overflow.	
100	EXE	OPER or STBY was received when the Calibrator is in measure mode or thermocouple source mode.	
101	CME	A non-numeric entry was received in a field that must contain a numeric entry.	
102	EXE	The numeric field is more than 10 characters.	
103	CME	incorrect units name or prefix.	
104	EXE	An attempt to go into RTD source mode was made when SPRT is selected, or to select SPRT when RTD source mode is selected.	
105	EXE	Entry is above top limit for the selected output range.	
106	EXE	Entry is below lower limit for the selected output range.	
108	CME	A necessary command parameter was missing.	
109	CME	An incorrect TC_MEAS or RTD_MEAS unit parameter (not CEL or FAR) was received, or an incorrect PRES_UNIT or ISO_PRES_UNIT parameter was received.	
110	CME	An incorrect RANGELCK parameter was received.	
111	EXE	RANGELCK ON was received when the Calibrator is not in Volts mode.	
112	CME	An incorrect RTD_TYPE parameter was received.	
113	CME	An incorrect TC_REF parameter was received.	
114	CME	An incorrect TSENS_TYPE parameter was received.	
116	EXE	No pressure module was present when a pressure function was requested, or the total zero offset from calibration is more than 6%. This error can also occur if the total zero offset from calibration is out of limits when zeroing the thermocouple millivolts type (maximum offset $\pm 1$ mV), or the RTD ohms type (maximum $\pm 0.1$ ohm on high range, or $\pm 0.01$ ohm on the low range).	
117	CME	An unrecognizable command was received.	

Error Number	Message Class	Description
118	CME	An incorrect parameter was received.
120	EXE	The serial input buffer overflowed.
121	EXE	The command string buffer overflowed.
122	QYE	The serial output buffer overflowed.
123	DDE	The output overloaded. See display error message OVER LOAD in Chapter 1.
124	DDE	The Calibrator is out of tolerance. This error is set after a failed initialization or a failed *TST? command.
125	DDE	The Calibrator ADC has failed. This error is set after a failed initialization or a failed *TST? command.

#### Table 6-7. Error Code List (cont.)

## **Remote Command List**

An alphabetical list of all Calibrator remote commands and queries is shown below. This list includes common commands and the device-dependent commands. Each command title includes a checkbox that shows the remote interface applicability, IEEE-488 and/or RS-232, and the command group, Sequential or Overlapped. See the "Types of Commands" section of Chapter 5 for a description of these terms.

*CLS	× IEEE-488	X RS-232	X Sequential	Overlapped

Clear Status command. This command clears the ESR, the error queue, and the RQS bit in the status byte. This command stops pending operation complete commands, \*OPC or \*OPC?.

Parameter:	<none></none>
Response:	<none></none>
Example:	*CLS
	This example clears the ESR, the error queue, and the RQS bit in the status byte.

\*ESE X IEEE-488 X RS-232 X Sequential Overlapped

Event Status Enable command. This command puts a byte into the Event Status

Enable (ESE) register. See the Event Status Enable Register (ESE) description in the "Check Product Status" section of Chapter 5.

Parameter:	<value></value>
	where <value> is the decimal equivalent of the ESE byte, 0 to 255</value>
Response:	<none></none>
Example:	*ESE 140
	This example loads decimal 140 (binary 10001100) to enable bits 7 (PON), 3 (DDE) and 2 (QYE).

* ESE?	🗴 IEEE-488 🗴 RS-232 🗴 Sequential 🗌 Overlapped
Event Status Enable query (ESE) register. See the Ev Product Status" section of	This command shows the contents of the Event Status Enable ent Status Enable Register (ESE) description in the "Check Chapter 5.
Parameter:	<none></none>
Response:	<value></value>
	where <value> is the decimal equivalent of the ESE byte, 0 to 255</value>
Example:	*ESE?
	133
	This example shows decimal 133 (binary 10000101) which shows that bits 7 (PON), 2 (QYE), 1 (OPC) are enabled.
* ESR?	⊠ IEEE-488 ⊠ RS-232 ⊠ Sequential □ Overlapped
* ESR? Event Status Register quer Register (ESR) and clears Product Status" section of	<ul> <li>✓ IEEE-488 X RS-232 X Sequential Overlapped</li> <li>Y. This command shows the contents of the Event Status the register. See the Event Status Register (ESR) in the "Check Chapter 5.</li> </ul>
* ESR? Event Status Register quer Register (ESR) and clears Product Status" section of Parameter:	<ul> <li>✓ IEEE-488 X RS-232 X Sequential Overlapped</li> <li>This command shows the contents of the Event Status the register. See the Event Status Register (ESR) in the "Check Chapter 5.</li> <li><none></none></li> </ul>
* ESR? Event Status Register quer Register (ESR) and clears Product Status" section of Parameter: Response:	▼ IEEE-488 ▼ RS-232 ▼ Sequential ○ Overlapped This command shows the contents of the Event Status the register. See the Event Status Register (ESR) in the "Check Chapter 5. <none> <value></value></none>
* ESR? Event Status Register quer Register (ESR) and clears Product Status" section of Parameter: Response:	▼ IEEE-488 ▼ RS-232 ▼ Sequential ○ Overlapped This command shows the contents of the Event Status the register. See the Event Status Register (ESR) in the "Check Chapter 5. <none> <value> where <value> is the decimal equivalent of the ESR byte, 0 to 255</value></value></none>
* ESR? Event Status Register quer Register (ESR) and clears Product Status" section of Parameter: Response: Example:	▼ IEEE-488 ▼ RS-232 ▼ Sequential ○ Overlapped y. This command shows the contents of the Event Status the register. See the Event Status Register (ESR) in the "Check Chapter 5. <none> <value> where <value> is the decimal equivalent of the ESR byte, 0 to 255 *ESR?</value></value></none>
* ESR? Event Status Register quer Register (ESR) and clears Product Status" section of Parameter: Response: Example:	<ul> <li>IEEE-488 RS-232 Sequential Overlapped</li> <li>This command shows the contents of the Event Status the register. See the Event Status Register (ESR) in the "Check Chapter 5.</li> <li><none></none></li> <li><value></value></li> <li>where <value> is the decimal equivalent of the ESR byte, 0 to 255</value></li> <li>*ESR?</li> <li>61</li> </ul>

## FAULT? X IEEE-488 X RS-232 X Sequential Overlapped

This command shows the most recent error code from the error queue. If the queue is empty (no errors have occurred) it shows 0. The command is typically used to verify that the prior command did what it was intended to do.

Parameter:	<none></none>
Response:	<value></value>
	where <value> is one of the error codes documented in Chapter 6.</value>
Example:	FAULT?
	105
	This example shows the error code which will occur if the prior command tried to set a value more than 100 mA for current output. The error code 105 is an indications that the value was above the maximum limit for the selected output range.

## FUNC?

X IEEE-488 X RS-232 X Sequential Overlapped

This command shows the current output, measurement, or calibration function for the primary and isolated displays.

Parameter:	<none></none>	
Response:	<isolated>,<primary< td=""><td>/&gt;</td></primary<></isolated>	/>
	where <isolated> is</isolated>	one of the following:
	DC10V	measure DC voltage, 10V range
	DC100V	measure DC voltage, 100V range
	DCI	measure DC current
	PRESSURE	measure pressure
	and where <primary< td=""><td>&gt; is one of the following:</td></primary<>	> is one of the following:
	DCV	source DC voltage
	DCI	source DC current
	RTD_OUT	source RTD/Ohms
	RTD_IN	measure RTD/Ohms
	TC_OUT	source thermocouple
	TC_IN	measure thermocouple
	PRESSURE	measure pressure
Example:	FUNC?	
	DC10V,PRESSURI	Ξ
	This example is an i	ndication that the isolated display is

This example is an indication that the isolated display is selected to the 10V range and the primary display is selected to pressure.

HART?	X IEEE-488 X RS-232 X Sequential □ Overlapped
This command shows the	isolated DC current input HART resistor status.
Parameter:	<none></none>
Response:	<value></value>
	where <value> is ON or OFF</value>
Example:	HART?
	OFF
	This example is an indication that the isolated DC current input HART resistor is turned off.
HART_OFF	⊠ IEEE-488 ⊠ RS-232 ⊠ Sequential □ Overlapped
This command disables th	e isolated DC current input HART resistor.
Parameter:	<none></none>
Response:	<none></none>
Example:	HART_OFF
	This example disables the isolated DC current input HART resistor.
HART_ON	⊠ IEEE-488 ⊠ RS-232 ⊠ Sequential □ Overlapped
This command enables the	e isolated DC current input HART resistor.
Parameter:	<none></none>
Response:	<none></none>
Example:	HART_ON
	This example enables the isolated DC current input HART resistor.

*IDN?	🛛 IEEE-488 🖾 RS-232 🖾 Sequential 🗌 Overlapped
This command shows the serial number, and firmwa	unit identification: instrument manufacturer, model number, are revision level.
Parameter:	<none></none>
Response:	<text string=""></text>
	where <text string=""> contains the subsequent four fields separated by commas:</text>
	1. Manufacturer
	2. Model number
	3. Serial number (always 0)
	4. Firmware revision level
Example:	*IDN?
	FLUKE, Calibrator,0,1.2
	This example is an indication the manufacturer is Fluke, the model is Calibrator, the serial number is 0, and the firmware version is 1.2.
	X IFEE 488 X PS-232 Sequential X Overlapped
ISO_MEAS	
<b>ISO_MEAS</b> This command sets the iso	blated measurement type.
<b>ISO_MEAS</b> This command sets the iso Parameter:	olated measurement type.
<b>ISO_MEAS</b> This command sets the ise Parameter:	<pre>olated measurement type.     </pre> <pre>value&gt;     where <value> is one of these:</value></pre>
<b>ISO_MEAS</b> This command sets the ise Parameter:	<pre>oblated measurement type. <value> where <value> is one of these: DC10V measure DC voltage, 10V range</value></value></pre>
<b>ISO_MEAS</b> This command sets the iso Parameter:	olated measurement type. <value>         where <value> is one of these:         DC10V       measure DC voltage, 10V range         DC100V       measure DC voltage, 100V range</value></value>
ISO_MEAS This command sets the ise Parameter:	Image: Sector is included measurement type. <value>         where <value> is one of these:         DC10V       measure DC voltage, 10V range         DC100V       measure DC voltage, 100V range         DCI       measure DC current</value></value>
ISO_MEAS This command sets the ise Parameter:	cvalue>         where <value> is one of these:         DC10V       measure DC voltage, 10V range         DC10V       measure DC voltage, 100V range         DCI       measure DC current         PRESSURE       measure pressure</value>
ISO_MEAS This command sets the ise Parameter: Response:	cvalue>         where <value> is one of these:         DC10V       measure DC voltage, 10V range         DC10V       measure DC voltage, 100V range         DC1       measure DC current         PRESSURE       measure pressure         <none></none></value>
ISO_MEAS This command sets the iso Parameter: Response: Example:	cvalue>         vvalue>         where <value> is one of these:         DC10V       measure DC voltage, 10V range         DC100V       measure DC voltage, 100V range         DC1       measure DC current         PRESSURE       measure pressure         <none>       ISO_MEAS DCI</none></value>

ISO\_PRES\_UNITIEEE-488 IRS-232SequentialOverlappedThis command sets the isolated pressure unit.Parameter:<value> where <value> is one of these:

		PSI	pounds per square inch
		INH2O4C	inches of water at 4 °C
		INH2O20C	inches of water at 20 °C
		INH2O60F	inches of water at 60 °F
		CMH2O4C	centimeters of water at 4 °C
		CMH2O20C	centimeters of water at 20 °C
		MMH2O4C	millimeters of water at 4 °C
		MMH2O20C	millimeters of water at 20 °C
		BAR	bars
		MBAR	millibars
		KPA	kilopascals
		MPA	megapascals
		INHG	inches of mercury at 0 °C
		MMHG	millimeters of mercury at 0 °C
		KG/CM2	kilograms per square centimeter
Response:	<nc< td=""><td>one&gt;</td><td></td></nc<>	one>	
Example:	ISO	_PRES_UNIT B	AR
	This	s example sets th	e isolated pressure unit to bars.

ISO\_PRES\_UNIT?

This command shows the isolated pressure unit.

<None> Parameter:

Response: <value>

where <value> is one of these:

		PSI	pounds per square inch
		INH2O4C	inches of water at 4 °C
		INH2O20C	inches of water at 20 °C
		INH2O60F	inches of water at 60 °F
		CMH2O4C	centimeters of water at 4 °C
		CMH2O20C	centimeters of water at 20 °C
		MMH2O4C	millimeters of water at 4 °C
		MMH2O20C	millimeters of water at 20 °C
		BAR	bars
		MBAR	millibars
		KPA	kilopascals
		MPA	megapascals
		INHG	inches of mercury at 0 °C
		MMHG	millimeters of mercury at 0 °C
		KG/CM2	kilograms per square centimeter
Example:	ISO	PRES_UNIT?	
	BAF	R	
	This bars	example is an in	ndication that the isolated pressure unit is
LOCAL		IEEE-488 🗵 F	RS-232 🗵 Sequential 🔲 Overlapped
This command puts the Ca (see the REMOTE comma command). It duplicates th	librat nd) ai e con	or into the local nd the front pane dition of when t	condition, clearing the remote condition el lockout condition (see the LOCKOUT he IEEE-488 REN line to false.
Darameter:	<no< td=""><td>ne&gt;</td><td></td></no<>	ne>	

Parameter:	<none></none>
Response:	<none></none>
Example:	LOCAL
	This example puts the instrument into the local condition, clearing the remote condition and front panel lockout condition, if enabled.

LOCKOUT	□ IEEE-488 X RS-232 X Sequential □ Overlapped
This command puts the C the REMOTE command). panel. This includes the L command. This command	alibrator into the lockout condition when in remote control (see In this condition, no local operation is permitted at the front OCAL key. To clear the lockout condition, use the LOCAL duplicates the IEEE-488 LLO (Local Lockout) message.
Parameter:	<none></none>
Response:	<none></none>
Example:	LOCKOUT
	This example puts the instrument into the lockout condition. No front panel controls can be used.
LOOP_POWER?	🗴 IEEE-488 🗴 RS-232 🛛 Sequential 🗌 Overlapped
This command shows the	isolated DC current input 24V loop power status.
Parameter:	<none></none>
Response:	<value></value>
	where <value> is ON or OFF</value>
Example:	LOOP_POWER?
	OFF
	This example is an indication that the isolated DC current input 24V loop power is turned off.
LOOP_POWER_OFF	🗵 IEEE-488 🗵 RS-232 🛛 Sequential 🗌 Overlapped
This command disables the	ne isolated DC current input 24V loop power.
Parameter:	<none></none>
Response:	<none></none>
Example:	LOOP_POWER_OFF
	This example disables the isolated DC current input 24V loop power.
LOOP_POWER_ON	X IEEE-488 X RS-232 X Sequential ☐ Overlapped
LOOP_POWER_ON This command enables th	IEEE-488       Image: RS-232       Image: Sequential       Overlapped         e isolated DC current input 24V loop power.
LOOP_POWER_ON This command enables th Parameter:	IEEE-488 IN RS-232 IN Sequential Overlapped e isolated DC current input 24V loop power.
LOOP_POWER_ON This command enables th Parameter: Response:	▼ IEEE-488 ▼ RS-232 ▼ Sequential ○ Overlapped e isolated DC current input 24V loop power. <none></none>
LOOP_POWER_ON This command enables th Parameter: Response: Example:	★ IEEE-488 ★ RS-232 ★ Sequential Overlapped e isolated DC current input 24V loop power. <none> <none> LOOP_POWER_ON</none></none>

*OPC	X IEEE-488 X RS-232 X Sequential Overlapped
Operations Complete comm Register to 1 when all pend command.	nand. This command sets bit 0 (OPC) of the Event Status ling device operations are complete. Also see the *ESR?
Parameter:	<none></none>
Response:	<none></none>
Example:	*OPC
	This example sets bit 0 of the Event Status Register to 1 when all pending device operations are done.
*OPC?	X IEEE-488 X RS-232 X Sequential Overlapped
Operations Complete query operations are complete. T operations are complete, an operations are complete. A	y. This command shows a 1 after all pending Calibrator his command does not answer until all pending Calibrator nd causes the control program execution to pause until lso see the *WAI command.
Parameter:	<none></none>
Response:	1
Example:	*OPC?
	1
	This example does not answer until all pending Calibrator operations are complete, and then shows 1.
OPER	⊠ IEEE-488 ⊠ RS-232 □ Sequential ⊠ Overlapped
This command puts the Ca terminals. This command c standby mode.	librator in operate mode and start the output at the front panel loes the same as if you push the front panel key when in
Parameter:	<none></none>
Response:	<none></none>
Example:	OPER
	This example connects the selected output to the Calibrator front panel terminals. It also shows Opr on the display.

OPER?	🗵 IEEE-488 🗵 RS-232 🛛 Sequential 🗌 Overlapped
This command shows the o	current operate/standby mode setting.
Parameter:	<none></none>
Response:	<value></value>
	where <value> is "1" for operate mode and "0" for standby mode</value>
Example:	OPER?
	1
	This example is an indication that the Calibrator is in operate mode.
*OPT?	X IEEE-488 X RS-232 X Sequential Overlapped
<b>*OPT?</b> This command shows a lis command is reserved for fi	■ IEEE-488 ■ RS-232 ■ Sequential ■ Overlapped t of the installed hardware and software options. This ature use.
<b>*OPT?</b> This command shows a lis command is reserved for fr Parameter:	■ IEEE-488 ■ RS-232 ■ Sequential ■ Overlapped t of the installed hardware and software options. This uture use. <none></none>
* <b>OPT?</b> This command shows a lis command is reserved for fr Parameter: Response:	▼ IEEE-488 ▼ RS-232 ▼ Sequential ○ Overlapped t of the installed hardware and software options. This uture use. <none> <text string=""></text></none>
* <b>OPT?</b> This command shows a lis command is reserved for fr Parameter: Response:	★ IEEE-488 ★ RS-232 ★ Sequential Overlapped t of the installed hardware and software options. This uture use. <none> <text string=""> where <text string=""> is "0" if no options are installed, or a list of installed options separated by commas</text></text></none>
* <b>OPT?</b> This command shows a lis command is reserved for for Parameter: Response: Example:	★ IEEE-488 ★ RS-232 ★ Sequential Overlapped t of the installed hardware and software options. This uture use. <none> <text string=""> where <text string=""> is "0" if no options are installed, or a list of installed options separated by commas *OPT?</text></text></none>
* <b>OPT?</b> This command shows a lis command is reserved for for Parameter: Response: Example:	★ IEEE-488 ★ RS-232 ★ Sequential Overlapped t of the installed hardware and software options. This uture use. <none> <text string=""> where <text string=""> is "0" if no options are installed, or a list of installed options separated by commas *OPT? 0</text></text></none>

OUT X IEEE-488 X RS-232 Sequential X Overlapped

This command sets the output mode and value of the Calibrator. To source a temperature, select the necessary mode and sensor parameters first with the TSENS\_TYPE, RTD\_TYPE, and TC\_TYPE commands. Use the multiplier prefixes k for kilo, m for milli, and u for micro with the OUT command units, as necessary. The unit can be ignored if the output mode is not to be changed.

Parameter:	<value> <units></units></value>	
	where <value> is the output value to be made and where <units> is one of the items below, with a possible prefix multiplier (k, m, or u) as given above:</units></value>	
	V	DC volts
	А	DC current
	OHM	Resistance
	CEL	Temperature in Celsius
	FAR	Temperature in Fahrenheit
Response:	<none></none>	
Examples:		Explanation
	OUT 15.2 V	Change to DC volts, output 15.2 V
	OUT 1.2 mA	Change to DC current, output 1.2 mA, note units prefix multiplier m
	OUT 5 Ohm	Change to Resistance, output 5 O
	OUT 100 CEL	Change to temperature in °C, output 100 °C
	OUT 3	No change to output mode, output a value of 3 in the current units

OUT?	X IEEE-488 X	RS-232 🛛 Sequential 🗌 Overlapped		
This command shows the current output value and units of the Calibrator.				
Parameter:	<none></none>			
Response:	<value>,<units></units></value>			
	where <value> is the current output value and where <units> is one of these:</units></value>			
	V	DC volts		
	А	DC current		
	OHM	Resistance		
	CEL	Temperature in Celsius		
	FAR	Temperature in Fahrenheit		
Examples:		Explanation		
	OUT?			
	1.88300E-02,A Current output is 18.83 mA			
	OUT?			
	1.23000E+00,V Current output is 1.23 V			
	OUT?			
	4.00000E+03,OHM	Current output is 4.0 KO		
	OUT?			
	1.0430E+02,CEL	Current output is 104.3 °C		

## PRES?

This command queries the connected pressure module for its manufacturer, serial number, and firmware version.

X Sequential Overlapped

X IEEE-488 X RS-232

<none></none>		
<text string=""></text>		
where <text string=""> contains the subsequent three fields isolated by commas:</text>		
1. Manufacturer		
2. Serial number		
3. Firmware revision level (always 0)		
PRES?		
FLUKE,610070,0		
This example is an indication that the manufacturer is Fluke, the serial number is 610070, and the firmware version is 0.		
PRES_MEAS	IEEE-488 I RS-232 I Sequential I Overlapped X IEEE-488 I RS-232 I Sequential I Seq	
-------------------------------------	---	
This command changes the Parameter:	e primary display operation mode to pressure measurement. <none></none>	
Response:	<none></none>	
Example:	PRES_MEAS	
	This example changes the primary display operation mode to pressure measurement.	
PRES_UNIT	⊠ IEEE-488 ⊠ RS-232 □ Sequential ⊠ Overlapped	

This command sets the primary display pressure units.

<value>

	where <value> is one of these:</value>			
	PSI	pounds per square inch		
	INH2O4C	inches of water at 4 °C		
	INH2O20C	inches of water at 20 °C		
	INH2O60F	inches of water at 60 °F		
	CMH2O4C centimeters of water at 4 °C			
	CMH2O20Ccentimeters of water at 20 °CMMH2O4Cmillimeters of water at 4 °C			
	MMH2O20C	millimeters of water at 20 °C BAR bars		
	MBAR	millibars		
	KPA	kilopascals		
	MPA megapascals			
	INHG	inches of mercury at 0 °C		
	MMHG	millimeters of mercury at 0 °C		
	KG/CM2	kilograms per square centimeter		
Response:	<none></none>			
Example:	PRES_UNIT BAR			
	This example sets th	e primary display pressure units to bars.		

PRES_UNIT?	X IEEE-488 X F	RS-232 🗵 Sequential 🗌 Overlapped			
This command shows the primary display pressure units.					
Parameter:	<none></none>				
Response:	<value></value>				
	where <value> is on</value>	e of these:			
	PSI	pounds per square inch			
	INH2O4C	inches of water at 4 °C			
	INH2O20C	inches of water at 20 °C			
	INH2O60F	inches of water at 60 °F			
	CMH2O4C	centimeters of water at 4 °C			
	CMH2O20C centimeters of water at 20 °C				
	MMH2O4C millimeters of water at 4 °C				
	MMH2O20Cmillimeters of water at 20 °CBARbarsMBARmillibars				
	kilopascals				
	MPA	megapascals			
	INHG inches of mercury at 0				
	MMHG	millimeters of mercury at 0 °C			
	KG/CM2	kilograms per square centimeter			
Example:	PRES_UNIT?				
	BAR				
This example shows that the primary pressure display us are bars.					

RANGE?	X IEEE-488 X	RS-232 🛛 Sequential 🗌 Overlapped			
This command shows the current DC voltage or current output range.					
Parameter:	<none></none>				
Response:	<value></value>				
	where <value> is or</value>	ne of these:			
	V_0.1V	DC volts, 100 mV range			
	V_1V	DC volts, 1V range			
	V_10V	DC volts, 10 V range			
	V_100V	DC volts, 100 V range			
	A_0.1A	DC current			
	NONE	neither volts nor current is selected			
Example:	RANGE?				
	V_10V				
	This example is an indication that the current output range is 10 V.				
RANGELCK	X IEEE-488 X	RS-232 🛛 Sequential 🗌 Overlapped			
This command locks or unlocks the DC voltage output range in reference to the current output value.					
Parameter:	<value></value>				
	where <value> is one of these:</value>				
	ON	to lock the current voltage range			
	OFF	to unlock the current voltage range			
Response:	<none></none>				
Example:	RANGELCK ON				
	If the ourrent DC w	$\mathbf{v}$			

RANGELCK?	× IEEE-488	× RS-232	X Sequential	Overlapped	
This command shows the DC voltage range lock status.					
Parameter:	<none></none>				
Response:	<value></value>				
	where <value></value>	is one of the	se:		
	ON	DC vo	ltage range lock	is on	
	OFF	DC vo	ltage range lock	is off	
Example:	RANGELCK?				
OFF					
	This example is an indication that the range lock is off.				
REMOTE	EEE-488	X RS-232	X Sequential	Overlapped	
This command puts the Calibrator into the remote condition. It duplicates the IEEE-488 REN (Remote Enable) message. When the Calibrator is in the remote condition, but not locked out, only the LOCAL key is active. If the front panel is also locked out, no front panel keys are active. See the LOCKOUT command. To unlock the front panel, use the LOCAL command, or push the Calibrator power switch.					
Parameter:	<none></none>				
Response:	<none></none>				
Example:	REMOTE				
	This example p	places the Cal	ibrator into the r	emote condition.	

## \*RST X IEEE-488 X RS-232 Sequential X Overlapped

This command resets the Calibrator to the power-up condition and holds off execution of subsequent commands until the reset operation is complete.

A reset action invokes the subsequent commands and values for the primary display:

	<u>Command</u>	Value		
	OUT	0 V		
	PRES_UNIT	Last selected		
	RANGE	0.1 V		
	RTD_TYPE	Last selected		
	STBY	(No output)		
	TC_REF	INT		
	TC_TYPE	Last selected		
	TSENS_TYPE	Last selected		
The isolated display and se	elections stay as they w	vere last selected.		
Parameter:	<none></none>			
Response:	<none></none>			
Example:	*RST			
	This example resets and values shown ab	the Calibrator, invoking the commands ove.		
RTD_MEAS	X IEEE-488 X R	S-232 🗵 Sequential 🗌 Overlapped		
This command puts the pri	mary display in RTD	measure mode.		
Parameter:	<value></value>			
	where <value> is one of the these:</value>			
	CEL	display in degrees Celsius		
	FAR	display in degrees Fahrenheit		
	<none></none>	display in the last selected temperature unit		
Response:	<none></none>			
Example:	RTD_MEAS CEL			
This example puts the Calibrator to RTD measure mode a shows in degrees Celsius.				

## RTD\_TYPE X IEEE-488 X RS-232 Sequential X Overlapped

This command sets the Resistance Temperature Detector (RTD) sensor type for RTD source and measure. Typically, before you use the RTD\_TYPE command to select the RTD type, use the TSENS\_TYPE command to select RTD mode, and afterwards set the output temperature with the OUT command, if applicable. A change in temperature sensors sets the output to 0 °C. Note that the SPRT can only be used to measure signals, not source them.

Parameters:

<value>

where <value> is one of the these:

	PT385_100	100-ohm RTD, curve a=0.00385 ohms/ohm/°C	
	PT385_200	200-ohm RTD, curve a=0.00385 ohms/ohm/°C	
	PT385_500	500-ohm RTD, curve a=0.00385 ohms/ohm/°C	
	PT385_1000	1000-ohm RTD, curve a=0.00385 ohms/ohm/°C	
	PT392_100	100-ohm RTD, curve a=0.003926 ohms/ohm/°C	
	PTJIS_100	100-ohm RTD, curve a=0.003916 ohms/ohm/°C	
	CU10	10-ohm RTD, empirical curve	
	NI120	120-ohm RTD, empirical curve	
	YSI_400	YSI thermistor curve	
	OHMS_HIGH	4000 ohms range	
	OHMS_LOW	400 ohms range	
	SPRT	standard PRT with user defined error coefficients, only available for measurement	
	USR_DEF <x></x>	RTD with user defined custom coefficients, where x is the curve number and ranges from 1 to 5, i.e. USR_DEF2 for curve 2	
Response:	<none></none>		
Example:	RTD_TYPE PTJIS_100		
	This example puts the RTD sensor to a 100-ohm type, with the PT3916 curve (a= $0.003916$ ohms/ohm/°C). The resistance of 100 ohms refers to the ice point property, the resistance of the RTD at 0 °C (32 °F).		

RTD\_TYPE? X IEEE-488 X RS-232 X Sequential Overlapped

This command shows the Resistance Temperature Detector (RTD) sensor type that is in operation for RTD temperature source and measurement.

Parameter:	<none></none>			
Response:	<value></value>			
	where <value> is one of these:</value>			
	PT385_100	100-ohm RTD, curve a=0.00385 ohms/ohm/°C		
	PT385_200	200-ohm RTD, curve a=0.00385 ohms/ohm/°C		
	PT385_500	500-ohm RTD, curve a=0.00385 ohms/ohm/°C		
	PT385_1000	1000-ohm RTD, curve a=0.00385 ohms/ohm/°C		
	PT392_100	100-ohm RTD, curve a=0.003926 ohms/ohm/°C		
	PTJIS_100	100-ohm RTD, curve a=0.003916 ohms/ohm/°C		
	CU10	10-ohm RTD, empirical curve		
	NI120	120-ohm RTD, empirical curve		
	YSI_400	YSI thermistor curve		
	OHMS_HIGH	4000 ohms range		
	OHMS_LOW	400 ohms range		
	SPRT	standard PRT with user-specified error coefficients, only available for measurement		
	USR_DEF <x></x>	RTD with user-specified custom coefficients, where x is the curve number and ranges from 1 to 5, i.e. USR_DEF2 for curve 2		
Example:	RTD_TYPE?			
	PTJIS_100			
	This example is an i 100-ohm RTD with	ndication that the RTD sensor type is a curve a=0.3916 ohm/°C.		

*SRE	X IEEE-488 X RS-232 X Sequential Overlapped					
Service Request Enable command. This command puts a byte into the Service Request Enable (SRE) register. See the Service Request Enable Register (SRE) description in the "Check Product Status" section of Chapter 5. Since bit 6 is not used (decimal value 64), the maximum entry is 255 - 64 = 191.						
Parameter:	<value></value>					
	where <value> is the decimal equivalent of the SRE byte, 0 to 191</value>					
Response:	<none></none>					
Example:	*SRE 48					
	This example enables bits 4 (MAV) and 5 (ESB).					
*SRE?	⊠ IEEE-488 ⊠ RS-232 ⊠ Sequential □ Overlapped					
Service Request Enable qu Enable Register (SRE). Se "Check Product Status" se	ery. This command shows the byte in the Service Request e the Service Request Enable Register (SRE) description the ction of Chapter 5.					
Parameter:	<none></none>					
Response:	<value></value>					
	where <value> is the decimal equivalent of the SRE byte, 0 to 191</value>					
Example:	*SRE?					
	48					
	This example is an indication that bits 4 (MAV), and 5 (ESB) are enabled.					
*STB?	⊠ IEEE-488 ⊠ RS-232 ⊠ Sequential □ Overlapped					
Status Byte Register query See the Status Byte Regist Chapter 5.	This command shows the byte in the Status Byte Register. er (STB) description in the "Check Product Status" section of					
Parameter:	<none></none>					
Response:	<value></value>					
	where <value> is the decimal equivalent of the STB byte, 0 to 255</value>					
Example:	* STB?					
	96					
	This example is an indication that bits 5 (ESB) and 6 (MSS) are set.					

STBY	🗴 IEEE-488 🗴 RS-232 🗌 Sequential 🗴 Overlapped
This command puts terminals. This com operate mode.	the Calibrator in standby mode. This stops the output at front panel mand does the same as if you push the front panel key when in
Parameter:	<none></none>
Response:	<none></none>
Example:	STBY
	This example disconnects the selected output from the Calibrator front panel terminals. It also shows Stby on the display.
ST_START	🗴 IEEE-488 🛛 RS-232 🔍 Sequential 🗌 Overlapped
This command puts calibrartor is alread	the Calibrator in switch test mode and starts a new switch test. If the y is switchtest mode it simply starts a new switch test.
Parameter:	<none></none>
Response:	<none></none>
Example:	ST_START

This example puts the calibrator in switch test mode and starts a new switch test

T_CLOSE?	3 🗶 RS-232	X Sequential	Overlapped
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In switch test recall mode this command shows the value at which the switch closed.

Parameter:	<none></none>
Response:	<value>,<units></units></value>
	where <value> is the value recorded from the primary display at the time the switch closed and where <units> are the units recorded from the primary display at the time the test was done.</units></value>
Example:	ST_CLOSE?
	5.00000E+01,CEL
	This example shows the value at which a temperature switch closed in Celsius.

ST_OPEN?	X IEEE-488 X RS-232 X Sequential ☐ Overlapped		
In switch test recall mode, this command shows the value at which the switch opened.			
Parameter:	<none></none>		
Response:	<value>,<units></units></value>		
	where <value> is the value recorded from the primary display at the time the switch opened and where <units> are the units recorded from the primary display at the time the test was done.</units></value>		
Example:	ST_OPEN?		
	5.53000E+01,CEL		
	This example shows the value at which a temperature switch opened in Celsius.		
<b>ST_DEAD?</b> In switch test recall mode	<b>IEEE-488 RS-232 Sequential Overlapped</b> this command shows the dead band of the switch.		
Parameter:	<none></none>		
Response:	<value>,<units></units></value>		
	where <value> is the deadband of the switch. To calculate this, subtract the second recorded contact transition from the first recorded contact transition and where <units> are the units recorded from the primary display at the time the test was done.</units></value>		
Example:	ST DEAD?		
<u>^</u>			
	This example shows the value of the calculated deadband temperature of the switch in Celsius.		

TC_MEAS	X IEEE-48	8 🗴 RS-232	X Sequential	Overlapped
This command places the primary display in thermocouple measure mode.				
Parameter:	<value></value>			
	where <valu< td=""><td>ue&gt; is one of the</td><td>ese:</td><td></td></valu<>	ue> is one of the	ese:	
	CEL	display in degr	rees Celsius	
	FAR	display in degr	rees Fahrenheit	
	<none></none>	display in the	last selected temp	perature unit
Response:	<none></none>			
Example:	TC_MEAS FAR			
	This examp mode, and s	le puts the Calib hows in degrees	prator into thermo s Fahrenheit.	ocouple measure
TC_REF	X IEEE-48	88 🗶 RS-232	Sequential	X Overlapped
This command selects the cold junction compensation	internal temp on of thermoco	erature sensor o ouple source and	or an external refe d measurement.	erence value for
Parameter:	<value></value>			
	where <value> is one of these:</value>			
	INT	use int	ternal temperatur	re sensor

	11N 1	use internal temperature sensor
	EXT	use external reference value
Response:	None	
Example:	TC_REF EXT	
	This example sets the	e thermocouple reference to external.

## TC\_REF? X IEEE-488 X RS-232 X Sequential Overlapped

This command shows the source of the temperature that is used for cold junction compensation of thermocouple source and measurement.

Parameter:	<none></none>	
Response:	<value></value>	
	where <value> is one of these:</value>	
	INT	internal temperature sensor in use
	EXT	external reference value in use
Example:	TC_REF?	
	INT	
	This exampl	le is an indication that the internal sensor is in use.

## TC\_TYPE X IEEE-488 X RS-232 Sequential X Overlapped

This command sets the Thermocouple (TC) sensor type that is used for TC temperature source and measurement. Typically, before you use the TC\_TYPE command to select the TC type, use the TSENS\_TYPE command to select TC mode, and afterwards set the output temperature with the OUT command, if applicable. A change in temperature sensors sets the output to 0  $^{\circ}$ C.

Parameters:

<value>

where <value> is one of these:

	В	B-type thermocouple
	С	C-type thermocouple
	Е	E-type thermocouple
	J	J-type thermocouple
	Κ	K-type thermocouple
	L	L-type thermocouple
	Ν	N-type thermocouple
	R	R-type thermocouple
	S	S-type thermocouple
	Т	T-type thermocouple
	U	U-type thermocouple
	XK	XK-type thermocouple
	BP	BP-type thermocouple
	Z 1 r	mV/°C
Response:	<none></none>	
Example:	TC_TYPE	J
	This examp	ple sets the thermocouple type to J-type.

TC\_TYPE? IEEE-488 X RS-232 X Sequential Overlapped

This command shows the Thermocouple (TC) sensor type that is used for TC temperature source and measurement.

Parameter:

Example:

Response:	
-----------	--

<none></none>	
<value></value>	
where <value> is o</value>	ne of these:
В	B-type thermocouple
С	C-type thermocouple
E	E-type thermocouple
J	J-type thermocouple
K	K-type thermocouple
L	L-type thermocouple
Ν	N-type thermocouple
R	R-type thermocouple
S	S-type thermocouple
Т	T-type thermocouple
U	U-type thermocouple
XK	XK-type thermocouple
BP	BP-type thermocouple
Ζ	1 mV/°C
TC_TYPE?	
Κ	
This example is an	indication that the thermocouple

This example is an indication that the thermocouple sensor type is K-type.

TSENS_TYPE	X IEEE-48	8 🗶 RS-232	Sequential	X Overlapped
This command puts the ter	nperature mo	de to thermoco	uple (TC) or Res	sistance
Temperature Detector (RT	D) for temper	ature source a	nd measurement.	
Parameters:	<value></value>			
	where <valu< td=""><td>e&gt; is one of the</td><td>ese:</td><td></td></valu<>	e> is one of the	ese:	
	TC	Thermocouple	e	
	RTD	Resistance Te	mperature Detec	ctor
Response:	<none></none>			
Example:	TSENS_TYPE RTD			
	This example	e sets the temp	erature mode to	RTD.

TSENS_TYPE?	IEEE-488 I RS-232 I Sequential □ Overlapped			
This command shows the current temperature mode, thermocouple (TC) or Resistance Temperature Detector (RTD).				
Parameter:	<none></none>			
Response:	<value></value>			
	where <value> is one of these:</value>			
	TC Thermocouple			
	RTD Resistance Temperature Detector			
Example:	TSENS_TYPE?			
	TC			
	This example is an indication that the current temperature mode is thermocouple.			
*TST?	X IEEE-488 X RS-232 X Sequential Overlapped			
<b>*TST?</b> This command does a serie faults are found, they are p query.	■ IEEE-488 ■ RS-232 ■ Sequential ■ Overlapped es of self-tests and shows a "0" for pass or a "1" for fail. If out into the fault queue where they can be read by the FAULT?			
<b>*TST?</b> This command does a serie faults are found, they are p query. Parameter:	■ IEEE-488 ■ RS-232 ■ Sequential ■ Overlapped es of self-tests and shows a "0" for pass or a "1" for fail. If out into the fault queue where they can be read by the FAULT? <none></none>			
* <b>TST?</b> This command does a serie faults are found, they are p query. Parameter: Response:	▼ IEEE-488 ▼ RS-232 ▼ Sequential ○ Overlapped es of self-tests and shows a "0" for pass or a "1" for fail. If out into the fault queue where they can be read by the FAULT? <none> <value></value></none>			
* <b>TST?</b> This command does a serie faults are found, they are p query. Parameter: Response:	★ IEEE-488 ★ RS-232 ★ Sequential Overlapped es of self-tests and shows a "0" for pass or a "1" for fail. If out into the fault queue where they can be read by the FAULT? <none> <value> where <value> is one of these:</value></value></none>			
*TST? This command does a serie faults are found, they are p query. Parameter: Response:	▼ IEEE-488       ▼ RS-232       ▼ Sequential       Overlapped         es of self-tests and shows a "0" for pass or a "1" for fail. If out into the fault queue where they can be read by the FAULT? <none> <value>         where <value> is one of these:         0       failed self-test</value></value></none>			
*TST? This command does a serie faults are found, they are p query. Parameter: Response:	IEEE-488 IN RS-232 IN Sequential Overlapped es of self-tests and shows a "0" for pass or a "1" for fail. If out into the fault queue where they can be read by the FAULT?			
*TST? This command does a serie faults are found, they are p query. Parameter: Response: Example:	▼IEEE-488       ▼RS-232       ▼ Sequential       Overlapped         es of self-tests and shows a "0" for pass or a "1" for fail. If out into the fault queue where they can be read by the FAULT? <none> <value>         where <value> is one of these:         0       failed self-test         1       passed self-test         *TST?</value></value></none>			
*TST? This command does a serie faults are found, they are p query. Parameter: Response: Example:	▼IEEE-488       ▼RS-232       ▼ Sequential       Overlapped         es of self-tests and shows a "0" for pass or a "1" for fail. If out into the fault queue where they can be read by the FAULT? <none> <value>         where <value> is one of these:         0       failed self-test         1       passed self-test         *TST?         1</value></value></none>			

VAL? X IEEE-488 X RS-232 X Sequential Overlapped

This command shows the last values for the isolated and primary measurements, in that sequence.

Parameter: <None>

Response:

<iso-value>,<iso-units>,<primary-value>,<primary-units> where <iso-value> is the current isolated measurement expressed in scientific notation.

and where <iso-units> is one of these:

V	DC volts
А	DC current
OVER	measurement is over or under range
or	one of the pressure units listed with the ISO PRES UNIT? command

and where <primary-value> is the current primary measurement expressed in scientific notation.

and where <primary-units> is one of these:

	FAR	°F
	CEL	°C
	OHM	Ohms
	V	DC volts (thermocouple millivolts)
	OVER	measurement is over or under range
	NONE	primary display is currently set to a source mode
	or	one of the pressure units listed with the PRES_UNIT? command
Example:	VAL?	
	2.137000E+00,V,5.	763300E+01,CEL
	This example is an i 2.137 volts and that	ndication that the isolated measurement is the primary measurement is 57.633 °C.

\*WAI This command prevents further remote commands from being executed until all prior remote commands are complete. For example, if you send an OUT command, you can cause the Calibrator to wait until the output has settled before continuing on to the next command if you follow OUT with a \*WAI command. The \*WAI command is useful with all overlapped commands. This prevents the Calibrator from processing other commands until the overlapped command is complete. <None> Parameter: Response: <None> OUT 1.1 V Example: \*WAI **OPER** FAULT? This example demonstrates setting the Calibrator output to 1.1 volts, waiting for the output to become stable before activating the output and checking if the sequence of commands completed successfully.

## ZERO\_MEAS X IEEE-488 X RS-232 X Sequential Overlapped

This command zeros a pressure module, the thermocouple mV offset, or the RTD ohms offset. For more zeroing instructions for RTD ohms, thermocouple millivolts, or pressure, see Chapter 2.

Parameter:	<none> for RTD ohms, thermocouple millivolts, or a pressure module that does not measure absolute pressure</none>
	<value> is barometric pressure for absolute pressure modules, expressed in the currently selected pressure units</value>
Response:	<none></none>
Example:	ZERO_MEAS
	If thermocouple millivolts are currently selected, this example zeros the offset.

ZERO\_MEAS?

This command shows the zero offset for pressure modules, thermocouple millivolts, or RTD ohms.

Parameter:	<none></none>		
Response:	<zero offset="">,<units></units></zero>		
	where < zero offset > is the current offset. and where <units> is one of these:</units>		
	OHM	Ohms	
	V	DC volts (thermocouple millivolts)	
	or	one of the pressure units listed with the PRES_UNIT? command	
Example:	ZERO_MEAS?		
	1.060000E-01,PSI		
	This example is an indication that the pressure zero for the connected module is 0.106 psi.		

# Chapter 7 Maintenance

#### Title

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### Introduction

This chapter tells you how to do the usual maintenance and tasks necessary to keep the Product in service.

## <u>∧</u>∧Warnings

To prevent possible electrical shock, fire, or personal injury:

- Have an approved technician repair the Product.
- Disconnect the mains power cord before you remove the Product covers.
- Do not operate the Product with covers removed or the case open. Hazardous voltage exposure is possible.
- Use only specified replacement parts.

## **Clean the Calibrator**

Clean the Calibrator and pressure modules with a soft cloth dampened with water, or mild soap and water.

## Replace a Line Fuse

The line power fuses and line voltage selector are found in the compartment above the power switch on the right rear side of the Calibrator. See the rear-panel layout in Chapter 1.

Table 7-1 shows the correct replacement fuse for each line voltage setting.

#### Table 7-1. Replacement Fuses

Fuse Description	Line Voltage Setting	
▲ 0.25 A/250 V (SB)	120 V (100 V to 120 V) $\pm$ 10 % about setting	
▲ 0.125 A/250 V (SB)	220 V (198 V to 240 V) $\pm$ 10 % about setting	

 $\underline{\mathbf{M}}$ To ensure safety, use exact replacement only.

To examine or replace a fuse:

- 1. Disconnect the line power.
- 2. Use the blade of a flat screwdriver to pry up the tab at the base of the line fuse compartment. Insert the blade into the center slot under the tab. The compartment cover will come part way out.
- 3. Remove the compartment cover. The fuses come out with the compartment cover and can easily be examined or replaced.
- 4. To install the fuse holder, push the compartment cover back into the compartment until the tab locks in position.

## Change the Line Voltage

The Calibrator comes from the factory configured for the line voltage applicable for the country of purchase, or as specified when it is ordered. To verify the line voltage setting, examine the line voltage indicator on the power line fuse compartment cover.

Make sure that the line voltage selection is set for 120 V for line voltages between 100 V

and 120 V  $\pm$ 10 % about setting, or that the selector is set to 240 V for line voltages between 220 V and 240 V  $\pm$ 10 % about setting.