

**FLUKE**®

**Calibration**

# **5560A/5550A/5540A**

## Calibrator

## Operators Manual

August 2022 Rev. 1, 10/23

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## Introduction

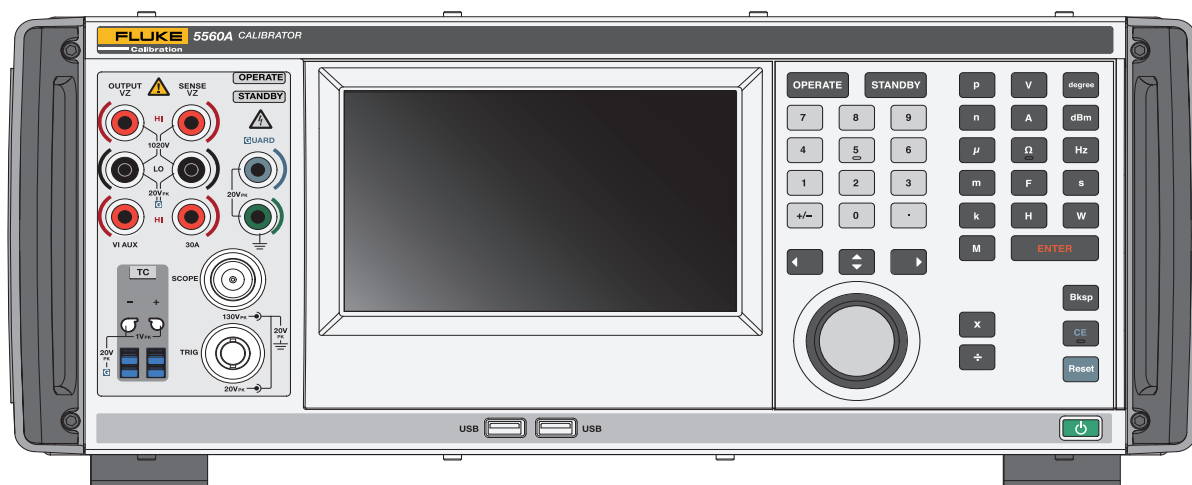
The 5560A/5550A/5540A Calibrators (the Product or the Calibrator) addresses a wide calibration workload that includes 6.5 digit bench Digital Multimeters (DMMs), and comes with internal and external features that protect it against damage and make it easier to transport for on-site or mobile calibration. The Product, shown in Figure 1, can also be fully automated with MET/CAL®.

The Product is a fully-programmable precision source for:

- DC voltage from 0 V to  $\pm 1020$  V
- DC current from 0 A to  $\pm 30.2$  A
- AC voltage from 1 mV to 1020 V
- AC current from 10  $\mu$ A to 30.2 A
- AC waveforms include sine wave and square wave.
- Synthesized Resistance values from a short circuit to 1200 M $\Omega$
- Synthesized Capacitance values from 220 pF to 120 mF
- Synthesized Inductance values from 12  $\mu$ H to 120 H (Inductance not available on 5540A).
- Simulated output for 10 types of Resistance Temperature Detectors (RTDs)
- Simulated output for 17 types of thermocouples
- Simulated power output (not available on 5540A)

*Note*

*All images shown in this manual are the 5560A unless noted otherwise.*



**Figure 1. 5560A Calibrator**

Product features include:

- Automatic meter error calculation, with user-selectable reference values.
- **x** (Multiply) and **÷** (Divide) that change the output value by multiples of ten or to pre-determined cardinal values for various functions, including standard oscilloscope timebase and gain steps.
- Programmable entry limits that prevent the operator from entering values that exceed preset output limits.
- Simultaneous output of voltage and current, simulating power up to 30.9 kW (not available on 5540A).
- 10 MHz sync pulse reference input and output. Use this to input a high-accuracy 10 MHz reference to transfer the frequency accuracy to the Calibrator, and/or to synchronize one or more additional Calibrators to a primary 5560A/5550A/5540A.
- Simultaneous output of two voltages.
- Extended bandwidth mode outputs multiple waveforms down to 0.01 Hz, and sine waves to 2 MHz.
- Variable output between 10 MHz reference input and primary OUTPUT, and between voltage and current outputs.
- Standard IEEE-488 (GPIB) interface, complying with ANSI/IEEE Standards 488.1-1987 and 488.2-1987.
- EIA Standard RS-232 serial data interface for Calibrator remote control.
- Universal Serial Bus (USB) 2.0 high-speed interface device port for remote control of the Product using USBTMC.
- Integrated 10/100/1000BASE-T Ethernet port for network connection remote control of the Product.
- USB Host port to save calibration reports to a flash drive and to provide firmware updates.
- Visual Connection Management input terminals illuminate to help show correct cable connection configurations.
- Soft Power - automatic selection of line voltage/frequency.
- WVGA display with touch-screen and keypad control.



## **Contact Fluke Calibration**

Fluke Corporation operates worldwide. For local contact information, go to our website:

[www.flukecal.com](http://www.flukecal.com)

To register your product, view, print, or download the latest manual or manual supplement, go to our website.

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[info@flukecal.com](mailto:info@flukecal.com)

## **Safety Information**

A **Warning** identifies conditions and procedures that are dangerous to the user. A **Caution** identifies conditions and procedures that can cause damage to the Product or the equipment under test.

General Safety Information is located in the printed *5560A/5550A/5540A Safety Information* document that ships with the Product. It can also be found online at [www.flukecal.com](http://www.flukecal.com). More specific safety information is listed in this manual where applicable.

## **Specifications**

Safety Specifications are located in the Safety Specifications section of the *5560A/5550A/5540A Safety Information* manual. Complete specifications are at [www.flukecal.com](http://www.flukecal.com). See the *5560A Product Specifications*, *5560A Product Specifications*, or *5540A Product Specifications*.

## **Service Information**

Contact an authorized Fluke Calibration Service Center if the Product needs calibration or repair during the warranty period. See *Unpack and Inspect*. Please have Product information such as the purchase date and serial number ready when you schedule a repair.

## **Operation Overview**

Operate the Product from the front panel in the local mode, or remotely with the IEEE-488, RS-232, USBTMC, or LAN ports. For remote operations, see the *5560A/5550A/5540A Remote Programmers Manual* at [www.flukecal.com](http://www.flukecal.com). Several software options are available to integrate product operation into a wide variety of calibration requirements.

## **Local Operation**

Typical local operations include front-panel connections to the Device Under Test (DUT), and then manual keystroke and touch-screen entries from the front panel that place the Product in the necessary output mode.

## **Remote Operation (GPIB)**

The Product rear-panel GPIB port is a fully-programmable parallel interface bus meeting the GPIB (IEEE-488.1) standard and supplemental IEEE-488.2 standard. Under the remote control of an instrument controller, the Product operates exclusively as a *talker/listener*. Use the IEEE-488 command set or run MET/CAL software (optional) to write your own programs. See the *5560A/5550A/5540A Remote Programmers Manual* at [www.flukecal.com](http://www.flukecal.com) for a discussion of the commands available for IEEE-488 operation.

## **Remote Operation (RS-232)**

The rear panel RS-232 port is dedicated to serial data communications to operate and control the Product during calibration procedures complying with the supplemental IEEE-488.2 standard.

The RS-232 serial data port connects a host terminal or personal computer (PC) to the Product. See the *5560A/5550A/5540A Remote Programmers Manual* at [www.flukecal.com](http://www.flukecal.com) for a discussion of the RS-232 commands.

## **Remote Operation (USBTMC)**

The Product rear-panel USB 2.0 type B port is a fully-programmable USBTMC interface that meets the USBTMC-USB488 interface standard and supplemental IEEE-488.2 standard. Use the USBTMC command set. See the *5560A/5550A/5540A Remote Programmers Manual* at [www.flukecal.com](http://www.flukecal.com) for a discussion of the commands available for USBTMC operation.

## **Remote Operation (Ethernet)**

The Product rear-panel Integrated 10/100/1000BASE-T Ethernet port is for network connection remote control of the Calibrator and complies with supplemental IEEE-488.2 standard. The Ethernet port connects a host PC to the Product. To send commands to the Product, enter commands from a telnet session running on the host computer. See the *5560A/5550A/5540A Remote Programmers Manual* at [www.flukecal.com](http://www.flukecal.com) for a discussion of the Ethernet commands available for Ethernet operation.

## **Prepare the Product for Operation**

This section provides instructions to unpack and install the Calibrator and connect to line power. Instructions for cable connections other than line power can be found here:

DUT connections: See [Front Panel Operation](#)

For remote operation, and these topics, see the *5560A/5550A/5540A Remote Programmers Manual* at [www.flukecal.com](http://www.flukecal.com):

- IEEE-488 parallel interface connection
- RS-232C serial interface connection
- LAN Interface Connections
- USB 2.0 Interface Connections

## Unpack and Inspect

Inspect the Product for damage and immediately report any damage to the shipper. Instructions for inspection and claims are included in the shipping container.

Check the shipping container for all the standard equipment listed in Table 1 and check the shipping order for any additional items ordered.

**Table 1. Standard Equipment**

Item	Model or Part Number
Calibrator	5560A/5550A/5540A
Line Power Cord	See Table 3.
Lead Set <sup>[1]</sup>	55XXA/LEADS SET
Transit Case	55XXA/CASE, TRANSIT CASE
<i>5560A/5550A/5540A Safety Information</i>	5037050
<i>5560A/5550A/5540A Operators Manual</i>	See the Fluke Calibration website.
<i>5560A Specifications</i>	See the Fluke Calibration website.
<i>5550A Specifications</i>	See the Fluke Calibration website.
<i>5540A Specifications</i>	See the Fluke Calibration website.
<p>[1] 55XXA/LEADS SET - Contains:</p> <p><b>Stackable Test Leads</b></p> <p style="padding-left: 20px;">Rated Voltage: 30 V ac or 60 V dc, max non-contact use</p> <p style="padding-left: 20px;">Rated Current: 30 A, max</p> <p><b>Shielded Calibration Test Leads</b></p> <p style="padding-left: 20px;">Rated Voltage: 1000 V, max. For calibration use only, max transient 1500 V pk. Non-contact use</p> <p style="padding-left: 20px;">Rated Current: 3.2 A, max</p> <p><b>High Current Test Leads</b></p> <p style="padding-left: 20px;">Rated Voltage: 30 V ac or 60 V dc, max non-contact use</p> <p style="padding-left: 20px;">Rated Current: 30 A, max</p> <p><b>Thermocouple Extension</b></p> <p style="padding-left: 20px;">Thermocouple Extension, 3 ft, J (brown wire, black connectors)</p> <p style="padding-left: 20px;">Thermocouple Extension, 3 ft, K (brown wire, yellow connectors)</p> <p style="padding-left: 20px;">Thermocouple Extension, 3 ft, CU (white wire, white connectors)</p> <p style="padding-left: 20px;">Thermocouple Assembly, K-Type, Beaded, Molded-Plug</p> <p style="padding-left: 20px;">Thermocouple Set, J Assembly with extensions</p> <p style="padding-left: 20px;">Thermocouple Short, Plug, Thermocouple, Shorted, Cu-Cu, White</p> <p style="padding-left: 20px;">K - Type Thermocouple Adapter - Fluke</p>	

**Table 2. Optional Calibration Accessories**

Item	Model	Part Number
Thermocouple and test leads set	55XXA-525/ LEADS SET	5128204
1, 2, and 10-Turn Current Coil	55XXA/COIL 10	5128219
50-Turn Current Coil	55XXA/COIL 50	5128228
DMM Autocal Adapter	55XXA/ DMMCAL	5128237
Portability kit for on site calibrations	55XXA/ PORTKIT	5128243
Transit Case	55XXA/CASE, TRANSIT CASE	5128255

### **Mains Voltage Selection**

The Calibrator automatically detects the mains line voltage when you push the soft power switch (Table 4, 20) and configures itself to work at that voltage level. Nominal mains voltages that range from 100 Vrms to 120 Vrms and from 220 Vrms to 240 Vrms ( $\pm 10\%$ ) are acceptable, with frequencies from 47 Hz to 63 Hz.

### **Connect to Line Power**

#### **⚠⚠ Warning**

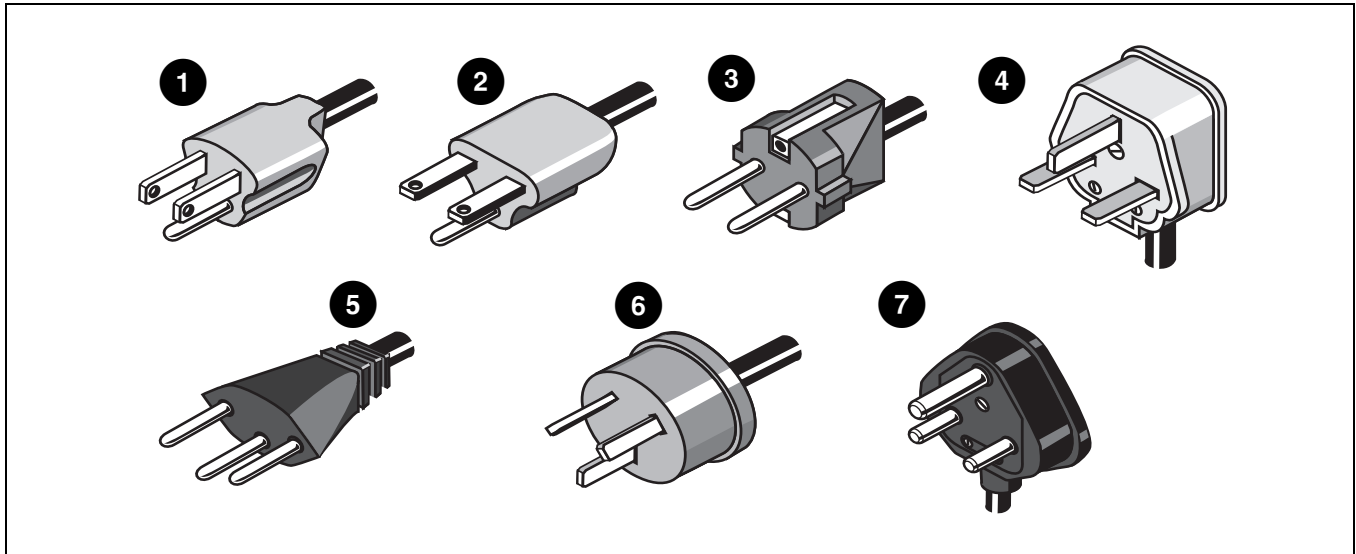
**To prevent possible electrical shock, fire, or personal injury:**

- **Connect an approved three-conductor mains power cord to a grounded power outlet.**
- **Make sure that the Product is grounded before use.**
- **Do not use an extension cord or adapter plug.**

The Product comes with the appropriate line power plug for the country of purchase. If you need a different type, see Table 3 For the line power plug types available from Fluke Calibration.

After you verify that the correct fuse for that line voltage is installed, connect the Product to a properly grounded three-prong outlet.

**Table 3. Line Power Cord Types Available from Fluke Calibration**



Number	Type	Voltage/Current	Fluke Option Number
1	North America	120 V/15 A	LC-1
2	North America	240 V/15 A	LC-2
3	Universal Euro	220 V/15 A	LC-3
4	United Kingdom	240 V/13 A	LC-4
5	Switzerland	220 V/10 A	LC-5
6	Australia	240 V/10 A	LC-6
7	South Africa	240 V/5 A	LC-7

**Overload Protection**

The Product provides reverse-power protection and fast output disconnection.

Reverse-power protection prevents damage to the Product from occasional, accidental, normal-mode and common-mode overloads to a maximum of  $\pm 300$  V peak. It is not intended as protection against frequent (systematic and repeated) abuse. Such abuse will cause the Product to fail.

For volts, ohms, capacitance, inductance, and thermocouple functions, there is fast output disconnection protection. This protection senses applied voltages  $>20$  V on the output terminals. It quickly disconnects the internal circuits from the output terminals and places the Product into standby when such overloads occur.

## **Placement and Rack Mounting**

### **⚠️⚠️ Warning**

**To prevent possible electrical shock, fire, or personal injury, do not restrict access to the Product mains power cord. The mains power cord is the mains disconnecting device. If access to the power cord is inhibited by rack mounting, a properly-rated accessible mains disconnect switch must be provided within reach as part of the installation.**

Place the Product on a bench top or mount it in a standard-width, 24-inch (61-cm) deep equipment rack. For bench-top use, the Product is equipped with non-slipping, non-marring feet. To mount the Product in an equipment rack, use the 5560A/5550A/5540A Rack Mount Kit (Y5538). The kit includes mounting instructions and hardware.

## **Cooling Considerations**

### **⚠️ Caution**

**To prevent damage to the Product, make sure the space around the Product meets minimum requirements listed below.**

The accuracy and dependability of all internal parts of the Product are enhanced by maintaining the coolest possible internal temperature. Lengthen the life of the Product and enhance its performance by observing these rules:

- Keep the vents on the Product clear of obstructions (3 inches from nearby walls or rack enclosures). The fan draws in air from the left side of the Product.
- The exhaust perforations on the right side of the Product must be clear of obstructions.
- The air that enters the Product must be at room temperature: make sure the exhaust air from another instrument is not directed into the fan inlet.

## **Calibration Security Passcode**

The integrity of Product calibration is protected by a security passcode that must be entered before new calibration constants can be saved to non-volatile memory. This passcode replaces the hardware calibration switches found on older calibrators such as the Fluke 5522A. As with the 5522A, the passcode also protects the ability to set the date for the internal real-time clock.

If the passcode is not entered, the Product is secured. Once the passcode is entered, the Product is unsecured. The Product secures itself when it is reset or when the setup menus are closed. The Product can be unsecured at any time over the remote interface with the CAL\_SECURE command and by entering the passcode.

The passcode contains 1 to 8 decimal digits. The Product ships with the passcode set to the serial number of the Product. If connected to a network, Fluke Calibration highly recommends that you change the passcode from this default. To change the passcode, select **Setup > Calibration > Change Passcode**. The Product prompts for the current passcode and then the new passcode. The passcode can also be changed over the remote interface with the CAL\_PASSCODE command.

Make sure to save your passcode in a safe location. If you lose the passcode, the Product will need to be serviced at Fluke Calibration. See [Contact Fluke Calibration](#).

## **Features**

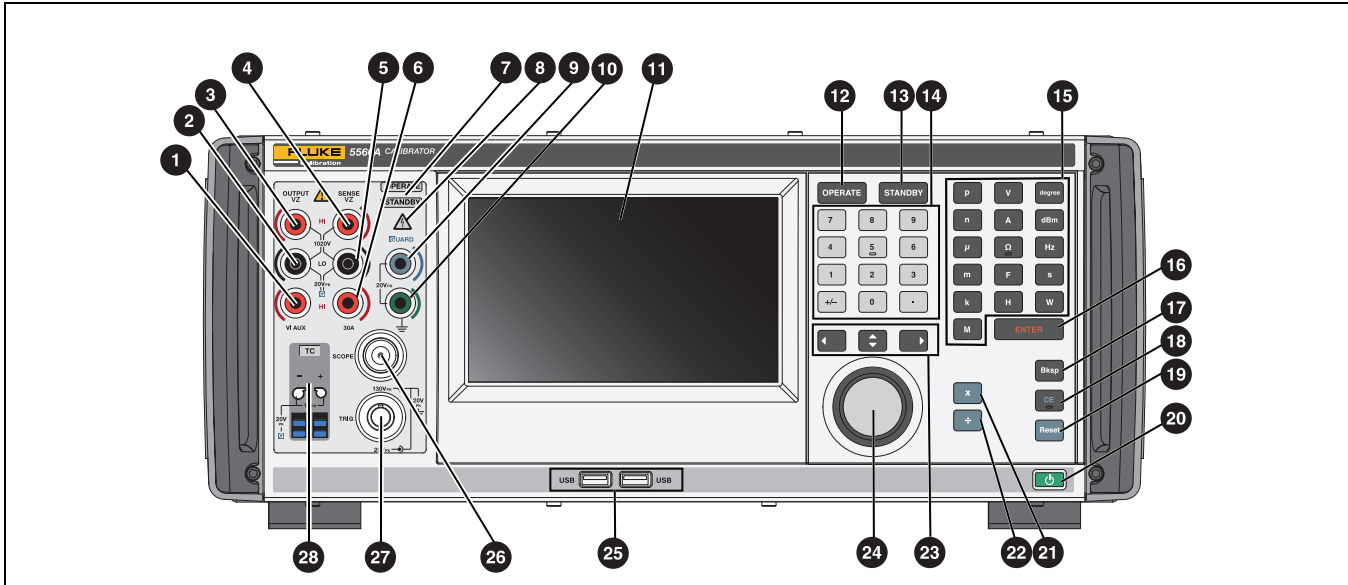
This section is a reference for the functions and locations of the Calibrator's front and rear-panel features. Read this information before you operate the Calibrator. Front-panel operating instructions for the Calibrator are in [Front Panel Operation](#). Remote operating instructions are provided in the *5560A/5550A/5540A Remote Programmers Manual* at [www.flukecal.com](http://www.flukecal.com).

The front panel features Visual Connection Management Terminals. When you push **ENTER**, after entering a value, the appropriate terminals illuminate, whether in Standby mode (Standby) or Operate mode (Operate). The terminals offer visual guidance for proper cable connections for specific functions, protect the user by indicating which terminals are active, and protect the Calibrator from damage from incorrect connections.

### **Front-Panel Features**

Front-panel features (including all controls, the Display, indicators, and terminals) are shown and described in [Table 4](#).

Table 4. Front-Panel Features



Number	Description
1	<b>VI AUX (3.1 A Current OUTPUT) terminal</b> <sup>[1]</sup> - This terminal is the source of current output when $\leq 3.1$ A is selected.
2	<b>OUTPUT LO terminal</b> <sup>[1]</sup> <sup>[2]</sup>
3	<b>Volts/Impedance (VZ) OUTPUT HI terminal</b> <sup>[1]</sup> - Terminal for ac and dc voltage, resistance, capacitance and inductance sourcing, and Resistance Temperature Detector (RTD) simulation.
4	<b>Volts/Impedance (VZ) SENSE HI terminal</b> <sup>[1]</sup> - In voltage functions, or 2-wire / 4-wire compensation in impedance functions, use the <b>Volts/Impedance (VZ) SENSE</b> terminals to sense at the DUT. Use external sensing in the voltage functions when the DUT draws enough current to produce a significant voltage drop in the cables, and in the impedance functions when the DUT has a four-wire input. External sensing is also used for two-wire compensation in impedance functions to allow compensation to the DUT terminals.
5	<b>SENSE LO terminal</b> <sup>[1]</sup> <sup>[2]</sup>
6	<b>30A terminal</b> <sup>[1]</sup> - The 30 A terminal is the source of current output when the 30 A range is selected ( $>3.1$ A to 30.2 A).



Table 4. Front-Panel Features (cont.)

Number	Description
7	<b>OPERATE</b> and <b>STANDBY</b> indicators located above the output terminals. The <b>OPERATE</b> indicator illuminates when the output value and function shown on the Display are active at the selected terminals. The <b>STANDBY</b> indicator located above the output terminals illuminates when the output value and function shown on the Display are not active at the illuminated terminals.
8	<b>HIGH VOLTAGE</b> indicator illuminates when there is high voltage (>30 Vrms or 42 V peak) present at the output terminals.
9	<b>GUARD</b> terminal <sup>[1]</sup> The <b>GUARD</b> terminal is always connected internally to the internal guard shield. This shield is tied to the <b>OUTPUT LO</b> signal ground inside the Calibrator unless External Guard is selected. See <a href="#">External Guard</a> .
10	<b>Earth Ground</b> terminal - The <b>EARTH</b> terminal is always connected to the chassis ground.
11	The color touch-sensitive <b>Display</b> shows the output amplitude, frequency, and other active conditions and messages. The Display provides controls not available with the keys alone. The Calibrator interface is made up of multiple menus, selectable choices, and blue softkeys (at the bottom of the Display).
12	<p>Push <b>OPERATE</b> to place the Product in Operate. Operate is indicated by the <b>OPERATE</b> indicator (7) and also on the Display.</p> <p style="text-align: center;"><b>⚠⚠ Warning</b></p> <p style="text-align: center;"><b>To prevent possible electrical shock, fire, or personal injury, take care while the Product is in Operate. The terminals can have voltages present that could cause injury or death.</b></p>
13	Push <b>STANDBY</b> to place the Product in Standby. Standby is indicated by the <b>STANDBY</b> indicator (7) and also on the Display.
14	Use the <b>Numeric keypad</b> to enter the digits of the output amplitude and frequency.
15	Use a <b>Metric Prefix</b> key (if necessary) and an <b>Output Units</b> key to select the output function of the Product.
16	Push <b>ENTER</b> to load the output settings that were entered with the Numeric and Output Units keys. If you push <b>ENTER</b> without identifying the units for the entry, in Single Output functions the Product assumes the primary unit of the presently-displayed function. In Error (edit) mode, <b>ENTER</b> restores the output to the value of the reference.
17	Push <b>Bksp</b> (Back Space) to delete and re-enter a numerical entry.

**Table 4. Front-Panel Features (cont.)**

Number	Description
18	Push <b>CE</b> (Clear Entry) to delete a partially-completed keypad entry from the Display.
19	Push <b>Reset</b> to abort the current operating state of the Product. This returns the Product to the power-up default state.
20	Push <b>Power</b> (lighted <b>Soft-Power switch</b> ) to turn the Product power on and off.
21	Push <b>x</b> (multiplier key) to change the output to 10X the reference value (not necessarily the present output value) if the value is within performance limits. This key puts the Calibrator into Standby if the change is from $\leq 30$ V rms or 42 V peak to $>30$ V rms or 42 V peak. In some Scope functions, <b>x</b> changes the output to the next higher step in the sequence.
22	Push <b>÷</b> (divide key) to change the output to 1/10th reference value (not necessarily the present output value) if the value is within performance limits. In some Scope functions, <b>÷</b> changes the output to the next lower step in the sequence.
23	Push <b>↔</b> , <b>←</b> , <b>→</b> (selection keys) to select an output signal or a specific digit. The keys allow you to adjust the magnitude of changes by moving the highlighted digit. <b>↔</b> changes the selection between the main values on the Display. In practice, for voltage and current outputs, these keys (with the Edit knob) adjust the output until the DUT reads correctly. The Display then shows the DUT deviation from the reference.
24	Turn the <b>Edit knob</b> clockwise to increase the output value of the active-edit digit. Turn the Edit knob counterclockwise to decrease the output value of the active-edit digit. If a digit rolls past 0 or 9, the digit to it's left or right is carried. For some values, a relative error appears on the Display that shows the difference between the original (reference) output and the new output.
25	Use the front-panel (and rear-panel) USB host ports to save Calibration report data to a flash drive or to update Product firmware.
26	<b>SCOPE OUT</b> (Oscilloscope) Type N connector is used for outputs during oscilloscope calibration. This is active only when an oscilloscope calibration option is installed.
27	<b>TRIG</b> (Scope Trigger) BNC connector is used to trigger the oscilloscope during oscilloscope calibration. This is active only when an oscilloscope option is installed.
28	<b>TC</b> (Thermocouple) connector is for thermocouple temperature sourcing and measurement. This connector accepts standard TC plugs, miniature TC plugs, and bare wires.
<p>[1] Visual Connection Management Terminals. The appropriate terminals light up in green or blue when you push <b>ENTER</b>, whether in Standby or Operate. The terminals offer visual guidance for cable connections for specific functions, protect the user by indicating which terminals are active, and help to protect the Product from damage from incorrect connections.</p> <p>[2] The low terminal for current outputs changes from out low to sense low when changing from single output to simulated power (dual output).</p>	

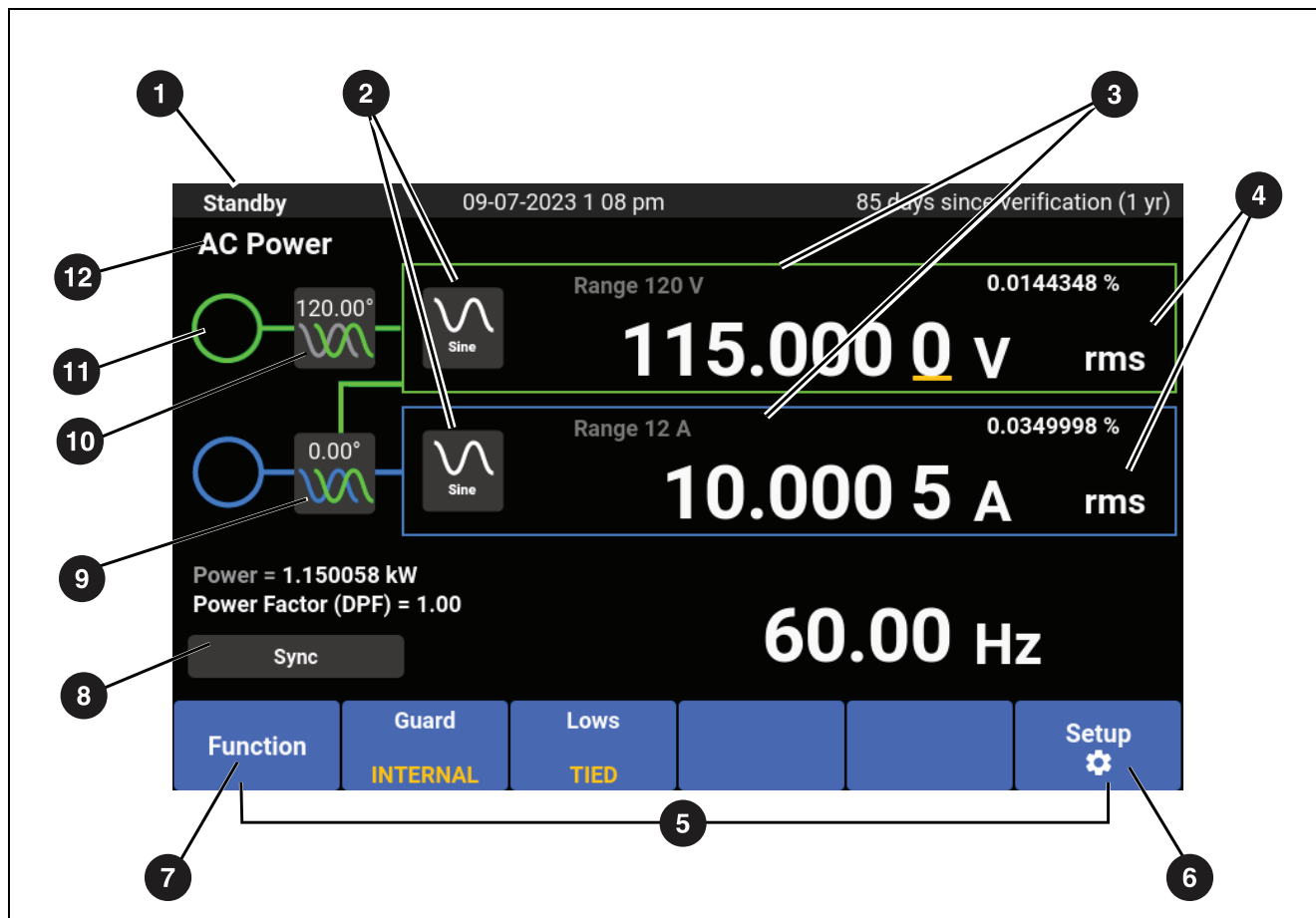
## The Display

A sample display is shown in Table 5. Note that this is only an example for reference. The Display changes and allows access to different portions of the user interface, depending upon what function the Calibrator is in.

### Note

AC Power and other dual outputs are not available on the 5540A. These items are noted throughout this manual.

Table 5. Sample Display



Number	Description
1	Operate / Standby indicator.
2	Select waveform buttons. Push to open the Select Waveform. In some functions, buttons in this location open the Select RTD or Select Thermocouple panels.

Table 5. Sample Display (cont.)

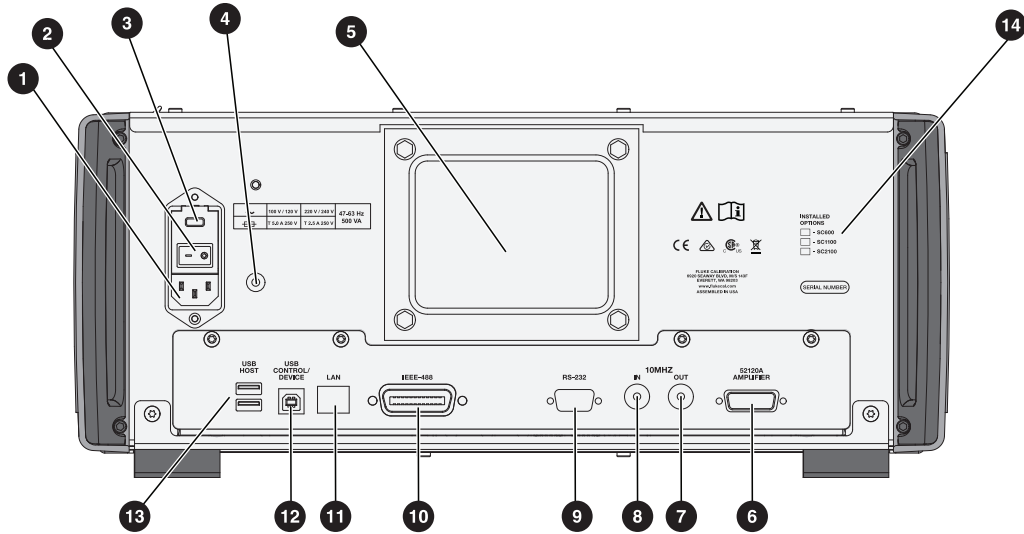
Number	Description
3	Range Lock toggle. Not available in all functions.
4	p-p, or rms indicator
5	See <a href="#">Softkeys</a> .
6	See <a href="#">Setup Menu</a> .
7	See <a href="#">Function Menu</a> .
8	Multi-Unit Phase Synchronization button sends a sync pulse from the primary Calibrator in a system with 2 or more Calibrators.
9	Adjust Phase - Aux to Output button. Push to open the Adjust Phase panel and adjust the phase between Voltage and Current for AC Power functions.
10	Phase - Output to Reference button. Push to open the Adjust Phase panel and adjust the phase between the OUTPUT signal and the 10 MHz reference.
11	Hazardous voltage indicator. Illuminates when the output is programmed to a value >30 V rms or 42 V peak.
12	Selected Function button. Push to open the Function Menu. See <a href="#">Function Menu</a> .

## Rear-Panel Features

Rear-panel features (including all terminals, sockets, and connectors) are shown in Table 6.

**Table 6. Rear-panel Features**

Number	Description
1	<p style="text-align: center;"><b>⚠⚠ Warning</b></p> <p>To avoid shock hazard, connect the factory-supplied three-conductor line power cord to a properly grounded power outlet. Do not use a two-conductor adapter or extension cord; this will break the protective ground connection.</p> <p>The <b>AC Power Input Module</b> provides a grounded three-prong connector that accepts the line power cord, a switch mechanism to select the operating line voltage, and a mains-power fuse. See <a href="#">Mains Voltage Selection</a>.</p>
2	The <b>Rear AC Power Switch</b> must be in the ON (I) position before the Soft-Power button on the front-panel will function.
3	<b>Mains Power Fuse.</b> See <a href="#">Replace the Mains Power Fuse</a> for fuse rating information.
4	The <b>CHASSIS GROUND</b> post is internally grounded to the chassis. If the Calibrator is the ground reference point in a system, this binding post can be used to connect other instruments to earth ground. See <a href="#">Connect the Calibrator to a DUT</a> for details.
5	<b>Transformer Cover</b>



**Table 6. Rear-panel Features (cont.)**

Number	Description
6	For future external amplifier control.
7	The <b>10 MHz OUT</b> BNC connector passes the internal or external 10 MHz clock signal to another 5560A/5550A/5540A to synchronize one or more secondary product to a primary product.
8	The <b>10 MHz IN</b> BNC connector applies an optional external clock signal to the Calibrator. This replaces the normal internal 10 MHz clock signal in the Calibrator. Frequency accuracy of the Calibrator is governed by the frequency accuracy of the clock signal internal or external. This connector is also used to connect the Calibrator as a secondary unit to another calibrator. This connection is used for multi-phase power calibration with multiple calibrators.
9	A male (DTE) <b>RS-232 Serial Port</b> connector for remote control of the Calibrator. See the <i>5560A/5550A/5540A Remote Programmers Manual</i> at <a href="http://www.flukecal.com">www.flukecal.com</a> for proper cabling, remote programming instructions, how to set up the serial interface and connect to it.
10	The <b>IEEE-488</b> connector is a standard parallel interface to operate the Calibrator in remote control as a Talker/Listener on the IEEE-488 bus. See the <i>5560A/5550A/5540A Remote Programmers Manual</i> at <a href="http://www.flukecal.com">www.flukecal.com</a> for bus connection and remote programming instructions.
11	<b>LAN</b> 10/100/1000 Base/T Ethernet connector for remote control of the Calibrator. See the <i>5560A/5550A/5540A Remote Programmers Manual</i> at <a href="http://www.flukecal.com">www.flukecal.com</a> for proper cabling instructions and how to set up the interface, and how to transmit data from the Calibrator. The section also describes how to use the Ethernet interface for remote control.
12	<b>USB Control Device</b> is a Remote port for remote control of the Calibrator. See the <i>5560A/5550A/5540A Remote Programmers Manual</i> at <a href="http://www.flukecal.com">www.flukecal.com</a> for instructions to connect to the USBTMC interface and for remote programming instructions.
13	<b>USB Host</b> ports use the rear-panel (and front-panel) USB ports to save Calibration report data to a flash drive. These ports are also used to update the Product firmware.
14	Installed options list.

## Front Panel Operation

### Warning


The Calibrator is capable of supplying lethal voltages. To avoid shock hazard, do not make connections to the output terminals when any voltage is present. Placing the Product in Standby may not be enough to avoid shock hazard, since **OPERATE** could be pushed accidentally. Push **Reset** and verify that the Calibrator is in Standby before making connections to the output terminals.

This section explains how to operate the Calibrator from the front panel. For a description of front-panel controls, the Display, and terminals, see [Features](#).

### Turn on the Calibrator

### Warning

To prevent possible electrical shock, fire, or personal injury, make sure that the Product is grounded before use.

Prior to powering up the Calibrator, make sure that the rear mains power switch is in the I (ON) position and the Soft Power button is illuminated. Now push the front Soft Power button (). The Calibrator turns on.

When the Calibrator is powered on, it completes a self-test routine. If the self test fails, the Display identifies an error code. For a description of error codes, see [Maintenance](#). After the self test, the DCV function is on screen. When you push **Reset**, the Product returns to this screen.

### Warm up the Calibrator

When you turn on the Calibrator, allow a warm-up period of at least 30 minutes for the internal components to stabilize. This ensures that the Calibrator meets or exceeds its specifications.

If you turn the Calibrator off after warm-up and then on again, allow a warm-up period of at least twice the length of time it was turned off (maximum of 30 minutes). For example, if the Calibrator is turned off for 10 minutes and then on again, allow a warm-up period of at least 20 minutes.

## Menus

The Product user interface features keys, the knob on the right of the front panel, and the menus, buttons, and softkeys on the Display. A sample Display is briefly explained in [Table 4](#). The Display contains the menu system where the Product settings are viewed, changed, and stored.

### Softkeys

At the bottom of the screens for each function are blue softkeys. The softkey options change depending on which function is active on the Display. The softkeys are only visible while in a function. They are not visible while in a menu.

The screens and menus are explained in the subsequent sections.

## DCV Screen

The DCV (dc volts) screen is the first screen shown after the Product is powered on. This screen shows the dc voltage that is currently entered into the Product. When you first turn on the Product, the output defaults to 0 mV dc, Standby, 120 mV range. The DCV screen has these different softkeys:

- Function (see [Function Menu](#))
- Guard (see [Guard Softkey](#))
- Sense (inactive when EXTERNAL is not available) (see [Sense Softkey](#))
- Setup (see [Setup Menu](#))

## Setup Menu

The initial Product setup establishes the default configuration going forward. The Setup Menu (**Setup**) is a multi-layer set of menus and screens used to set the parameters of the Product. The Setup Menu is made up of these submenus:

- Calibration
- Instrument Setup
- System Settings
- Self Test and Diagnostics
- Languages
- About

These submenus are explained in the subsequent sections.

### *Note*

*Some Setup Menu items must be manually adjusted.*

To select or make changes to individual menu items:

1. Tap the menu item.
2. Select the menu choice.
3. Tap **x** under the submenu list to close the menu.

Some of the menu choices use sliders to change parameter. Touch and slide to move the sliding handle to the left or right. Some of the menus use scrollbars. Touch and slide up or down to move the scrollbar.



### Setup Menu > Calibration

The **Calibration** menu (**Setup Menu > Calibration**) is on the left of the Setup Menu.

The Calibration menu includes:

- Ambient Temperature
- Ambient Humidity
- Zero Adjustment
- 5560A/5550A/5540A Adjustment
- $\Omega$  - Zero Adjustment
- Scope Adjustment (inactive when no scope option installed)
- Verification Date/Temp
- Change Passcode (see [Calibration Security Passcode](#))
- Restore Default Calibration (calibration constants are deleted and the Product requires a full calibration to meet specifications)
- Restore Default Setup (resets setup defaults including Instrument Setup values, System Setting values and Language)

### Setup Menu > Instrument Setup

The **Instrument Setup** menu (**Setup Menu > Instrument Setup**) is the second choice of the list of submenus shown on the left of the Setup Menu. Parameters are nonvolatile and remain set after you reset the Product or when the Product power is turned on.

#### Note

*There is a scrollbar on the right of the screen. Place your finger anywhere on the active section of the Display and drag your finger to move the screen content.*

The Instrument Setup menu includes:

- **Output Limits**
  - Set or view the upper and lower ac and dc voltage and terminal current limits.
  - Restore Limit Defaults
- **Defaults**
  - Set or view the Product defaults

The Product Setup Choices are in Table 7.

**Table 7. Product Setup Choices**

Parameter	Setting Choices
Thermocouple Type <sup>[1]</sup>	A1 (BP, A), B, C, D, E, G, J, K, L, N, R, S, T, U, XK, J, N, T, 10 $\mu$ V/ $^{\circ}$ C, 1mV/ $^{\circ}$ C
RTD Type <sup>[1]</sup>	Pt 100 (3926), Pt 100 (3916), Pt 100 (385), Pt 200 (385), Pt 500 (385), Pt 1000 (385), Ni120 (672), Cu10 (427), Cu50 (428), Cu100 (428)
Temperature Unit <sup>[1]</sup>	$^{\circ}$ C/ $^{\circ}$ F
Temperature Scale <sup>[1]</sup>	ITS-90, IPTS-68
dBm Reference <sup>[1]</sup>	50,100, 300,1k(dBv), 75,135, 600,1200, 90,150, 900
Verification Interval	90 Day, 1 Year, 2 Year
Confidence Level	95%, 99%
Error Reference	Nominal Value, True Value
Reference Clock	Internal, External
Multi-Unit Phase Synchronization Button	Show, Hide
Error Unit	Scientific Notation, Percent, Parts Per Million (x 10-6): when <10 PPM, <100 PPM, <1000 PPM
Specification Unit	Percent, Base Units
Reference Phase Default <sup>[1]</sup>	-180.0 to 180.0
Scope Overload Time Limit Default	1 to 60 seconds
Show Specifications	Show or Hide
Restore Factory Defaults	-
<sup>[1]</sup> Changes to these default values does not affect the current active setting until you Reset, Power Cycle, or re-select the function through the function menu.	

## Setup Menu > System Settings

The **System Settings** menu (**Setup Menu > System Settings**) is the third choice of the list of submenus on the left of the Setup Menu. Some of these settings require the Product passcode. See [Calibration Security Passcode](#). The System Settings are in Table 8.

**Table 8. System Settings**

Parameter	Setting Choices
Date/Time	<p><i>Note</i></p> <p><i>The Product needs to be unlocked to change the date.</i></p> <p>Date Format: MM/DD/YYYY, DD/MM/YYYY, YYYY/MM/DD</p> <p>Date</p> <p>Time Format: 12, 24</p> <p>Time</p> <p>Restore Date / Time Defaults</p>
Display Controls	<p>The <b>Display Controls</b> button accesses the menu for Screen Brightness, LED Brightness, and a Restore Display Defaults Reset button. Screen Brightness: 0% to 100%, LED Brightness: 0% to 100%</p>
Remote Port Setup	<p>USB, Ethernet, GPIB, RS-232 (See <a href="#">Remote Port Setup</a>)</p>

## Remote Port Setup

Use the **Remote Port Setup** menu (inside the System Settings menu) to enable or disable USBTMC, GPIB, Ethernet, and RS-232 ports by toggling a green/white switch. Tapping the individual port buttons provides additional options and information. See the 5560A/5550A/5540A *Remote Programmers Manual* at [www.flukecal.com](http://www.flukecal.com).

The menu is:

- **USB**

This has USBTMC information:

- USB0::0x0F7E::0x800A::[serial number]::INSTR

Where:

- 0x0F7E: The Fluke vendor ID
- 0x800A: The Product ID number
- [serial number]: The serial number of the Product (the serial number is also on the rear panel) or available using the \*IDN? on one of the other remote interfaces. You can also find it with the **Setup > About** menu.
- Restore USB Defaults with the **Reset** button.

- **Ethernet**

- DHCP (On or Off)
- Static IP Settings (IP Address, Gateway, Subnet Mask)
- Current IP Address, Gateway and MAC Address
- Port
- End of Line Character (CR/LF, CR, LF)
- Remote Interface (Terminal, Computer)
- Network Security Settings (Starting Address, Ending Address)
- Restore Ethernet Defaults

- **GPIB**

- GPIB Address
- Restore GPIB Defaults

- **RS-232**
  - Data Bits (8, 7)
  - Stop Bits (1, 2)
  - Flow Control (None, RTS/CTS, XON/XOFF)
  - Parity (None, Even, Odd)
  - Baud Rate (9600, 19200, 38400, 57600, 115200)
  - End of Line Character (CR/LF, CR, LF)
  - Remote Interface (Terminal, Computer)
  - Restore RS-232 Defaults

### *Setup Menu > Self Test and Diagnostics*

The **Self Test and Diagnostics** menu (**Setup Menu > Self Test and Diagnostics**) is the fourth choice of the list of submenus on the left of the Setup Menu. The Self Test and Diagnostics menu includes:

- **Touch Screen Test**  
Test the touch interaction with the Display and visually confirm the functionality.
- **Key/Bell/Knob Tests**
  - Key Test
  - Knob Test
  - Beeper Test

Test each of the front-panel keys, the rotary knob, and the beeper.
- **Diagnostics**  
Run checks on the Calibrator functions. Follow on-screen instructions to run Diagnostics.
- **LED Test**  
To run the test:
  1. Tap the Run button.
  2. Tap Next to visually confirm each set of LEDs on the front terminal lights up matching the on-screen representation. You may exit this test at any time.
- **Color Test**  
This is an automatic test the goes through a range of colors and when finished, goes back to the main Self Test and Diagnostic screen.
- **Diagnostic Fault Action**
  - Halt
  - Continue
  - Abort

Select the desired Product response to errors that are encountered during Diagnostics.

Once started, Diagnostics can be aborted at any time. If you select the Diagnostic Fault Action of **Halt**, a **Continue** button appears when an error is encountered. This allows Diagnostics to either be aborted or continued. If you select **Continue** as the default action, errors will not display until Diagnostics are complete. A Diagnostic Fault Action of **Abort** results in Diagnostics aborting when an error is encountered.

### Setup Menu > Languages

The **Languages** menu (**Setup Menu > Languages**) is the fifth choice of the list of submenus on the left of the Setup Menu. This menu changes the Display menus and controls to different languages. A flag indicates the current language selection.

Available language selections are:

- **English**
- **Español** (Spanish)
- **Português** (Portuguese)
- **Deutsch** (German)
- **Français** (French)
- **Русский** (Russian)
- 日本語 (Japanese)
- 简体中文 (Simplified Chinese)
- 한국어 (Korean)

### Setup Menu > About

The **About** menu (**Setup Menu > About**) is the sixth choice of the list of submenus on the left of the Setup Menu. This menu shows:

- Serial Number
- Build Date
- Main SW Version
- Inguard SW Version
- Kernal Build Version
- License Files (**Previous** and **Next** buttons allow you to step through the license files). Push **Exit** to return to the Setup Menu.
- Open-Source Offer (provides information on how to request open-source code)

The Product Setup defaults are in Table 9.

**Table 9. Product Default Values**

Parameter	Default Value
Display Brightness	50
LED Brightness	50
Show Sync Button	true
Show Specifications	true
Time Format	12 hours
Date Format	MDY
Passcode	Serial Number
Report String	5560 hello world
Verification Date	1970-01-01,00:00:00
Zero Adjust Date	1970-01-01,00:00:00

**Table 9. Product Default Values (cont.)**

<b>Parameter</b>	<b>Default Value</b>
Mains Adjust Date	1970-01-01,00:00:00
Scope Adjust Date	1970-01-01,00:00:00
Unsecured Date	1970-01-01,00:00:00
PUD String	5560A
Verification Count	0
Verification Interval	1 yr
Confidence Level	95%
Current Max	30.2
Current Min	-30.2
dBm Reference	600 Ω
Degree Default	Celsius
Error Reference	Nominal
Specification Unit	Percent
GPIB Address	4
GPIB Enabled	true
Language	English
RS232 Baud Rate	9600
RS232 Data Bits	8
RS232 Enabled	true
RS232 EOL Char	CR/LF
RS232 Flow Control	XON/XOFF
RS232 Interface	Terminal
RS232 Parity	none
RS232 Stop Bits	1
RTD Default	PT100(385)
Temperature Source Function	TC
TC Default	K

**Table 9. Product Default Values (cont.)**

<b>Parameter</b>	<b>Default Value</b>
Telnet Enabled	true
Telnet Port	3490
Telnet EOL Char	CR/LF
Telnet Interface	Terminal
Temperature Scale Default	ITS90
USBTMC Enabled	true
Voltage Max	1020.0
Voltage Min	-1020.0
Error Unit	Scientific Units
Reference Clock Default	Internal
Reference Phase Default	0.0
Scope Overload Time Limit Default	10 seconds
Diagnostic Fault Action	Halt
Telnet MAC Address	0.0.0.0
Telnet IP Address	0.0.0.0
Telnet Static IP	0.0.0.0
Telnet Netmask	255.255.255.0
Telnet Gateway	0
Telnet Static Gateway	0.0.0.0
Telnet DHCP	On
User Entered Verification Temp	23.0



## Function Menu

This section is a brief list of the four main Function menus. For more of an explanation of these menus and their submenus, see these sections:

- [Single Output Menu](#)
- [Dual Output Menu \(Not available on 5540A\)](#)
- [Measure Menu](#)
- [Scope Menu](#)

### Function Menu > Single Output

The **Single Output** menu (**Function Menu > Single Output**) offers the choices shown in Table 10. Single Output menu functions are explained in their respective sections.

**Table 10. Single Output Menu Functions**

Menu Item	See Section
DCV	<a href="#">Set DC Voltage Output</a>
ACV	<a href="#">Set AC Voltage Output</a>
DCI	<a href="#">Set DC Current Output</a>
ACI	<a href="#">Set AC Current Output</a>
Resistance	<a href="#">Set Resistance Output</a>
Capacitance	<a href="#">Set Capacitance Output</a>
Inductance	<a href="#">Set Inductance Output (Not Available on 5540A)</a>
RTD Source	<a href="#">Set Temperature Simulation (RTD) Source</a>
TC Source	<a href="#">Set TC Source</a>

### Function Menu > Dual Output (Not available on 5540A)

The **Dual Output** menu (**Function Menu > Dual Output**) offers the choices shown in Table 11. Dual Output menu functions are explained in their respective sections.

**Table 11. Dual Output Menu Functions**

Menu Item	See Section
DC Power	<a href="#">Set DC Power Output</a>
AC Power	<a href="#">Set AC Power Output</a>
DCV DCV	<a href="#">Set a Dual DC Voltage Output</a>
ACV ACV	<a href="#">Set a Dual AC Voltage Output</a>

### **Function Menu > Measure**

The **Measure** menu (**Function Menu > Measure**) consists of just the TC Measure function. See [Measure Thermocouple Temperatures](#).

### **Function Menu > Scope**

The **Scope** menu (**Function Menu > Scope**) is active once you install the scope options. See [Scope Options](#).

### **Reset the Calibrator**

At any time during front panel operation (except during remote operation), you can push **Reset** to return the Calibrator to the power-up state: 0 mV dc, Standby, 120 mV range, all volatile values set to their most recent default values.

### **Zero the Calibrator**

Zeroing adjusts internal circuitry, most notably dc offsets in all ranges of operation. To meet the specifications, zeroing is required every seven days, or when the Calibrator ambient temperature changes by more than 5 °C. The Display shows a message when it is time to zero the Calibrator. Zeroing is particularly important when the calibration workload has 1 mW or 1 mV resolution, and when there has been a significant temperature change in the Calibrator work environment.

To zero the Calibrator:

1. Turn on the Calibrator and allow a warm-up period of at least 30 minutes.
2. Tap the **Setup** softkey to open the Setup Menu.
3. Under **Zero Adjustment**, tap the **Run** button to open the calibration activity menu.
4. Push **Continue** as needed to step through the Zero Adjustment process. Push **Abort** to exit this function.

### **Operate and Standby Modes**

When the **OPERATE** annunciator is lit and **Operate** shows on the Display, the output value and function shown on the Display are **active** at the selected terminals. When the **STANDBY** annunciator is lit and **Standby** is shown on the Display, the output value and function shown on the Display are **inactive** at the selected terminals. To enable Operate, push **OPERATE**. To place the Calibrator in Standby, push **STANDBY**.

If any of these events occur as the Calibrator operates, the Calibrator automatically goes into Standby:

- **Reset** is pushed.
- A voltage >30 V rms or 42 V peak is selected when the previous output voltage was ≤30 V rms or 42 V peak.
- The Calibrator changes functions.
- The output location for current is changed from AUX to 30 A, or vice versa.
- An overload condition is detected.
- A reverse-power condition is detected.
- The function screen is obscured such as when the Function and Setup menus shows.

## Connect the Calibrator to a DUT

### Warning

The Calibrator is capable of supplying lethal voltages. To avoid shock hazard, do not make connections to the output terminals when any voltage is present. Placing the Product in Standby may not be enough to avoid shock hazard, since **OPERATE** could be pushed accidentally. Push **Reset** and verify that the Calibrator is in Standby before making connections to the output terminals.

The outputs labeled OUTPUT (HI and LO) source voltage, resistance, capacitance, inductance, and simulate resistance temperature detector (RTD) outputs. The LO terminal connects to the analog signal ground inside the guard shield. This signal line may or may not be tied to the guard shield, depending on the Guard setting. See [55XXA/DMMCAL Cable](#) for an explanation of this internal connection. An external connection is required to connect the signal LO to the chassis ground.

When an oscilloscope calibration option is installed, the coaxial connectors labeled SCOPE OUT and TRIG deliver signals for oscilloscope calibration.

The socket labeled TC is used to measure thermocouples and to generate simulated thermocouple outputs.

## Recommended Cable and Connector Types

### Warning

To prevent possible electrical shock, fire, or personal injury, do not touch exposed metal on banana plugs, they can have lethal voltages.

Cables to the Calibrator are connected to the OUTPUT and SENSE terminals. To avoid errors induced by thermal voltages (thermal emfs), use connectors and conductors made of copper or materials that generate small thermal emfs when joined to copper. Avoid using nickel-plated connectors. Optimum results can be obtained by using Fluke Model 5730A-7002 Low Thermal EMF Test Leads, which are constructed of well-insulated copper wire and tellurium copper connectors. See [Options and Accessories](#).

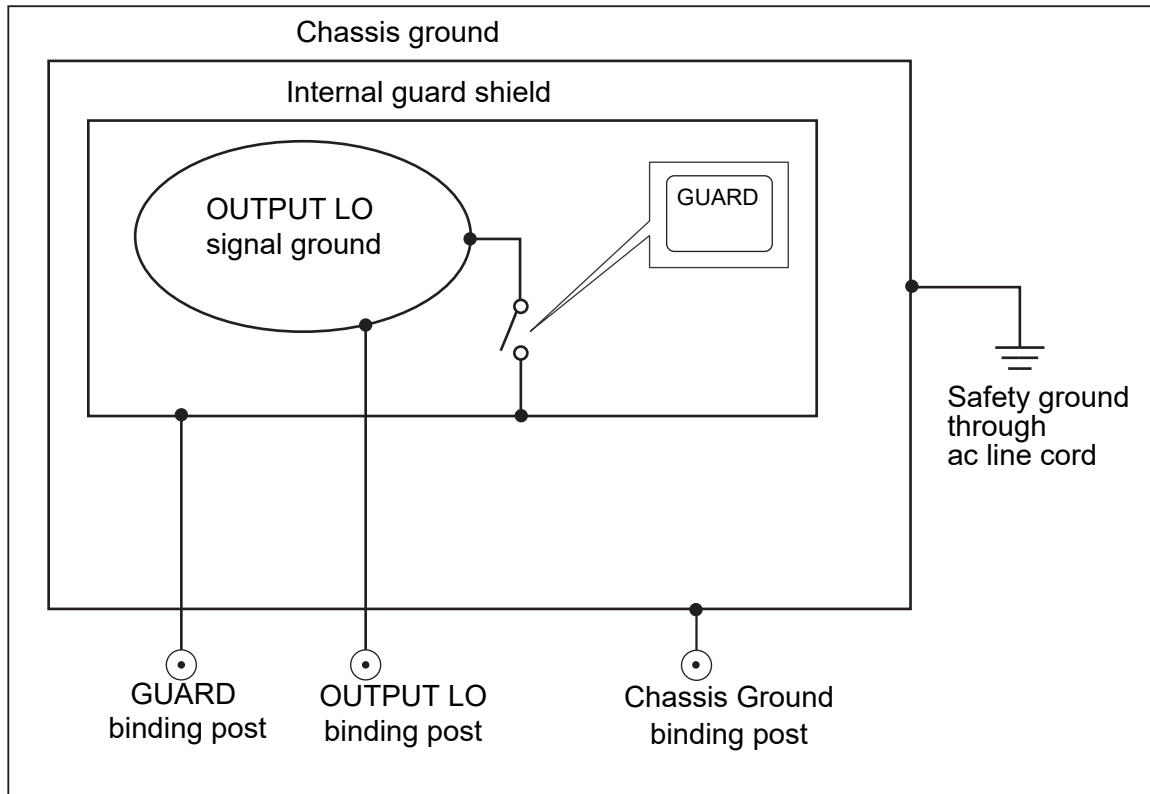
## 55XXA/DMMCAL Cable

The Fluke 55XXA/DMMCAL cable is specifically designed to connect handheld and bench DMMs to the Calibrator. The cable provides all the connections needed for most DMMs and provides the lowest thermal EMF, lowest leakage, and best ac performance possible. Additionally, the 55xxA/DMMCAL cable minimizes the number of setup changes which reduces operator intervention and increases throughput when you calibrate DMMs. The cable supports most recessed banana-style terminal DMMs. Some advanced meters may have a safety feature that if a test lead is plugged into the **mA/μA** or **A** terminal and the rotary switch is turned to a non-current function, the Meter chirps and flashes **LEAd**. In this case, remove the current leads while you test other functions.

- AC and dc voltages
- All resistances, including 2W and 4W Comp
- AC and dc currents up to 15 A

## When to Use EARTH and GUARD

Figure 2 shows the internal connections made by the Guard setting.



**Figure 2. EARTH and GUARD Internal Connections**

### Earth

The Calibrator front-panel OUTPUT LO terminal is normally isolated from earth (chassis) ground. To make a connection between the OUTPUT LO terminal and earth ground, an external connection must be made to the chassis ground terminals.

To avoid ground loops and noise, you must have only one earth ground-to-LO terminal connection in the system. Usually you make all signal ground connections at the DUT. Generally, a connection to Earth ground is only used for ac and dc volts where the DUT is isolated from earth ground. There must, however, be a safety ground for the Calibrator. See [Connect to Line Power](#).

### External Guard

The guard is an electrical shield, isolated from the chassis, that protects the analog circuitry. The guard provides a low-impedance path for common-mode noise and ground loop currents. The internal guard is connected to OUTPUT LO through approximately 30  $\Omega$ . There is normally an internal connection between the guard and the OUTPUT LO terminal. When you select the external guard setting, you break this internal connection, which allows you to connect a lead from the GUARD terminal to earth ground on another instrument in an interconnected system. Use this external guard connection whenever you test a DUT that has a grounded LO terminal. Remember to always maintain only one earth ground tie point in a system.

## **Four-Wire versus Two-Wire Connections**

Four-wire and two-wire connections refer to methods used to connect the Calibrator to the DUT to cancel out test lead resistance to assure the highest precision of the calibration output. The external sensing capability of the four- and two-wire compensated connections provides increased precision for lower impedance values. Part of setting up the Calibrator output for resistance, capacitance, inductance, and RTD includes selections for four-wire compensation (**Comp 4 Wire**), two-wire compensation (**Comp 2 wire**) and two-wire no compensation (**Comp OFF**). (See [Set Resistance Output](#), [Set Capacitance Output](#), [Set Inductance Output \(Not Available on 5540A\)](#), and [Set Temperature Simulation \(RTD\) Source](#). Note that compensated connections for capacitance and inductance are to compensate for lead and internal resistances, not for lead and internal capacitances or inductances. See [Specifications](#) for impedance values where compensation is available.

### **Four-Wire Connection**

The four-wire connection is typical for calibrating laboratory measurement equipment. Increased precision is provided by four-wire connections. See [Specifications](#) for impedance values where compensation is available.

### **Two-Wire Compensation**

The two-wire connection is typical for calibrating precision handheld Digital Multimeters (DMMs) with a two-wire input. Increased precision is provided for lower impedance values. For higher values, the Calibrator changes the compensation to off (**Comp OFF**). See [Specifications](#) for impedance values where compensation is available.

### **Compensation Off**

Compensation off is a typical connection used to calibrate handheld analog meters or DMMs with a two-wire input. This connection is available for most values of resistance, capacitance, and inductance and is usually selected when the analog meter or DMM level of accuracy does not require the additional precision. This is the default condition whenever an impedance output is made, following an output that was not impedance.

## **Cable Connections**

Table 12 indicates a figure reference for each type of connection between a DUT and the Calibrator, referencing Figures 3 through 10.

When calibrating Resistance Temperature Detector (RTD) meters with the three-terminal connection shown in Figure 9, be sure the test leads have identical resistances to cancel any errors due to lead resistance. This can be accomplished, for example, by using three identical test lead lengths and sizes and identical connector styles.

When you calibrate a thermocouple meter, it is important to use the correct hookup wire and a connector between the Calibrator front-panel TC terminal and the DUT. You must use thermocouple wire and connectors that match the type of thermocouple. For example, if you simulate a temperature output for a type K thermocouple, use type K-thermocouple wire and type-K plugs for the hookup.

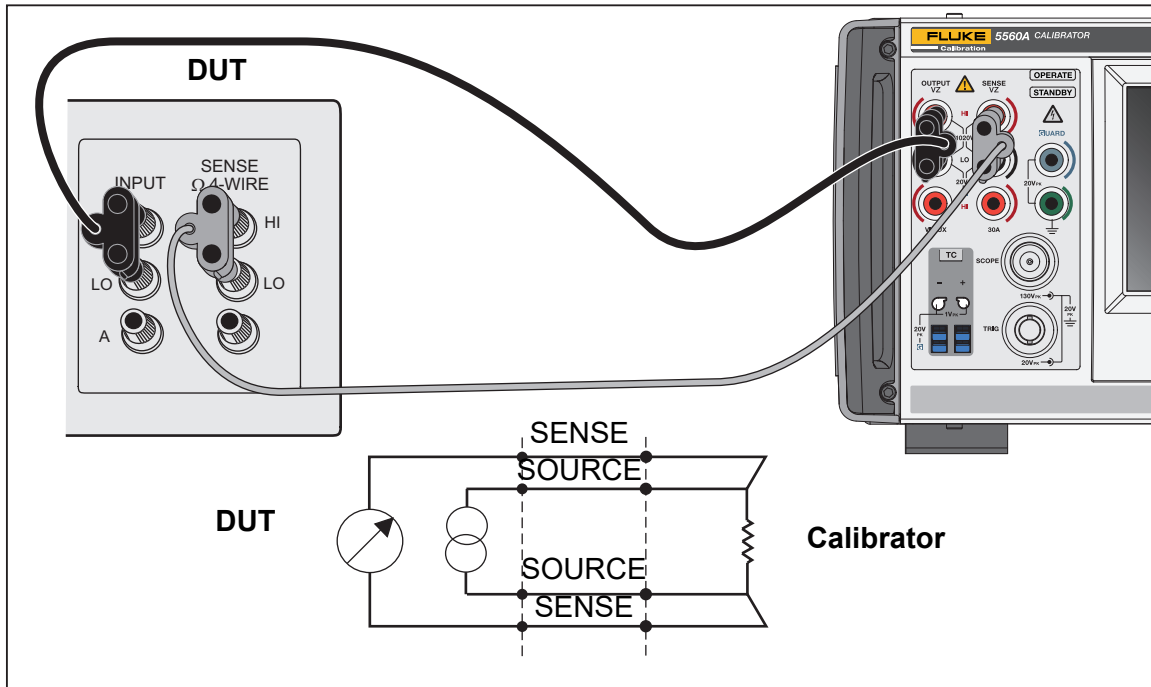
To connect the Calibrator to a DUT:

1. If the Calibrator is turned on, push **Reset** to remove the output from the Calibrator terminals.
2. Make the connections to the DUT by selecting the appropriate figure from Table 12 For capacitance outputs, null out stray capacitance by connecting the test leads to the DUT, routing them (but not connecting) to the Calibrator on a non-conductive surface. Null out the reading on the DUT using **rel**, **offset**, or **null**, whichever method applies, and then connect the test leads to the Calibrator.

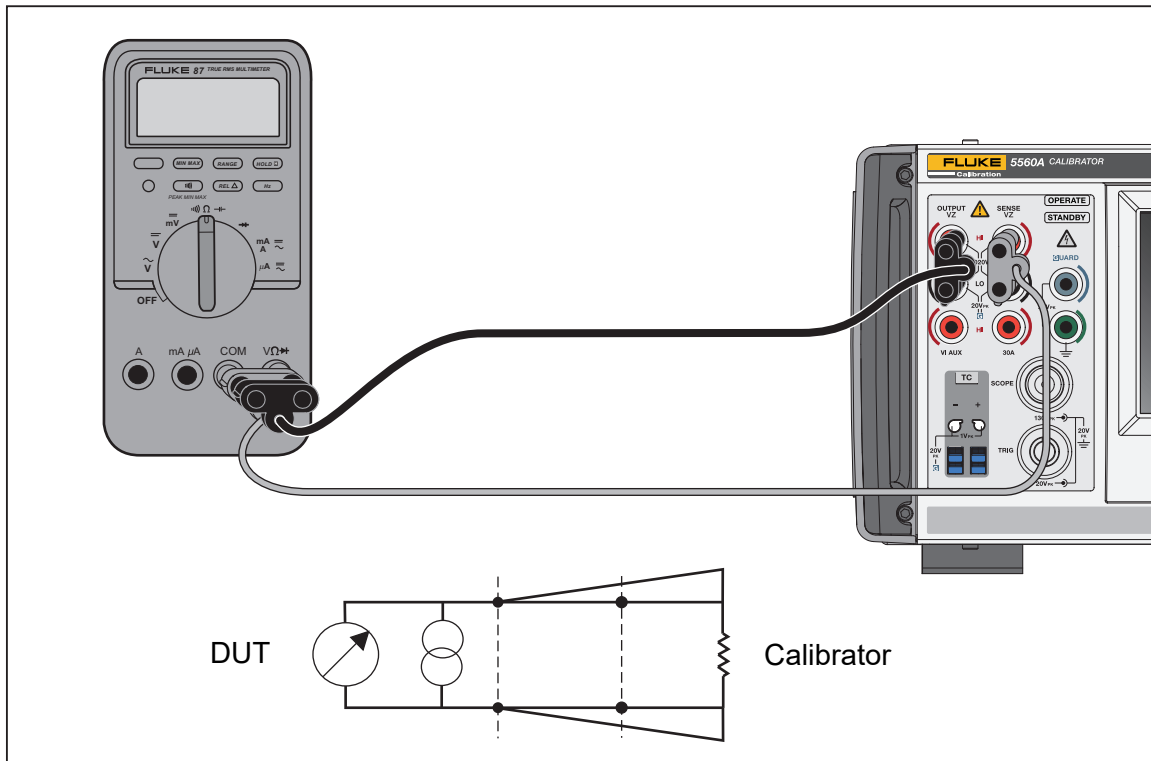
**Table 12. DUT Connections**

Calibrator Output	Figure Reference
Resistance	3 Impedance - four-wire compensated
Capacitance	4 Impedance - two-wire compensated
Inductance (not available on 5540A)	5 Impedance - compensation off
DC or AC Voltage	6 DC Voltage/AC Voltage
DC or AC Current <3 A	7 DC Current/AC Current <3 A
DC or AC Current $\leq 3$ A	8 DC Current/AC Current $\geq 3$ A
RTD Simulation	9 Temperature (RTD) - three-terminal connection
Thermocouple Simulation	10 Temperature (Thermocouple)

See the discussion in [Four-Wire versus Two-Wire Connections](#).



**Figure 3. DUT Connection: Impedance (Four-Wire Compensation)**



**Figure 4. DUT Connection: Impedance (Two-Wire Compensation)**

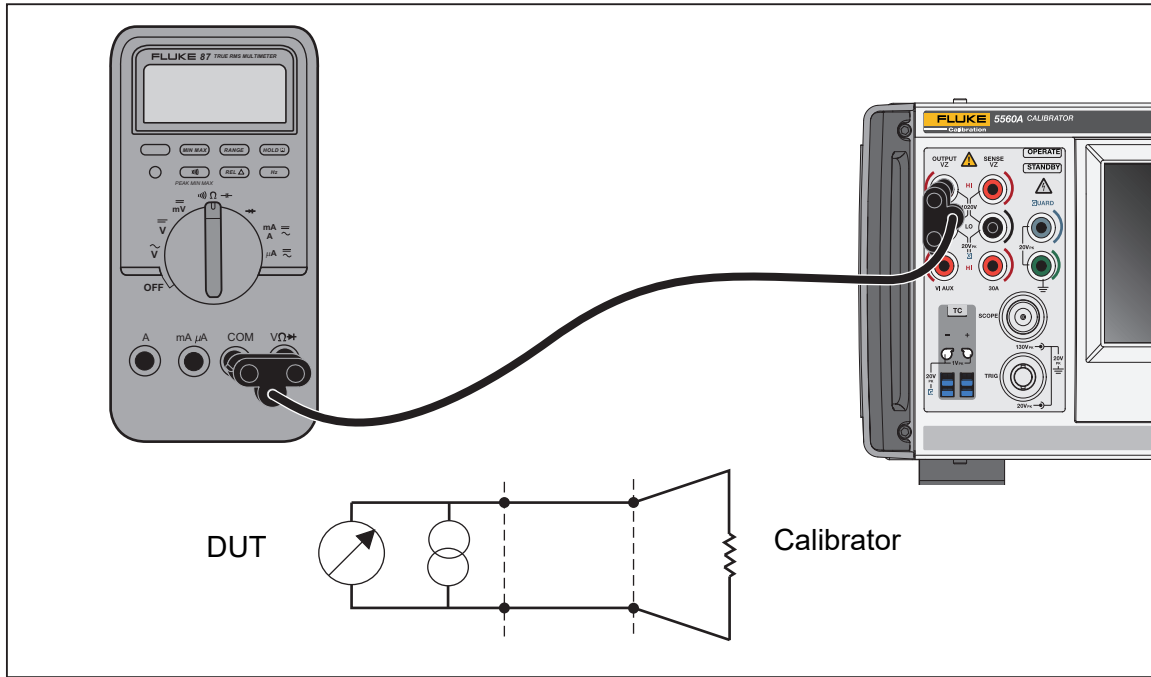


Figure 5. DUT Connection: Impedance (Compensation Off)

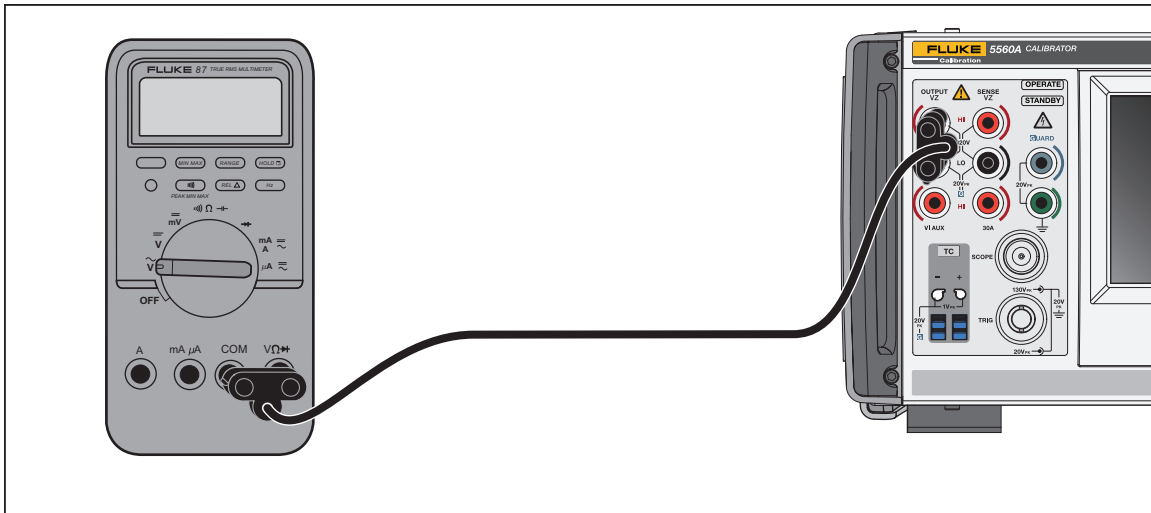
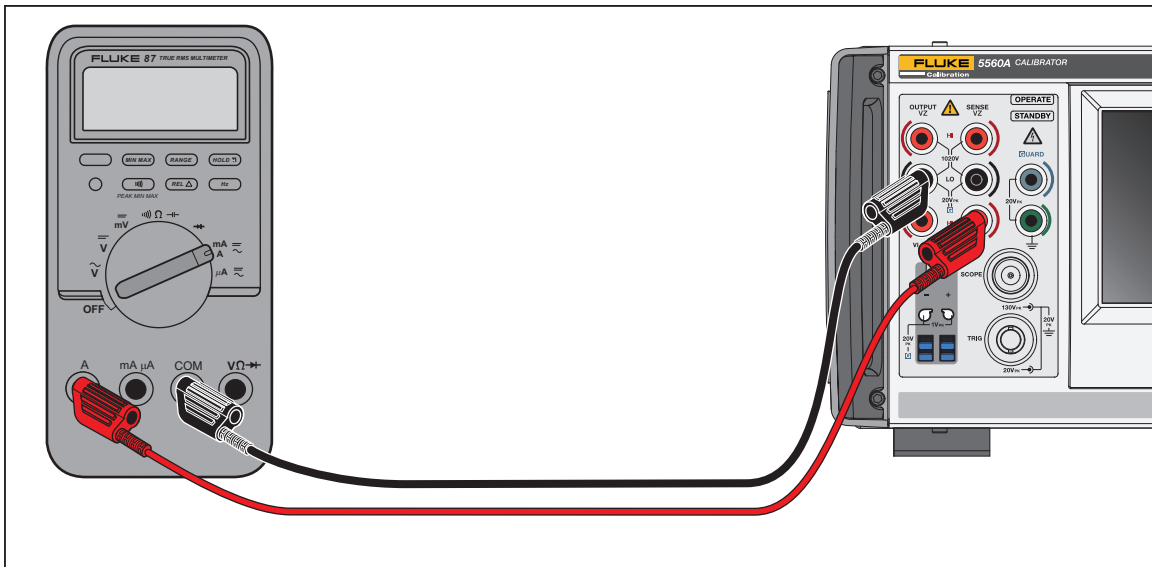


Figure 6. DUT Connection: DC Voltage/AC Voltage





**Figure 7. DUT Connection: DC Current/AC Current <3.1 A**



**Figure 8. DUT Connection: DC Current /AC Current  $\geq 3.1$  A**

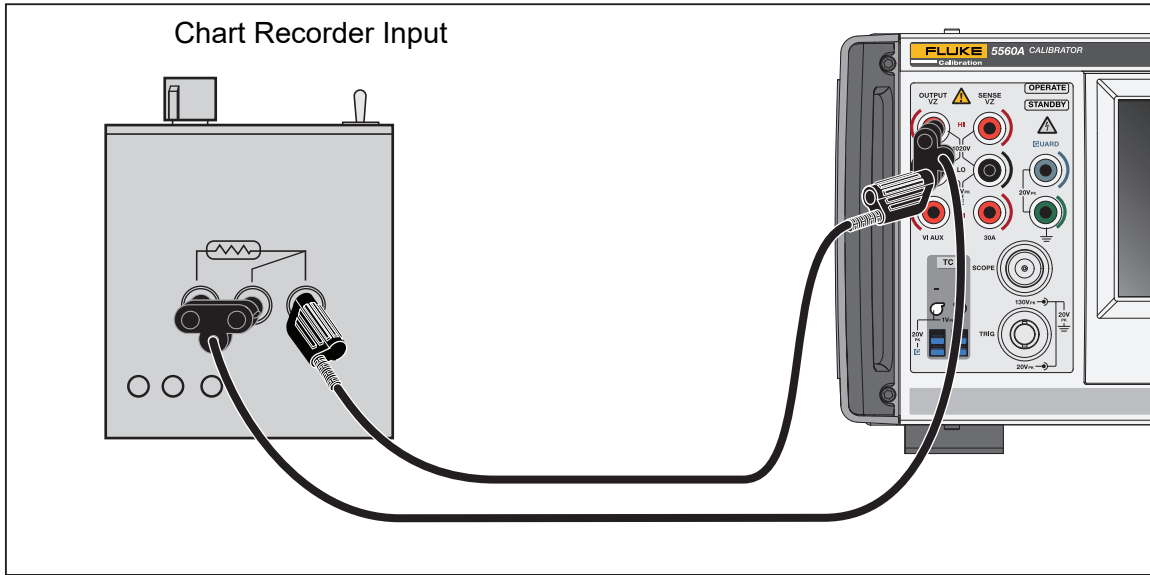


Figure 9. DUT Connection: Temperature (RTD) (Three-Terminal Connection)

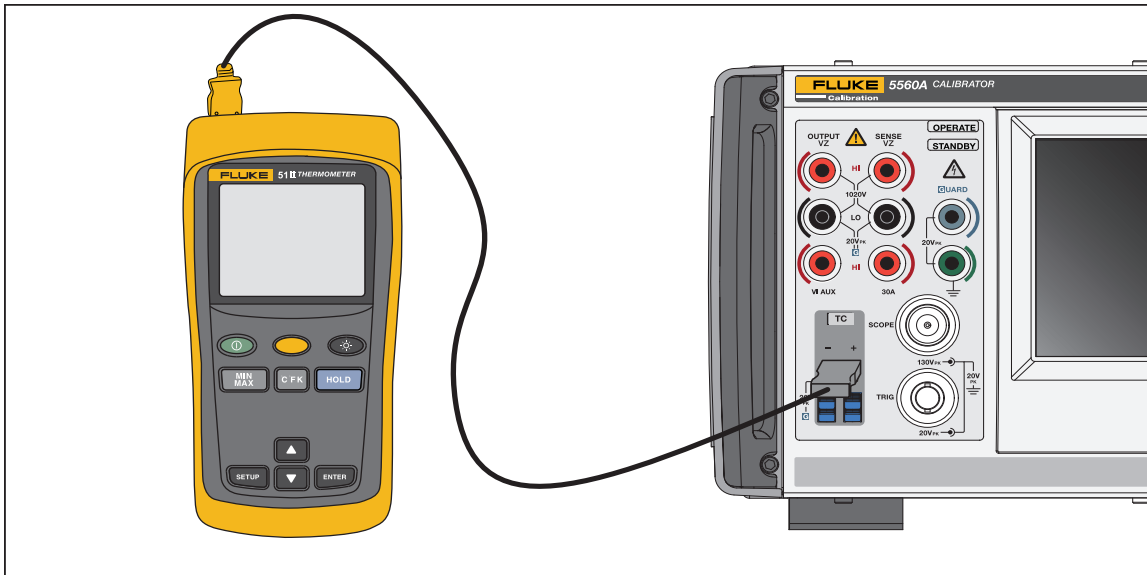


Figure 10. DUT Connection: Temperature (Thermocouple)

For Figure 10, connection wiring must match the thermocouple type (for example, K, J).

## **RMS Versus p-p Amplitude**

The Calibrator ranges for non-scope ac functions are specified in rms (root-mean-square; the effective value of the waveform). For example, Range 12 mV, Range 120 mV, Range 1.2 V, and so forth. Sinusoidal waveform outputs are represented in rms while square waveform outputs are represented in p-p. The relationship between p-p and rms for square wave is  $p-p \times 0.5 = rms$ . Scope, ac functions are specified in p-p.

## **Set an Output**

To set an output on the Calibrator, the basic steps are:

1. Use the numeric keypad to enter the value.
2. Select a multiplier if necessary (for example, **M**, **k**, or  **$\mu$** ).
3. Push an output units key to identify the unit to represent. The white entry box indicates the value and units as you type them into the Calibrator.
4. Repeat steps 1 through 3 for the next set of values, multiplier, and units until all desired parameters are entered (for example, voltage, current, and frequency).
5. Once you enter the values, push **ENTER**. If the Display indicates **Standby**, push **OPERATE** to output the selection.

### *Note*

*The display of a small empty yellow box (or a green circle in some functions) next to **OPERATE** in the upper left of the Display indicates the Calibrator is allowing its internal circuitry to settle. Once settled, the empty yellow box becomes solid green.*

### *Note*

*A useful feature of the user interface is that the Product can change from any single or dual output function to any other single or dual output function with the steps in this section. The exception to this are the scope functions and the temperature functions (TC Source, RTD Source, TC Measure). Follow the steps in this section and use a degree unit to take you to the last active temperature source function selected through the Function menu or through remote. TC Measure and scope functions must be selected through the Function menu or remote command. For most functions, when you push **ENTER** the selected unit(s) automatically configure the product to the new function.*

See Table 13 for an example that uses the ACV screen. This same basic process is used for all functions except scope and temperature functions as noted above. Note that ACV also has other adjustable parameters. See [Set AC Voltage Output](#).

**Table 13. Enter an Output Example (ACV)**

<p>If you make an entry error on any step, push <b>CE</b> to clear the Display or <b>Bksp</b> to remove the last item entered, and then reenter the value.</p> <p style="text-align: center;"><b>⚠ Caution</b></p> <p><b>To prevent damage to the DUT, make sure that the applied voltage to the DUT does not exceed the rating of the DUT insulation and the interconnecting wiring.</b></p>
1. Push <b>Reset</b> to place the Calibrator into its power up default state (0 mV DC). Note that the <b>OUTPUT HI</b> and <b>OUTPUT LO</b> terminals illuminate in green and also note that the <b>STANDBY</b> indicator illuminates.
2. Connect the DUT as described in <a href="#">Connect the Calibrator to a DUT</a> .
3. Set the DUT to measure the correct function (in this example, ac voltage) in the correct range.
4. Push the numbers on the numeric keypad (for example 100) to enter the voltage output.
5. Push a prefix key if necessary (for example <b>m</b> ).
6. Push the units key (in this example <b>v</b> ). In other examples, use the appropriate keys). The white entry box now shows the amplitude of your entry (in this example 100 mV).
7. Use the numeric keypad and prefix keys to enter the frequency (in this example, 60 <b>Hz</b> ).
8. Push <b>ENTER</b> . The values are added to the Display but the entered voltage (100 mV @ 60 Hz because you are on the ACV screen) is not yet active at the terminals.
9. (Optional) When necessary, push <b>+/-</b> to select the polarity of the current (default is +).
10. To activate the terminals, push <b>OPERATE</b> . The voltage is now present at the active terminal. Note that the <b>STANDBY</b> indicator turns off and the <b>OPERATE</b> indicator illuminates.
<p><i>Note</i></p> <p><i>At voltage outputs of <math>\geq 120</math> V, you may notice a slight high-pitched sound. This is normal.</i></p>

For all functions, except current, the terminals illuminate in green. For current functions, the terminals illuminate in blue.

The sequence to enter an output is relatively the same for each function as in the previous example. In the sections below, the manual will not restate these entry steps but will detail where there are deviations from this procedure.

Also see these sections:

- [Function Menu > Single Output](#)
- [Function Menu > Dual Output \(Not available on 5540A\)](#)
- [Function Menu > Measure](#)

## **Function Menu Common Features and Functions**

The Product Function menus share several common features and functions. Use this section of the manual as a reference for these items. Sections that explain the menus will refer back to this section where necessary.

### **Auto Range Versus Locked Range**

The option to toggle between locking and unlocking the range is available only for Single Output menu DCV and DCI functions. The range locking and unlocking is located above and left of the output value on the main function screen. If the range can be locked/unlocked, it is in white. If the range cannot be locked, the range is greyed out and does not respond.

When you select **Auto Range** (the default setting), the Calibrator automatically selects the range that provides the best output resolution. When you select **Locked**, the Calibrator locks the selected range and will not change ranges when you edit the output, or enter new outputs. Values higher than the locked range are not allowed. The locked selection is usually made when you do not want range changes that may cause a small deviation in the output, for example, when checking the linearity of a given multimeter range.

### **Guard Softkey**

The **Guard** softkey is available for all function menus under the Single Output menu, Dual Output menu, and Measure menu functions. This softkey can be toggled between **INTERNAL** and **EXTERNAL**. For more information about guarding, see [When to Use EARTH and GUARD](#).

### **Sense Softkey**

The **Sense** softkey is available for Single Output menu DCV and ACV functions. This softkey can be toggled between **INTERNAL** and **EXTERNAL**. In DCV and ACV, **EXTERNAL** is only available for voltages >120 mV.

## Select Waveforms

### Note


The units change from RMS for sine wave to p-p for square wave for single-output and dual-output functions. Scope functions provide p-p representation.

### Note

In the Scope Menu Marker Function, this feature is more complex. See [Set Scope Marker Output](#).

The Select Waveform slide-out menu is available for all Single Output menu ac, Dual Output menu ac, Scope Marker, and Scope Waveform Generator functions. This menu lets you select different waveforms. See [Waveform Types](#).



To select a waveform:

1. Tap the select waveform button (  ). The Select Waveform slide-out menu opens.
2. Choose the waveform type (not all waveforms listed are available in all Select Waveform menus):
  - Sine
  - Square
  - 20%Duty (Scope Only)
  - Spike (Scope Only)
  - Triangle (Scope Only)
3. Tap the **Apply** button or push **ENTER**. The Select Waveform menu closes and the entry is copied to the waveform button on the screen. Tapping **x** instead of **Apply** closes the menu without saving changes. Sourced temperature values may automatically be adjusted according to the limits of the selected Thermocouple type.

## Adjust Phase - Output to Reference

This slide-out menu is available for all ac functions and adjusts the phase between the primary Output and the 10 MHz reference.

To adjust the phase:

1. Tap the Adjust Phase Output to Reference button (  for ACV,  for ACI ). A menu opens and shows the current degrees.
2. Touch the deg white box and use the number pad to enter a value.
3. Tap the **Apply** button or push **ENTER**. This closes the menu. The entry is copied to the correct output on the screen. Tapping **x** instead of **Apply** closes the menu without saving changes.


When you use the knob to adjust phase, changes are applied immediately and the **Apply** button disappears. Push **ENTER** or tap **x** to exit the slide-out. Tapping **x** does not revert changes.

## **Adjust Phase - Aux to Output**

This slide-out menu is available for all Dual Output ac functions and adjusts the phase difference between the Aux Output and the primary Output.

For Sine-Sine AC Power, the phase shift adjustments may be entered as a displacement power factor (DPF) as well as in degrees. When you enter a power factor, this activates the Lead/Lag toggle. A leading or positive phase shift causes the AUX waveform to lead the OUTPUT waveform; a lagging or negative phase shift causes the AUX waveform to lag the OUTPUT waveform.

To adjust the phase:

1. Tap the Adjust Phase Aux to Output button (). A menu opens and shows the current degree, or degree and power factor for Sine-Sine ACP.
2. Touch the deg or DPF white box and use the number pad to enter a value. If a DPF is entered, then select Lead or Lag using the toggle.
3. Tap the **Apply** button or push **ENTER**. This closes the menu. The entry is copied to the correct output on the screen. Tapping **x** instead of **Apply** closes the menu without saving changes.

When you use the knob to adjust phase, changes are applied immediately and the **Apply** button disappears. Push **ENTER** or tap **x** to exit the slide-out. Tapping **x** does not revert changes.

## **Sync Button**

The **Sync** button is available for Single Output and Dual Output ac functions. Because the button requires a longer explanation, see [Synchronize the Calibrator Using 10 MHz IN/OUT](#).

## **Comp Softkey**

The **Comp** softkey is available in Single Output menu Resistance, Capacitance, and Inductance functions. Compensation (Comp) Applies 4-wire compensation, 2-wire compensation or turns compensation off. Compensation refers to methods of connecting the Calibrator to the DUT to cancel out test lead resistance. See [Four-Wire versus Two-Wire Connections](#) for more information. For the 3-lead connection (Figure 9) select Comp **OFF**.

## Reference Junction

### Note

*The Reference Junction softkey and slide-out menu are not available for TC Types X or Z (10  $\mu\text{V}/^\circ\text{C}$  or 1  $\text{mV}/^\circ\text{C}$ ).*

The Reference Junction slide-out menu is available in the Single Output menu TC Source, and Measure menu TC Measure functions.

The Reference Junction softkey selects the internal or external temperature reference source. The reference source indicates the ambient temperature contribution to the thermocouple output, which is taken into account when simulating an accurate temperature output. Select **Internal** when the selected thermocouple has alloy wires and the isothermal block internal to the Calibrator. Select **External** when you use an external isothermal block, and when the selected thermocouple has copper wires.

To edit the reference junction:

1. Tap the **Reference Junction** softkey to toggle from **INTERNAL** to **EXTERNAL**. When you select **EXTERNAL**, the **Reference Junction** button appears on the lower left of the Display.
2. Tap the **Reference Junction** button to open the Reference Junction slide-out menu.
3. Use the numeric keypad to enter the external reference junction temperature.
4. Tap the **Apply** button or push **ENTER**. This closes the menu. The Calibrator copies the entry to the Reference Junction area of the screen. Tapping **x** instead of **Apply** closes the menu without saving changes.

### Note

*The unsettled indicator (open yellow square) that occasionally appears in the upper left of the Display indicates an internal adjustment to the measured isothermal block temperature and is normal. If it appears for more than 10 seconds (nominal), or if it appears to flash continuously, check to see that you are not externally heating the thermocouple connector or wires, or that more time is needed for thermocouple path temperatures to come to equilibrium.*

## Lows Softkey



The **Lows** (Low Potential Output Terminals) softkey is available in all Dual Output menu functions. The **Lows** of both channels must be tied together at a single point. This can be done internally, with the Lows TIED/OPEN toggle set to **TIED** (default), or externally at the DUT with the toggle set to **OPEN**.



## Thermocouple Type

The Thermocouple Type slide-out menu is available in Single Output menu TC Source and Measure menu TC Measure functions.

To select a thermocouple:

1. Tap the Thermocouple Type button (  ). The Thermocouple Type slide-out menu opens.
2. Select the thermocouple type to simulate (listed in order horizontally):
  - A1 (BP, A)
  - B
  - C
  - D
  - E
  - G
  - J
  - K
  - L
  - N
  - R
  - S
  - T
  - U
  - XK
  - 10 $\mu$ V/ $^{\circ}$ C
  - 1mV/ $^{\circ}$ C
3. Tap the **Apply** button or push . This closes the menu. The entry is copied to the thermocouple button. Tapping **x** instead of **Apply** closes the menu without saving changes.

### Note

*The unsettled indicator (open yellow square) that occasionally appears in the upper left of the Display indicates an internal adjustment to the measured isothermal block temperature and is normal. If it appears for more than 10 seconds (nominal), or if it appears to flash continuously, check to see that you are not externally heating the thermocouple connector or wires, or that more time is needed for thermocouple path temperatures to come to equilibrium.*

## Single Output Menu

### Set DC Voltage Output

To set the dc voltage output (**Function > Single Output > DCV**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

Also see these sections:

- [Auto Range Versus Locked Range](#)
- [Guard Softkey](#)
- [Sense Softkey](#)

## Set AC Voltage Output

To set the ac voltage output (**Function > Single Output > ACV**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics. The output range is 1 mV to 1020 V.

Also see these sections:

- [Guard Softkey](#)
- [Sense Softkey](#)
- [Select Waveforms](#)
- [Adjust Phase - Output to Reference](#)
- [Enter a DC Offset](#)
- [Set a Reference](#)
- [Enter a Duty Cycle](#)
- [Sync Button](#)

Below are explanations of three other functions used with the Single Output ACV function.

### Enter a DC Offset

The dc offset (**Offset** on the lower section of the ACV screen and Scope Waveform Generator screen) is for ranges  $\leq 120$  V, and is limited in ACV to frequencies between 40.01 Hz and 500 kHz. In ACV, selecting a non-zero offset changes the range limits, based on the selected waveform. The offset mode range limits are always lower than the limits for non-offset mode.

See the specifications for details on these range limits and accuracy specifications in offset mode. If you use an offset voltage and you cause the output to move into a range where offset is not allowed, the Calibrator goes into Standby mode and the offset function is disabled.

To enter a dc voltage offset:

1. Tap a digit in the Offset field.
2. Enter the offset with the numeric keypad and decimal point key or rotate the knob to slew to the desired offset. For example, 0.123 V.
3. Push the **ENTER** key to enter the offset. The screen shows the offset.

### Set a Reference

The **Ref** button is on the lower left of the ACV screen and opens a slide-out menu where you can set a new reference for accuracy of a new standard.

1. Tap the **Ref** button to open the Select  $Z_0$  slide-out menu.
2. Choose from these values (listed in order horizontally):
  - 50  $\Omega$
  - 75  $\Omega$
  - 90  $\Omega$
  - 100  $\Omega$
  - 135  $\Omega$
  - 150  $\Omega$
  - 300  $\Omega$
  - 600  $\Omega$
  - 900  $\Omega$
  - 1000  $\Omega$
  - 1200  $\Omega$

3. Tap the **Apply** button or push **ENTER**. This closes the menu. The entry shows on the screen. Tapping **x** instead of **Apply** closes the menu without saving changes.

### **Enter a Duty Cycle**

Duty cycle adjustment is available for ACV when you select a square wave. After you select a square wave with the Waveform Selection procedure outlined in [Waveform Types](#), a **Mode** softkey appears. This toggles between **OFFSET** mode and **DUTY CYCLE** mode. The duty cycle value is adjusted in the same manner as offset. If the mode is changed from offset to duty cycle, the offset is automatically set to zero. If the mode is changed from duty cycle to offset, the duty cycle is set to 50 %.

To change the duty cycle of a square wave output:

1. Set the Product to an output such as 2 V p-p square wave at 1 kHz.
2. Tap the **Mode** softkey to show **DUTY CYCLE**.
3. Tap the duty cycle value.
4. Enter a new duty cycle between 1 and 99, or rotate the knob to slew to the desired duty cycle.
5. Push the **ENTER**.

### **Set DC Current Output**

To set the dc current output (**Function > Single Output > DCI**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics. Complete the procedure with the necessary output between VI AUX and OUTPUT LO or 30A and OUTPUT LO, depending on the current level selected. Current >3.1 A is sourced between the 30A and OUTPUT LO terminals.

Also see these sections:

- [Auto Range Versus Locked Range](#)
- [Guard Softkey](#)

### **Set AC Current Output**

To set the ac current output (**Function > Single Output > ACI**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics. The ac current output is at the VI AUX or 30A terminal to OUTPUT LO.

Also see these sections:

- [Guard Softkey](#)
- [Sync Button](#)
- [Waveform Types](#)
- [Adjust Phase - Output to Reference](#)

## Set Resistance Output

### Note

*Since this is a synthesized output, make sure the terminal connections from the Calibrator to the DUT are LO to LO and HI to HI.*

To set a synthesized resistance output at the front-panel OUTPUT terminals (**Function > Single Output > Resistance**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

Also see these sections:

- [Guard Softkey](#)
- [Comp Softkey](#)

## Set Capacitance Output

### Note

*Since this is a synthesized output, make sure the terminal connections from the Calibrator to the DUT are LO to LO and HI to HI.*

To set a synthesized capacitance output at the front-panel OUTPUT terminals (**Function > Single Output > Capacitance**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

Also see these sections:

- [Guard Softkey](#)
- [Comp Softkey](#)

## Set Inductance Output (Not Available on 5540A)

### Note

*Since this is a synthesized output, be sure the terminal connections from the Calibrator to the DUT are LO to LO and HI to HI.*

To set a synthesized inductance output at the front-panel OUTPUT terminals (**Function > Single Output > Inductance**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

Also see these sections:

- [Guard Softkey](#)
- [Comp Softkey](#)

## Set Temperature Simulation (RTD) Source


To set the RTD output (**Function > Single Output > RTD Source**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics. Note that output limits depend on the selected RTD type and keyed in values may automatically be adjusted according to those limits.

### Note

*When you calibrate Resistance Temperature Detectors (RTDs) with the three-terminal connection shown in Figure 9, make sure that the test leads have identical resistances to cancel any errors due to lead resistance. This can be accomplished, for example, by using three identical test lead lengths and identical connector styles.*

RTDs have a characteristic resistance at specific temperatures. The simulated output, then, is a resistance value based on the selected temperature and type of RTD being simulated. Where necessary, use **degree** to set °F or °C. To toggle the degree reference between the 1968 International Provisional Temperature Standard (IPTS-68) and the 1990 International Temperature Standard (IPTS-90), toggle the **Temperature Scale** softkey.

To select an RTD type:

1. Tap the RTD Type button (  ). The RTD Type slide-out menu opens.
2. Select the RTD type:
  - Cu 10 (427)
  - Cu 50 (428)
  - Cu100 (428)
  - Ni 120 (672)
  - Pt 100 (385)
  - Pt 100 (3916)
  - Pt 100 (3926)
  - Pt 200 (385)
  - Pt 500 (385)
  - Pt 1000 (385)
3. Tap the **Apply** button or push **ENTER**. This closes the menu. The entry is copied to the RTD Type button. Tapping **x** instead of **Apply** closes the menu without saving changes. Note that output values may automatically adjust according to the limits of the selected RTD type.

Also see these sections:

- [Comp Softkey](#)
- [Guard Softkey](#)

## Set TC Source

### Note

*Thermocouples often have no electrical isolation. Make sure the thermocouple wire and plug are not affected by extraneous temperature sources. For example, do not place fingers on the thermocouple plug or wire when simulating a temperature.*

*You must use thermocouple wire and connectors that match the type of thermocouple. For example, if simulating a temperature output for a type K thermocouple, use type K thermocouple wire and type K connectors.*

To set a simulated Thermocouple output (**Function > Single Output > TC Source**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics. Note that output limits depend on the selected TC type and keyed in values may automatically be adjusted according to those limits. The simulated thermocouple temperature output (a small dc voltage based on the selected temperature and type of thermocouple) is at the Calibrator front-panel TC connector. Where necessary, use **degrees** to set °F or °C. To toggle the degree reference between the 1968 International Provisional Temperature Standard (IPTS-68) and the 1990 International Temperature Standard (ITS-90), toggle the **Temperature Scale** softkey.

Also see these sections:

- [Guard Softkey](#)
- [Reference Junction](#)
- [Thermocouple Type](#)

## Dual Output Menu (Not available on 5540A)

Dual output functions facilitate calibration of power analyzers and meters for single-phase instruments. Multiple Calibrators can be configured together in a system for multiphase-power analyzers and meters.

For all dual output functions, two simultaneous outputs are generated and use four output terminals. The primary output is always voltage and uses the Output VZ and LO terminals, while currents  $\leq 3.1$  A use the VI AUX and Sense LO terminals. For dual outputs where the current is  $> 3.1$  A, use the 30A and Sense LO terminals.

When you enter only a current value, the Calibrator changes to SINGLE output current. When you enter only a voltage value, the Calibrator changes to SINGLE output voltage. When in dual output, always enter BOTH voltage and current, even if you want to change only one entry.

When you enter the inputs:

- You can tap a value and use the Edit knob for the values.
- Enter voltage or current and then a watts entry with **w** to open the DC Power function or to edit the AC Power function if an AC function is the active function. The remaining volts or current value is calculated and displayed.

## **Set DC Power Output**

To set the dc power output (**Function > Dual Output > DC Power**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

The Calibrator produces a dc power output by sourcing a dc voltage on the OUTPUT HI and OUTPUT LO terminals and an ac current on the VI AUX or 30A and SENSE LO terminal outputs.

Also see these sections:

- [Guard Softkey](#)
- [Lows Softkey](#)

## **Set AC Power Output**

To set the ac power output (**Function > Dual Output > AC Power**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

The Calibrator simulates an ac power output by sourcing an ac voltage on the OUTPUT HI and OUTPUT LO terminals and an ac current on the VI AUX and SENSE LO terminals, or the 30A and SENSE LO terminals, depending on amperage.

For Sine-Sine ACP, the Display also shows the real power output for sine waves. Power out is computed as  $\text{Power} = \text{Cosine } \Phi (\text{Volts} \times \text{Current})$  where  $\Phi$  is the phase difference between the volts and current waveforms. Cosine  $\Phi$  is also known as the Power Factor (DPF).

Adjust Phase- Aux to Output - selects the phase difference between the VI AUX and OUTPUT outputs.

Adjust Phase - Output to Reference - sets the phase difference between the OUTPUT and the 10 MHz reference or between the OUTPUT and an external primary Calibrator (using 10 MHz (IN/OUT) and the OUTPUT output. See [Synchronize the Calibrator Using 10 MHz IN/OUT](#).

Also see these sections:

- [Guard Softkey](#)
- [Lows Softkey](#)
- [Sync Button](#)
- [Select Waveforms](#)
- [Adjust Phase - Aux to Output](#)
- [Adjust Phase - Output to Reference](#)

## Set a Dual DC Voltage Output

### Note

*Voltage on the VI AUX output is limited to  $\pm 7$  V maximum.*

To set a dual dc voltage output (**Function > Dual Output > DCV DCV**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

The Calibrator produces a dual dc voltage output by sourcing one dc voltage on the OUTPUT terminals and a second on the AUX terminals.

Also see these sections:

- [Guard Softkey](#)
- [Lows Softkey](#)

## Set a Dual AC Voltage Output

### Note

*The VI AUX output is limited to 5 V rms for sine waves and 10 V p-p for square waves.*

To set a dual ac voltage output (**Function > Dual Output > ACV ACV**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

The Calibrator produces a dual ac voltage output by sourcing one ac voltage on the OUTPUT terminals and a second on the AUX terminals.

Also see these sections:

- [Guard Softkey](#)
- [Lows Softkey](#)
- [Sync Button](#)
- [Select Waveforms](#)
- [Adjust Phase - Aux to Output](#)
- [Adjust Phase - Output to Reference](#)



## Measure Menu

### Measure Thermocouple Temperatures

#### Note

Use thermocouple wire and connectors that match the type of thermocouple. For example, type K wire and type K connectors.

To select the TC Measure function (**Function > Measure > TC Measure**), refer to [Function Menu](#). Where necessary, use **degree** to set °F or °C. To toggle the temperature scale between the 1968 International Provisional Temperature Standard (IPTS-68) and the 1990 International Temperature Standard (IPTS-90), toggle the **Temperature Scale** softkey.

**Equivalent**, on the lower left of the screen, is the actual dc voltage at the front-panel TC terminals. This is a displayed reading only.

Also see these sections:

- [Guard Softkey](#)
- [Reference Junction](#)
- [Enter a DC Offset](#)
- [Thermocouple Type](#)

### Open TC Detect Softkey

The **Open TC Detect** softkey turns the Open TC Detect feature **ON** or **OFF**. When Open TC Detect is ON, a small electrical pulse checks for thermocouple continuity that, in most cases, has no effect on the measurement. If you measure the thermocouple with the Calibrator in parallel with another temperature-measuring device, select **OFF** for Open TC Detect. When an open thermocouple is detected, **Open TC** is displayed in the TC menu, providing positive identification of the fault.

### Waveform Types

AC voltage, ac current and ac power functions provide a waveform button to select between sine wave (sine) and square wave (square). Refer to [Select Waveforms](#) for additional information on waveforms available in Scope functions.

#### Note


*Dual output is not available on 5540A.*

Waveforms are expressed as RMS for Sine and Peak to Peak (p-p) for Square.

Also see these sections:

- [Select Waveforms](#)
- [Adjust Phase - Aux to Output](#)
- [Adjust Phase - Output to Reference](#)

## Sine Wave

When the wave selection is sine (  ), a sine wave current or voltage signal is present on the Calibrator outputs (Figure 11). The variables for the sine wave are amplitude, frequency, and dc offset voltage. When you select a sine wave, the Display indicates amplitude in rms units.

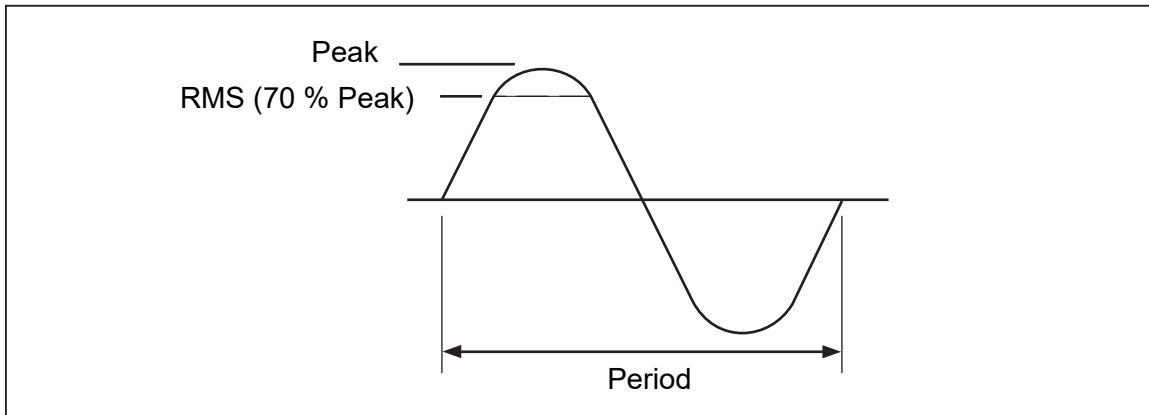



Figure 11. Sine Wave

## Square Wave

When the wave selection is square (  ), a square wave current or voltage signal is present on the Calibrator outputs (Figure 12). The variables for the square wave are duty cycle, amplitude, frequency, and dc offset voltage. Whenever a square wave is selected, the Display indicates amplitude in p-p units. If the Calibrator is set for a single voltage output, the duty cycle of the signal can be set through the numeric keypad. To enter a new duty cycle, tap the **Mode** softkey and toggle the setting to **DUTY CYCLE** tap the duty cycle value on screen to select it, then use the numeric keypad to enter the new duty cycle followed by **ENTER**. The negative-going edge of the square wave will move based on the duty cycle setting.

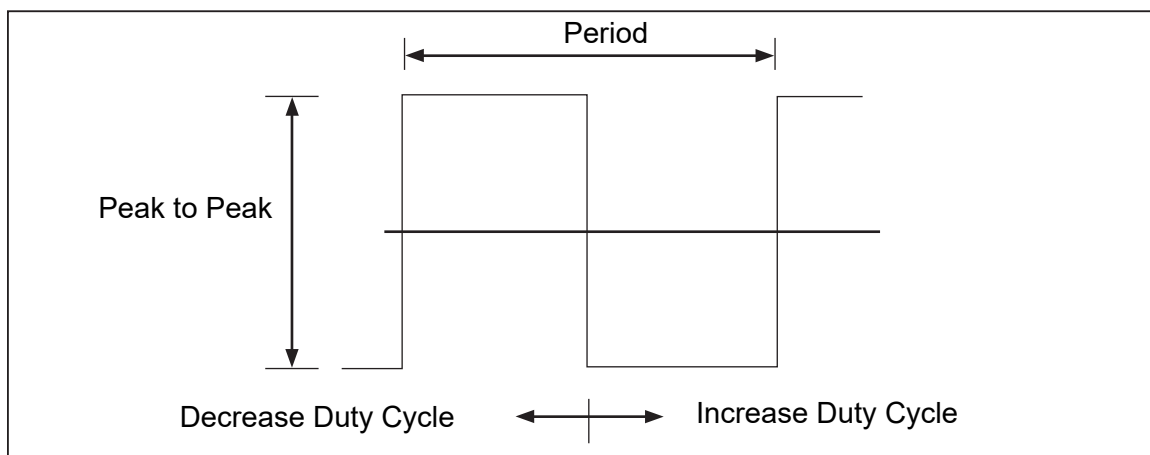







Figure 12. Square Wave and Duty Cycle

## Editing and Error Output Settings

All Calibrator outputs can be edited using the Edit knob and associated Selection keys. Using the knob in many cases opens an Error Mode slide out where the Error, Reference and Type (Error Reference, either Nominal Value or True Value), and sometimes Power is displayed. While *slewing* (turning) the knob, the error continues to update. Tap the **New Reference** button to save the new value to reference and clear the error value. Change the Error Reference Type in the Setup Menu if necessary. See [Display the DUT Error](#).

Table 14 shows the actions that cause the Calibrator to exit the error mode and return to the original reference output, or to output a new reference, as selected.

**Table 14. Keys That Exit Error Mode Or Output a New Reference**

Keys	Action
X or 	Returns to the previous reference value and exits the Error Mode.
<b>New Reference</b>	Establishes a new reference and exits the Error Mode.
A new numeric keypad entry + 	Establishes a new reference.
	Sets the Calibrator to ten times the reference value and establishes a new reference.
	Sets the Calibrator to one-tenth the reference value and establishes a new reference.
	Returns to the power-up state.

## Output Setting

When you initially source an output from the Calibrator, you enter a specific value. For example, 10.00000 V dc. To edit the output value to suit the application:

1. Tap the desired output on the screen to select it.
2. Turn the Edit Field knob clockwise to increase the value or counter-clockwise to decrease the value. Many pop-ups, slide-outs, and menu screens block the editing of function output fields and should be closed first.

To select a digit, use an Edit Field cursor key  or . The output digit in edit will be underlined.

The momentary display of the open yellow box or open green circle in the upper left of the Display when editing during OPERATE indicates **unsettled**. That is, the Calibrator output is settling with a new value when the open green square or circle goes solid.

## Display the DUT Error

When you edit the output value using the knob, the Error Mode slide out shows the difference between the reference value (the value that you originally entered) and the edit value (the value shown in the Display), displaying the error difference in scientific notation, parts per million (ppm), or percent (%). For example, if Error Units (found in the **Setup > Instrument Setup > Defaults** menu) is set to <100 ppm, the error shows in ppm up to 99 and then the error changes to 0.0100 % at 100 ppm. This allows you to edit the output such that the DUT displays the expected value and thus give an indication of the DUT accuracy. Note that if you enter digits from the front-panel keys, the Error Mode slide out is not shown.

For example, an edited difference of .00030 V for an output of 10.00000 V represents  $0.00030/10.00000=0.000030$ , or 30 parts per million. The sign is negative (-30.0 ppm) because the output necessary to display 10.00000 at the DUT shows the DUT is reading below the output value. When the reference is negative, the error sign is relative to the magnitude. For example, if the reference is -10.00000 V and the Display is -10.00030, the error is -30 ppm.

The Calibrator has two methods of displaying the DUT error. The first method, called the *nominal* method is used in the Fluke 57XXA and 55XXA Calibrators. The second method is called *true value*. Both methods are used in this Calibrator.

The nominal method of error calculation uses the formula:

$$\frac{\text{reference value} - \text{edit value}}{\text{reference value}}$$

The nominal method is useful for checking the error of the Calibrator itself, when you are verifying its performance against a more accurate measuring device.

The true value method of error calculation uses the formula:

$$\frac{\text{reference value} - \text{edit value}}{\text{edit value}}$$

With either the nominal or true value method, small changes in output value result in a calculated error that is the same. In the example above, the Display will show the error as -30.0 ppm ( $\times 10^{-6}$ ).

The true value method is useful for large changes in output value. For example, if you apply 10.0000 V to an analog meter, and then adjust the Calibrator output to 11.0000 V such that the analog meter now reads exactly 10 V, the true value method will display

$$\text{reference} = +10.0000 \text{ V}$$

$$\text{rel err} = -9.0909 \%$$

The -9.0909 % represents the relative error of the analog meter when compared to the true value (11.00000 V in this case).

To select the DUT error calculation method:

1. Tap the **Setup** softkey.
2. Select **Instrument Setup** from the Setup Menu.
3. Under **Defaults**, tap **Set** to open the defaults setup submenus.
4. Flick the screen up to get to the **Error Reference** options.
5. Tap the radio button for either Nominal Value or True Value.

## Multiply and Divide

The Calibrator output value (or reference value if you are in error mode) can be multiplied by a factor of 10 by pushing **X**. Similarly, the output value (or reference value if you are in error mode) can be divided a factor of 10 by pushing **÷**. The output will be placed in Standby if the multiplied value exceeds 30 V rms or 42 V peak. Push **OPERATE** to continue. This feature is useful for DUTs with ranges organized in decades. Refer to [Multiplier and Division Key Sequencing](#) when you use these keys in scope functions.

## Set Output Limits

The output limit feature helps prevent accidental damage to a DUT from overcurrent or overvoltage conditions. Use the feature to preset the maximum positive and negative allowable voltage or current output. These set entry limits prevent any output greater than the limit from being activated by entry through the front-panel keys or the output adjustment controls. Limit selections are saved in nonvolatile memory. Voltage limits are expressed as rms values, and any voltage offsets are ignored.

## Set Voltage and Current Limits

To set voltage and current entry limits:

1. Tap the **Setup** softkey.
2. Select **Instrument Setup** from the Setup Menu.
3. Under **Output Limits**, tap **Set** to open the output setup submenus.
4. Select the box for what you wish to limit, such as the box under **Voltage (V RMS), Upper Limit**.
5. Use the numeric keypad to enter the value.
6. Push the **ENTER**.
7. Select **Back** to go to the prior Setup Menu screen or **Exit** to close the Setup Menu.

## Synchronize the Calibrator Using 10 MHz IN/OUT

You can synchronize one or more Calibrators using the 10 MHz IN and OUT input/output on the rear panel. Example applications of this capability are connecting two or more calibrators in parallel in the current output function to sum their outputs, or using three calibrators to calibrate a three-phase power meter.

The multiphase system can be configured in different ways. In some cases, a **Sync** button will be necessary.

To show the Sync button:

1. Go to **Setup > Instrument Setup**.
2. Tap the **Set** button under **Defaults**.
3. Scroll down to Multi-Unit Phase Synchronization Button and select **Show**.

Set up your multiphase system as in one of these configurations:

- Complete standalone system, where the primary unit is set to internal clock and all secondary units are set to external clock. The clocks are all daisy chained in a ring. This system does not need a **Sync** button.
- Same as above, but without a ring configuration. In this case the primary unit needs the **Sync** button displayed.
- The entire system will be locked to a house 10 MHz standard. In this case all units have to be set to external clock and the **Sync** button needs to be displayed on the primary unit.

Another use for the 10 MHz IN reference input is to improve the frequency performance of the Calibrator by injecting a reference 10 MHz clock signal.

### **How to Use an External 10 MHz Clock**

The Calibrator uses an internal 10 MHz clock signal as a reference for all ac functions. Although this internal clock is very accurate and stable, you may have a lab standard that you want to govern the frequency performance of the Calibrator. To apply an external clock to the Calibrator, you can make external reference the power-up and reset default condition.

To make external reference the power-up and reset default setting:

1. Tap the **Setup** softkey.
2. Select **Instrument Setup** from the Setup Menu.
3. Under **Defaults**, tap **Set**.
4. Scroll the screen up to reach the **Reference Clock** options.
5. Tap the radio button for **Internal** or **External**.
6. Tap **Back** to go to the prior Setup Menu screen or **Exit** to close the Setup Menu.

### **Sample Applications**

See the subsequent sections for sample calibration examples for these models.

- Fluke 77 Series IV Digital Multimeter (DMM)
- Fluke 51 Digital Thermometer

The Calibration process is made up of two procedures:

- Verification of the Device Under Test (DUT) that tests each function and range for compliance to specifications.
- Adjustment of the DUT so that it meets the performance test ranges.

## Calibrate a 77 Series IV DMM

### Note

This is an example procedure. The 77 Series IV Calibration Information Manual contains the authoritative verification and adjustment procedures for that product.

This example uses the Fluke 55XXA/DMMCAL cable assembly and the Product to verify a Fluke 77 Series IV DMM.

### 55XXA/DMMCAL Cable Assembly

#### ⚠️⚠️ Warning

To prevent electric shock, fire, or personal injury, make sure the product is in Standby before making any connection between the product and tester.

Use the 55XXA/DMMCAL cable assembly to connect the DUT to the Calibrator. See Figure 13.

1. Connect the stackable double banana plug labeled DMM SENSE to the DUT inputs: **VΩ** and **COM**.
2. Stack the double banana plug labeled DMM INPUT into the DMM SENSE plug from step 1.
3. Connect the single banana plug labeled LO I INPUT to the DUT **400mA** input.
4. Connect the single banana plug labeled HI I INPUT to the DUT **10A** input.

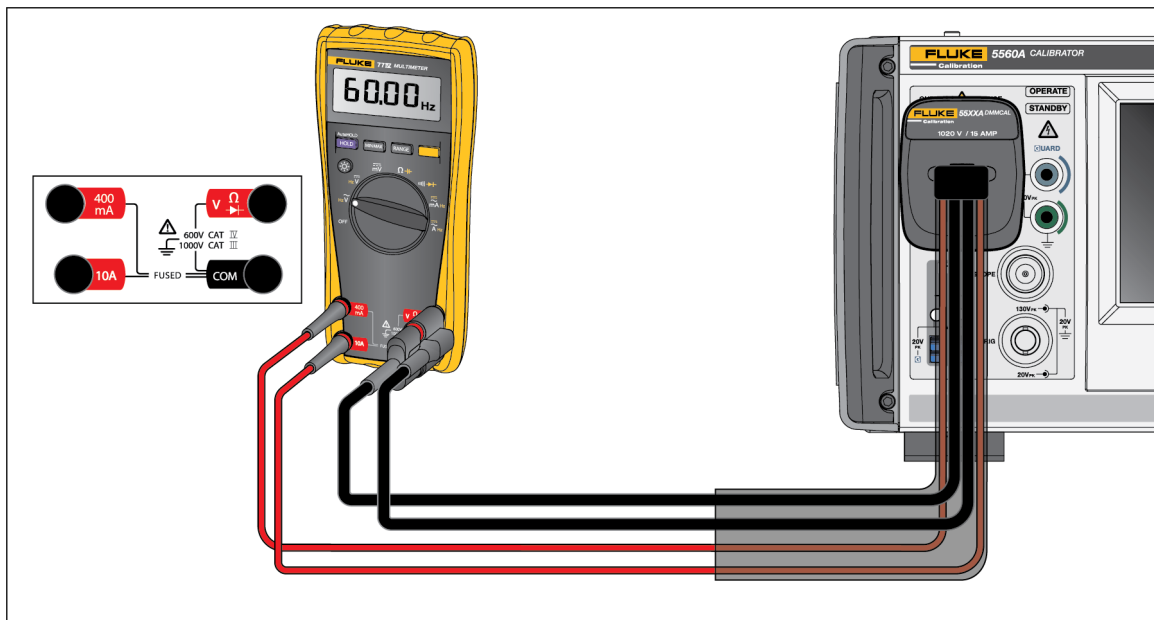


Figure 13. 55XXA/DMMCAL Cable Connection to a 77 IV Series DMM

### Verification Procedure

1. Set the DUT function to the position called for in Table 15.
2. Apply the indicated Calibrator output to the DUT for each test.
3. To verify the performance of the DUT, make sure that the DUT reads within the limits shown in the Meter Response column.

**Table 15. Performance Test - 77 Series IV DMM**

Steps	Test (Switch Position)	Calibrator Output	Meter Response	
			Lower Limit	Upper Limit
1	Ω Ohms <sup>[2]</sup>	500 Ω	497.3 Ω	502.7 Ω
2		5 kΩ	4.974 kΩ	5.026 kΩ
3		50 kΩ	49.74 kΩ	50.26 kΩ
4		5 MΩ	4.974 MΩ	5.026 MΩ
5		10 MΩ	9.79 MΩ	10.21 MΩ
6		40 MΩ	39.19 MΩ	40.81 MΩ
7	))) Continuity	25 Ω	Beeper On	
8		250 Ω	Beeper Off	
9	Ṽ AC Volts	50 mV 45 Hz	0.047 V ac	0.053 V ac
10		5 V 45 Hz	4.898 V ac	5.102 V ac
11		5 V 1 kHz	4.898 V ac	5.102 V ac
12		50 V 45 Hz	48.98 V ac	51.02 V ac
13		50 V 1 kHz	48.98 V ac	51.02 V ac
14		500 V 45 Hz	489.8 V ac	510.2 V ac
15		500 V 1 kHz	489.8 V ac	510.2 V ac
16		1000 V 45 Hz	978 V ac	1022 V ac
17		1000 V 1 kHz	978 V ac	1022 V ac
18	Ṽ Hz AC Volts Frequency <sup>[1]</sup>	5 V 99 Hz	98.89 Hz	99.11 Hz
19		5 V 900 Hz	899 Hz	901 Hz
21		5 V 50 kHz	49.94 kHz	50.06 kHz
22	V̄ DC Volts	5 V	4.984 V dc	5.016 V dc
23		50 V	49.84 V dc	50.16 V dc
24		300 V	299.0 V dc	301.0 V dc
25		1000 V	996 V dc	1004 V dc
26		-1000 V	-1004 V dc	-996 V dc



**Table 15. Performance Test - 77 Series IV DMM (cont.)**

Steps	Test (Switch Position)	Calibrator Output	Meter Response	
			Lower Limit	Upper Limit
27	$\overline{\text{mV}}$ DC Millivolts	30 mV dc	29.8 mV dc	30.2 mV dc
28		-300 mV dc	-301.0 mV dc	-299.0 mV dc
29		600 mV dc	598.1 mV dc	601.9 mV dc
30	$\overline{\mu\text{F}}$ Capacitance <sup>[1]</sup>	900 nF	887 nF	913 nF
31		9 $\mu\text{F}$	8.87 $\mu\text{F}$	9.13 $\mu\text{F}$
32		90 $\mu\text{F}$	88.7 $\mu\text{F}$	91.3 $\mu\text{F}$
33	$\rightarrow\text{+}$ Diode Test <sup>[1]</sup>	2.0 V	1.978 V dc	2.022 V dc
34	$\rightarrow\text{+}$ Diode Test <sup>[1]</sup>	0.5 mA 45 Hz	0.47 mA ac	0.53 mA ac
35		50 mA 1 kHz	48.73 mA ac	51.27 mA ac
36		$\overline{\text{mA}}$ AC Milliamps	400 mA 1 kHz	389.8 mA ac
37	$\tilde{\text{A}}$ AC Amps	4.0 A 45 Hz	3.898 A ac	4.102 A ac
38		9.0 A 1 kHz	8.75 A ac	9.25 A ac
39	$\overline{\text{mA}}$ DC Milliamps <sup>[1]</sup>	3 mA, 0 Hz	2.93 mA dc	3.07 mA dc
40		50 mA	49.23 mA dc	50.77 mA dc
41		-400 mA	-406.2 mA dc	-393.8 mA dc
42	$\overline{\text{A}}$ DC Amps <sup>[1]</sup>	4.0 A	3.938 A dc	4.062 A dc
43		-9.0 A	-9.16 A dc	-8.84 A dc
<p>[1] Push the YELLOW button to access this function.                  [2] Does not include test lead resistance.</p>				

## Adjustment

Adjust the DUT if it fails the verification tests.

The DMM buttons behave as follows when the calibration mode is enabled:

- Push and hold this button to test the present function. This measurement is uncalibrated and may be inaccurate. This is normal.
- Push and hold this button to display the required input.
- Push this YELLOW button to store the calibration value and advance to the next step. This button is also used to exit calibration mode after the calibration adjustment sequence is complete.

## Adjustment Procedure

To adjust the DMM:

1. Turn the Rotary Function Knob of the DMM to  $\overline{mV}$  (dc).
2. Turn the DMM over and find the Calibration Seal located near the top.
3. With a small probe, break the Calibration Seal and push the Calibration Button for 1 second. The DMM beeps and changes to the calibration mode. The Display reads [ -0 ], designating the first adjustment step. The DMM remains in calibration mode until the Rotary Function Knob is turned off.
4. Enter the input value listed in Table 16 for each step.
5. After each input value is applied, push  to accept the value and proceed to the next step.
6. When the last step in a function is reached, turn the Rotary Function Knob to the next required function. The DMM does not allow a step to be completed if the Rotary Function Knob is turned to the wrong function.

### Note

*If the adjustment procedure is not completed correctly, the DMM will not operate correctly. When adjustment is not performed correctly, the DMM displays the messages [RL and Err and you must adjust the DMM again.*

*The DMM is damaged and requires service if:*

- [RL and Err messages continue to appear after a proper adjustment.
- EEP<sub>r</sub> and Err messages are alternating on the Display.
- EEP<sub>r</sub> message appears on the Display.

**Table 16. Adjustment- 77 Series IV DMM**

Function (Switch Position)	Adjustment Step <sup>[1]</sup>	Input Value
$\overline{\text{mV}}$ (DC Millivolts)	[- 01]	600.0 mV dc
	[- 02]	120.0 mV dc
$\overline{\text{V}}$ (DC Volts)	[- 03]	6.000 V dc
	[- 04]	60.00 V dc
	[- 05]	600.0 V dc
$\tilde{\text{V}}$ (AC Volts)	[- 06]	600.0 mV, 60 Hz
	[- 07]	600.0 V, 60 Hz
$\Omega$ (Ohms)	[- 08]	600.0 $\Omega$
	[- 09]	6.000 k $\Omega$
	[- 10]	60.00 k $\Omega$
	[- 11]	600.0 k $\Omega$
	[- 12]	6.000 M $\Omega$
$\rightarrow +$ (Diode Test)	[- 13]	5.000 V dc
<b>mA</b> (Milliamps)	[- 14]	400.0 mA dc
	[- 15]	400.0 mA ac, 60 Hz
<b>A</b> (Amps)	[- 16]	6.000 A dc
	[- 17]	6.000 A ac, 60 Hz
[1] If the DMM is not connected correctly, or if the rotary switch is in the wrong position, the DMM beeps 2 times to alert the user.		

## Calibrate a Fluke 51 Thermometer

The Fluke 51 Thermometer measures temperature using a type J or K thermocouple. The Calibrator simulates both thermocouples, simplifying testing and calibration. This section demonstrates how the Calibrator is used to calibrate this thermometer.

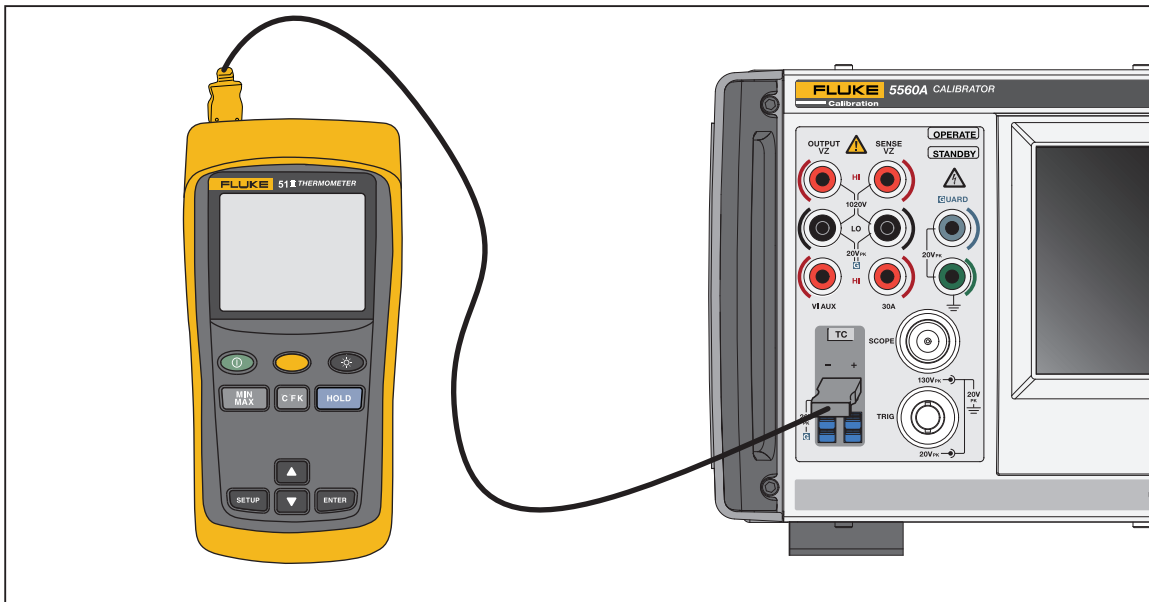
### Note

*These procedures are included here as an example. The Model 51 Service Manual contains the authoritative testing and calibration procedures.*

## Verification Procedure

Conduct this test only after the thermometer has had time to stabilize to an ambient temperature of  $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$  ( $73\text{ }^{\circ}\text{F} \pm 9\text{ }^{\circ}\text{F}$ ).

1. Connect the Fluke 51 Thermometer to the Calibrator using the appropriate connection cable (Figure 14). The connection cable and miniconnector material must match the thermocouple type. For example, if testing a K thermocouple, the cable and miniconnector are for a type K thermocouple.



**Figure 14. Cable Connections for Testing a 50 Series Thermometer**

For Figure 14, connection wiring must match the thermocouple type (for example, K, J).

2. Go to the TC Source function and push , , and .
3. Tap the Thermocouple Type button to select the thermocouple type. Ensure that the **Reference Junction** softkey selection indicates **Internal**. If not, tap the **Reference Junction** softkey.
4. Enter the Calibrator settings listed in Table 17 and verify that performance is within specification.

**Table 17. Thermocouple Performance**

Thermocouple Type <small>[1]</small>	Calibrator Output	Display Readings	
		Degrees C	Degrees F
K	-182.0 °C	-182.0 ±(0.9)	-295.6 ±(1.6)
K	-80.0 °C	-80.0±(0.8)	-112.0 ±(1.4)
K	530.0 °C	530.0 ±(1.2)	986.0 ±(2.3)
K	1355.0 °C	1355.0 ±(2.1)	2471.0 ±(3.8)
J	-197.0 °C	-197.0 ±(1.0)	-322.6 ±(1.7)
J	258.0 °C	258.0 ±(1.1)	496.4 ±(1.9)
J	705.0 °C	705.0 ±(1.5)	1301.0 ±(2.7)

[1] When changing thermocouple types, make sure to change the corresponding hookup wire. For example, K-type thermocouple wire changes to J-type thermocouple wire.

### Calibrate the Thermometer

The procedure below refers to the Fluke 51 as the Device Under Test (DUT). Use copper hookup wire for all connections, except for steps 17 to 20.

#### ⚠ Caution

**To prevent damage to the Fluke 51 Thermometer, use only the elastomeric switch pad supplied when directed to short the switch grid on the circuit board.**

1. Turn the DUT off and remove the top case, leaving the pca in the bottom case.
2. Ensure the Calibrator is in standby and connect the DUT to the Calibrator as shown in Figure 14. When making this connection with the DUT case top removed, make sure that the wide blade of the thermocouple is oriented the same as the case top would normally allow.
3. Simultaneously short the TP1 grid and turn on the DUT by shorting the ON/OFF switch grid. Hold the elastomeric switch pad on TP1 for at least 3 seconds after turn on. This puts the DUT into the Thermocouple Calibration mode.
4. Select °C mode and T1 on the DUT.

#### Note

*The next few steps require specific voltages to be present on the inputs of the Thermometer. By using the 10 μV/°C type thermocouple selection of the Calibrator, you can specify the output voltage on the TC terminals.*

5. Push **0**, **degree**, and **ENTER**.
6. Tap the Thermocouple Type button and select 10 μV/°C from the slide out so that 10 μV/°C is displayed.
7. Push **OPERATE**.
8. Allow the DUT reading to settle and then adjust the T1 offset adjustment (R7) for a display reading of 25.2 °C ±0.1 °C.
9. Change the Calibrator output to 5380.7 °C. This places 53.807 mV on the tc terminals.

10. Allow the DUT reading to settle and adjust R21 for a display reading of  $+1370.0\text{ }^{\circ}\text{C} \pm 0.4\text{ }^{\circ}\text{C}$ .
11. Push **Reset** on the Calibrator to remove voltage from the DUT. Disconnect the DUT from the Calibrator. Power down the DUT by shorting the ON/OFF switch grid.
12. With an elastomeric switch pad in both hands, use the left one to short out the TP2 grid, and use the right one to first turn on the instrument and then quickly short out the VIEW switch grid. Hold this position until the Display is held in self-test. This puts the DUT into the Reference Junction Sensor calibration mode, and the VIEW maneuver turns off a filter so that the reading settled immediately.
13. Using a type K thermocouple bead included with the Calibrator lead kit and the Calibrator TC Measure mode (**Function > Measure > TC Measure**) measure the reference junction transistor temperature by placing the K-bead into the middle hole of the isothermal block. The bead tip should be placed into the well, against the body of Q1. Hint: Covering the well and positioning the bead with a piece of tissue may help the bead stay in place. Do not hold the bead in place with your hands as this may introduce a measurement error. Wait for the temperature reading to stabilize.
14. Adjust R16 for a temperature reading on the DUT that is the same as displayed on the Calibrator.
15. Power down the DUT and reassemble.

## **Maintenance**

This section explains how to perform the routine maintenance and calibration task required to keep a normally-operating Calibrator in service.

Refer to the Service manual found on the Fluke Calibration website for intensive maintenance tasks such as troubleshooting, calibration or repair, and all procedures that require opening the cover of the instrument. The Service Manual also contains complete, detailed verification and calibration procedures.

### **Warning**

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

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

## **Clean the Product**

Clean the case, front-panel keys, and Display with a soft cloth slightly dampened with a mild detergent solution that is not harmful to plastics.

### **⚠ Caution**

**Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. They can damage the plastic materials used in the Product.**

## **Replace the Mains Power Fuse**

Access the fuses from the rear panel. The correct fuse rating for each operating voltage is shown on the label to the right of the fuse compartment.

### **⚠⚠ Warning**

**To prevent possible electric shock, fire, or personal injury:**

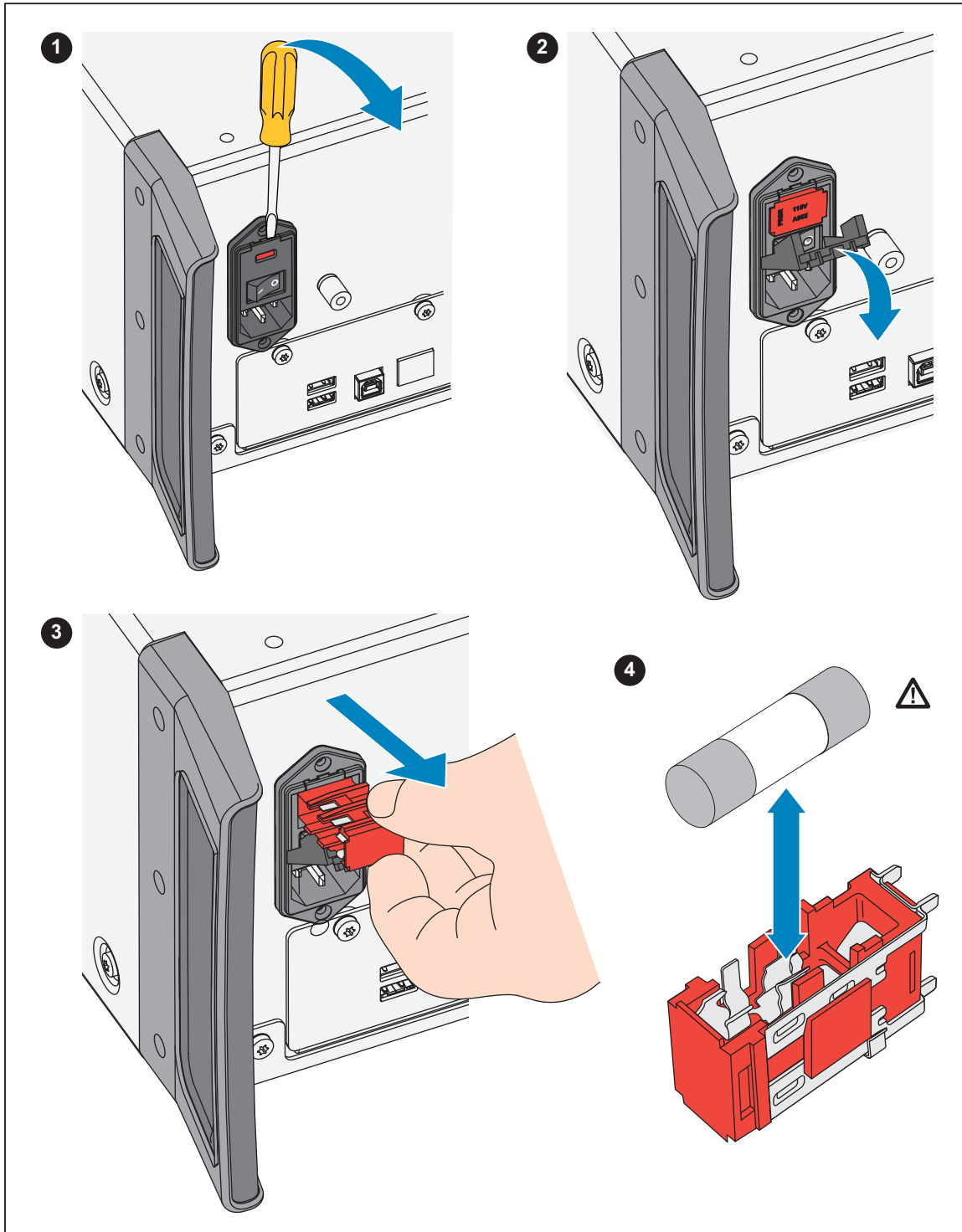
- **Turn the Product off and remove the mains power cord. Stop for two minutes to let the power assemblies discharge before you open the fuse door.**
- **Use only specified replacement fuses, see the back of the Product for the correct replacement fuse.**

To check or replace the fuse, refer to Table 18 and Figure 15 and proceed as follows:

1. **Disconnect line power.**
2. Open the fuse compartment by inserting a flat screwdriver blade into the tab located at the top of the compartment door and gently pry until it can be removed with the fingers.
3. Remove the fuse from the compartment for replacement or verification.
4. Install the fuse. Make sure the correct fuse is installed.
5. Push the fuse compartment door back into place until the tab locks.

**Table 18. Replacement Fuses**

Line Voltage Range	Fuse Description	Fluke Part Number
100 V to 120 V	T5.0 A 250 V	109215
220 V to 240 V	T2.5 A 250 V	851931



**Figure 15. Access the Fuse**



## Options and Accessories

Options and accessories for the Product are listed in this section. To order, note the Model Number and Description and [Contact Fluke Calibration](#), see Table 19.

**Table 19. Options and Accessories**

Model	Description
55X0A/600M	600 MHz Oscilloscope Calibration Option (Available for 5560A, 5550A and 5540A)
55X0A/1G	1.1 GHz Oscilloscope Calibration Option (Available for 5560A or 5550A)
5560A/2G	2.2 GHz Oscilloscope Calibration Option
55XXA/ CARRYCASE	Carry Case with removable front/back panels
55XXA/PORTKIT	Installable option with rugged handles, side handle, cross bar, and front pouch
55XXA/LEAD SET	Thermocouple and Test Leads Set
664828	MET/CAL-IEEE NT, Option, IEEE Interface
666339	MET/CAL-IEEE PCI, Option, IEEE Interface (PCI)
943738	RS-232 Modem Cable, 2.44 m (8 ft) (SERIAL 2 TO DUT) to DUT (DB-9)
MET/CAL-L	Automated Calibration Software.
MET/TEAM-L	T&M Asset management Software.
MET/TEAM	Fluke Metrology Software.
MET/CAL-IEEE NT	IEEE Interface Option.
MET/CAL-IEEE PCI	IEEE Interface Option.
MET/CAL-IEEE PCMIA	IEEE Interface Option.
MET/CAL-IEEE USB	IEEE Interface Option.
PM8914/001	RS-232 Null Modem Cable, 1.5 m (5 ft) (SERIAL 1 FROM HOST) to PC COM (DB-9)
RS40	RS-232 Null Modem Cable, 1.83 m (6 ft) (SERIAL 1 FROM HOST) to PC COM (DB-25)
5346298	5560A-2502, EAR, RACK, 7 in.
Y5538	Rack Mount Kit for 5560A, 5550A, and 5540A
55XXA/DMMCAL	Cable (See <a href="#">Earth</a> )
Y8021	Shielded IEEE-488 Cable 0.5 m (1.64 ft)
Y8022	Shielded IEEE-488 Cable 2 m (6.56 ft)
Y8023	Shielded IEEE-488 Cable 4 m (13 ft)
4376007	5730A-7002, TEST LEAD SET, LOW THERMAL BANANA

## **Rack Mount Kit**

The Y5538 rack mount kit provides all the hardware necessary to mount the Calibrator in a 24-inch (61 cm) equipment rack. Instructions are provided in the kit.

## **IEEE-488 Interface Cable**

Shielded IEEE-488 cables are available in three lengths (See Table 19). The cables attach to the Calibrator to any other IEEE-488 device. Each cable has double 24-pin connectors at both ends to allow stacking. Metric threaded mounting screws are provided with each connector. See the *5560A/5550A/5540A Remote Programmers Manual* at [www.flukecal.com](http://www.flukecal.com) for the pinout information for the IEEE-488 connector.

## **RS-232 Null-Modem Cables**

The PM8914/001 and RS40 null modem cables connect the Calibrator RS-232 Serial Port to a video display terminal, computer, or other serial device configured as DTE (Data Terminal Equipment). See the *5560A/5550A/5540A Remote Programmers Manual* at [www.flukecal.com](http://www.flukecal.com) for the pinouts for the serial connectors.

## **55XXA-525A/LEADS**

The optional test lead kit, 55XXA-525A/LEADS, is a kit of test leads for voltage and current, thermocouple extension wires, thermocouple miniconnectors, and thermocouple measuring *beads*.

## **Scope Options**

The Product has these scope options available: the SC600, SC100, and SC2100. Note that these options menus are available only when you install at least one of the scope options. These options share many of the same menus and functionality. For the sake of brevity, common scope option functions are documented once. Explanations of the main scope functions are in [Oscilloscope Calibration Options](#). Differences are noted where applicable. Non-common functionalities are described where applicable. For Scope Options Specifications, see [Specifications](#).

## **Oscilloscope Calibration Options**

To help maintain oscilloscope accuracy, the scope options verify and calibrate these oscilloscope characteristics:

- **Vertical deflection** - The DCV and ACV functions compares the voltage gain to the graticule lines on the oscilloscope.
- **Pulse transient response** - Verify the accuracy of the oscilloscope measurement of pulse transitions with the Edge function.
- **Frequency response or frequency response / bandwidth** - Verify the frequency response with the Leveled Sine function. Vertical deflection is monitored until the -3 dB point is observed on the oscilloscope.
- **Horizontal (time base) deflection** - Calibrate and verify with the Marker function. This calibration procedure is similar to the procedure that verifies the vertical deflection characteristics, except that it checks the horizontal axis.

- **The ability of the oscilloscope to display, capture, and measure pulse width** - Check with the Pulse function. This function can vary both the pulse width and the period.
- **The ability of the oscilloscope to trigger on different waveforms** - Check with the Waveform Generator function.
- **The ability of the oscilloscope to trigger on and capture complex TV Trigger signals** - Check with the Video function.
- **Oscilloscope input characteristics** - Measure with the Measure Resistance and Measure Capacitance functions.
- **Oscilloscope input protection circuit**- Test with the Overload DC and Overload AC functions.

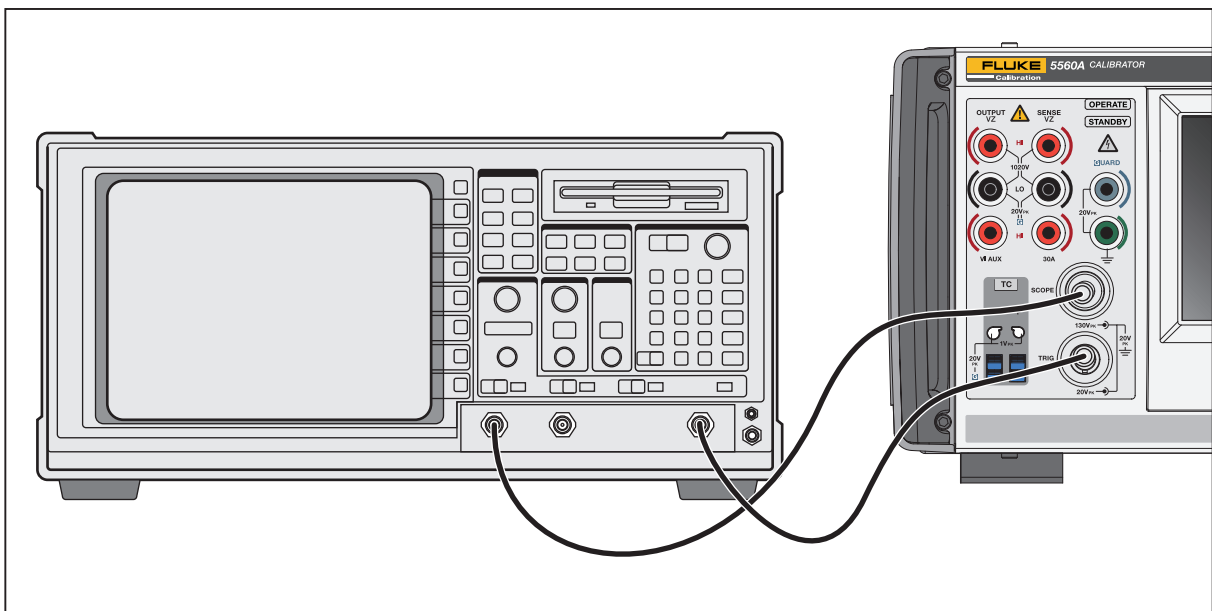
### **Oscilloscope Connections**

Use the cable supplied with the scope option to connect the SCOPE output on the Product to one of the channel connectors on the oscilloscope (see Figure 16).

- To use the external trigger, connect the TRIG output on the Product to the external trigger connection on the oscilloscope.
- To use the external trigger and view its signal with the calibration signal, connect the TRIG output to another channel.

See your oscilloscope manual for details to connect and view an external trigger.

**Figure 16. Oscilloscope Connection: Channel and External Trigger**





## Scope Menu







The Scope menu offers the choices shown in Table 20. To use the **Scope** menu (**Function Menu > Scope**). Scope menu functions are explained in their respective sections.

**Table 20. Scope Menu Functions**

Menu Item	See Section
DCV	<a href="#">Set Scope DC Voltage Output</a>
ACV	<a href="#">Set Scope AC Voltage Output</a>
Edge	<a href="#">Set Scope Edge Output</a>
Leveled Sine	<a href="#">Set Scope Leveled Sine Output</a>
Marker	<a href="#">Set Scope Marker Output</a>
Waveform Generator	<a href="#">Set Scope Waveform Generator Output</a>
Video	<a href="#">Set Scope Video Trigger Output</a>
Pulse	<a href="#">Set Scope Pulse Output</a>
Measure Resistance	<a href="#">Measure Scope Resistance</a>
Measure Capacitance	<a href="#">Measure Scope Capacitance</a>
Overload DC	<a href="#">Test Overload Protection DC</a>
Overload AC	<a href="#">Test Overload Protection AC</a>

When inside these menu functions, tap the digit or use  and  to move the cursor to the digit that needs to change and then use the Edit Knob to change the value.

### Multiplier and Division Key Sequencing

The  and  keys cause the present value of the signal to jump to a predetermined cardinal value, whose amount is determined by the active function. For example,  and  step the magnitude through cardinal point values of an oscilloscope in a 1-2-5 or 1-2-4 step sequence in most scope functions. If the voltage is 40 mV with a 1-2-5 step sequence setting, then  increases the voltage to the nearest cardinal point, which is 50 mV. Push  to decrease the voltage to the nearest cardinal point, which, in this example, is 20.

On functions that allow alteration of the step sequence, a 1-2-4/1-2-5 Sequence softkey is present. Tap the softkey to toggle the setting. Cardinal points that are unique to a function are listed for reference.

For Scope Edge Output, the sequence values are 5 mV, 10 mV, 25 mV, 50 mV, 60 mV, 80 mV, 100 mV, 200 mV, 250 mV, 300 mV, 500 mV, 600 mV, 1 V, and 2.5 V.

For Scope Leveled Sine Output, the sequence values 3 mV, 6 mV, 12 mV, 30 mV, 60 mV, 120 mV, 300 mV, 0.6 V, 1.2 V, and 3 V for voltage. For frequency, sequencing provides an incrementing or decrementing of the most significant digit.

## **Z<sub>0</sub>**

The **Z<sub>0</sub>** button is available for DCV, ACV, and Waveform Generator Scope menu functions. When pushed, the button toggles the impedance between 1 M $\Omega$  and 50  $\Omega$ . Some scope functions show the static impedance value with a grayed-out button that indicates that it cannot be toggled.

### **The V/DIV Slide Out Menu**

The V/DIV slide out menu, found in the scope dc and ac functions, sets the number of volts denoted by each division on the oscilloscope. This menu provides alternative methods to change the output amplitude that may be more convenient for certain oscilloscope applications. To access the V/DIV slide out menu, tap the icon in the lower left of the Scope > DCV and Scope > ACV screens.

- **V/division** Changes the scale of the output display by changing the number of volts that are represented by each division. The available settings are in 1-2-5 or 1-2-4 step increments, determined by the present sequencing setting. Tap + to increase the volts per division. Tap - to decrease the volts per division.
- **divisions** Specifies the number of divisions that establish the peak-to-peak value of the waveform. Adjust the value from one to eight divisions. Tap + to increase the signal height. Tap - to decrease the signal height.

### **Trigger**

The **Trigger** button is available in the Scope menu ACV, Edge, Marker, and Pulse functions. Tap **Trigger** to toggle between available trigger options. Available options depend on the output values for some functions. See [Oscilloscope Connections](#).

## **Calibrate the Voltage Amplitude on an Oscilloscope**

To calibrate the oscilloscope voltage (vertical) gain, apply a dc or low frequency square wave signal and adjust its gain to meet the height specified for different voltage levels, designated by the graticule line divisions on the oscilloscope. The Product applies the signal from the voltage functions. The specific voltages that you should use for calibration, and the graticule line divisions that need to be matched, vary for different oscilloscopes. Check your oscilloscope service manual.

### **Set Scope DC Voltage Output**



To set the scope dc voltage (**Function Menu > Scope > DCV**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

Also see these sections:

- [Z<sub>0</sub>](#)
- [The V/DIV Slide Out Menu](#)
- [Multiplier and Division Key Sequencing](#)

## Set Scope AC Voltage Output

To set the scope ac voltage (**Function Menu > Scope > ACV**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

The square wave button on this screen lets you invert the value between positive () and negative () waveforms.

Also see these sections:

- [Trigger](#)
- [Z0](#)
- [The V/DIV Slide Out Menu](#)
- [Multiplier and Division Key Sequencing](#) (applicable to frequency)

## Set Scope Edge Output

Use the Edge function (**Function Menu > Scope > Edge**) to calibrate the pulse response of an oscilloscope. To set the scope edge, refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

Also see these sections:

- [Trigger](#)
- [Multiplier and Division Key Sequencing](#)
- [Set the Nominal Value](#)

## Set the Nominal Value

Tap the **Nominal Value** button to open the Nominal Value slide out menu where a sequencing value may be selected. Tap **Apply** to output the desired value and close the slide out menu.

## Set Scope Leveled Sine Output

The Leveled Sine Wave function (**Function Menu > Scope > Leveled Sine**) uses a leveled sine wave whose amplitude remains relatively constant over a range of frequencies to check the bandwidth of the oscilloscope. When you check the oscilloscope, you change the wave frequency until the amplitude shown on the oscilloscope drops 30 %. This is the amplitude that corresponds to the -3 dB point. Default values are 30 mV p-p, 50 kHz.

Refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

Also see:

- [Multiplier and Division Key Sequencing](#)

## **Set Scope Marker Output**

The Scope Marker function (**Function Menu > Scope > Marker**) sets an oscilloscope output and calibrates the timing response. Refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

### *Note*

*The Marker function has some differences in the Select Waveform slide out menu*

*The waveform availability depends on the marker periods:*

- sine 18 ns to 477 ps (133.35 MHz to 2.096 GHz)
- spike 5.5 s to 18 ns (0.18 Hz to 55.56 MHz)
- square 5.5 s to 7.5 ns (0.18 Hz to 133.33 MHz)
- 20% Duty 5.5 s to 85 ns (28.58 Hz to 11.76 MHz)

### *Note*

*The trigger options are dependent on the frequency setting.*

- /1 between 750 ns and 5.5 s
- /10 between 7.5 ns and 34.999 ms
- /100 between 1.819 ns and 34.999 ms
- /128 between 477 ps and 1.8181 ns

Also see these sections:

- [Trigger](#)
- [Select Waveforms](#)
- [Multiplier and Division Key Sequencing](#)

## **Set Scope Waveform Generator Output**

Use the Wave Generator function (**Function Menu > Scope > Waveform Generator**) to test the ability of the oscilloscope to trigger on different waveforms. The wave generator transmits a square, sine, or triangle wave. Vary the wave output frequency, offset, and voltage to test the triggering capability at different levels.

### *Note*

*Do not use the wave generator to check the level or bandwidth accuracy of your oscilloscope.*

Refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

Also see these sections:

- [Enter a DC Offset](#)
- [Select Waveforms](#)
- [Z0](#)
- [Multiplier and Division Key Sequencing](#)
- [Multiply and Divide](#)

## Set Scope Video Trigger Output

To set the scope video trigger output (**Function > Scope > Video**), see Table 13 for output entry basics. Note that for the scope video function, a field must be selected by tapping the screen so that a keyed in unitless value can be applied to the desired field. The primary field is selected by default. After the basic entry, add these steps:

1. Select the correct frame format from the slide out menu.
2. Tap the **Line Marker** value on the Display. An underscore highlights the tapped digit.
3. Turn the Edit Knob to adjust the line marker or key in a new value and push **ENTER**.

Also see these sections:

- [Multiply and Divide](#)
- [Frame Format](#)
- [Field Softkey](#)

### Frame Format

Tap the **Frame Format** button to open its slide out menu. From this menu, select NTSC, SECAM, PAL, or PAL-M. Tap the **Apply** button to accept the choice and close the menu or tap **X** to close the menu without a selection or change. Note that Line Marker values are reset to 10 when the Frame Format is changed.

### Field Softkey

Tap the **Field** softkey to toggle between **ODD** and **EVEN** if applicable. For some video format selections, these choices are unavailable. If the selected format is PAL or SECAM, and the line marker is less than or equal to 313, the **Field** softkey is set to ODD and cannot be toggled and above 313 the Field softkey is set to EVEN and cannot be toggled.

## Set Scope Pulse Output

To set the scope pulse output (**Function > Scope > Pulse**), refer to [Set an Output](#) and the example shown in Table 13 for output entry basics.

After the basic entry, add these steps:

1. Tap the Amplitude button (**Ampl**) to open the Amplitude slide out menu
2. Tap the radio button for the necessary amplitude.

Choices are:

- 2.5 V
  - 250 mV
  - 25 mV
  - 1 V
  - 100 mV
  - 10 mV
3. Tap the **Apply** button or push **ENTER** to close the menu. The entry is copied to the **Ampl** button.
  4. Tap **x** instead of **Apply** to close the menu without saving changes.

Also see these sections:

- [Trigger](#)
- [Multiplier and Division Key Sequencing](#) (applicable to both width and period)



## Measure Scope Resistance

To use the Measure Scope Resistance function (**Function > Scope > Resistance**), select the desired DUT input impedance (50  $\Omega$  or 1 M $\Omega$ ). See [Connect the Calibrator to a DUT](#).

### Note

*The Product automatically goes to an Operate state when you engage the scope resistance function.*

## Measure Scope Capacitance

To use the Measure Scope Capacitance function (Function > Scope > Capacitance):

### Note

*The Product automatically goes to an Operate state when you engage the scope capacitance function*

1. Set the DUT for 1 M $\Omega$  input impedance. Note that input capacitance testing cannot be done with 50  $\Omega$  input impedance.
2. With the output cable connected to the Product but not connected to the oscilloscope, tap the **OFFSET** softkey to zero the capacitance measurement.
3. Connect the output cable to the DUT. See [Connect the Calibrator to a DUT](#).

## Test Overload Protection DC

The overload protection dc test (**Function Menu > Scope > Overload DC**) checks the power-handling capability of an oscilloscope. This function applies power into the 50  $\Omega$  oscilloscope input and monitors the current. The time measurement counter in the bottom left of the Display indicates the time duration of the applied overload signal. A user-selectable time limit applies a limited amount of energy to prevent front-end damage to the oscilloscope.

### **Caution**

**To prevent damage to the oscilloscope, make sure that the power rating specifications of the oscilloscope match the voltages and currents that this test produces.**

To set the scope overload voltage output, refer to [Set an Output](#) and the example shown in Table 13 for output entry basics. After the voltage entry, add these steps:

1. Tap a digit in the Time Limit field.
2. Enter the time limit with the numeric keypad, or rotate the edit knob to slew to the desired time limit. For example, 9 s.
3. Push **ENTER** to input the time limit. The screen shows the updated limit.

After you push **OPERATE**, the Status field shows the test status, for example, **Not Tripped** or **Tripped**.

## Test Overload Protection AC

The ac overload protection test (**Function Menu > Scope > Overload AC**) checks the power-handling capability of the 50  $\Omega$  oscilloscope input. This function applies ac power (1 kHz square wave) into the 50  $\Omega$  oscilloscope input and monitors the current. The time measurement counter in the bottom left of the Display indicates the time duration of the applied overload signal. A user-selectable time limit applies a limited amount of energy to prevent front-end damage to the oscilloscope.

### Caution

**To prevent damage to the oscilloscope, make sure that the power rating specifications of the oscilloscope match the voltages and currents that this test produces.**

To set the scope overload voltage output, refer to [Set an Output](#) and the example shown in Table 13 for output entry basics. After the voltage entry, add these steps:

1. Tap a digit in the Time Limit field.
2. Enter the time limit with the numeric keypad or rotate the edit knob to slew to the desired time limit. For example, 9 s.
3. Push **ENTER** to input the time limit. The screen shows the updated limit.

After you push **OPERATE**, the Status field shows the test status, for example, **Not Tripped** or **Tripped**.

## Error Codes

The subsequent is a list of the Calibrator error messages.

- Error 0 result No error
- Error -440 result 488.2 query after indefinite response
- Error -430 result 488.2 I/O deadlock
- Error -420 result 488.2 unterminated command
- Error -410 result 488.2 interrupted query
- Error -376 result Command only allowed on synchronous (for example, gpib/usb-tmc) interface type
- Error -375 result Command only allowed on asynchronous (for example, serial/telnet) interface type
- Error -374 result GPIB/488.1 unspecified error
- Error -373 result GPIB/488.1 write operation timeout
- Error -372 result GPIB/488.1 read/write operation aborted
- Error -371 result GPIB/488.1 board address error
- Error -370 result GPIB/488.1 system call has failed
- Error -369 result LAN port encountered error while reading data
- Error -368 result Fatal error occurred while accessing the LAN port
- Error -367 result USB-TMC encountered error while reading data
- Error -366 result GPIB/488.1 encountered error while reading data
- Error -365 result Fatal error occurred while accessing the serial port
- Error -363 result Input Buffer Overrun
- Error -361 result RS-232 framing/parity/overrun error detected
- Error -350 result Too many errors
- Error -302 result Command execution locked out
- Error -301 result Restricted Command
- Error -224 result Characters must be A-Z, 0-9, - or \_
- Error -223 result Character string was more than limit
- Error -222 result Illegal data value was entered
- Error -193 result No entry in list to retrieve
- Error -192 result Too many dimensions to be returned
- Error -191 result Parameter type detection error
- Error -190 result Parameter is not a boolean type
- Error -157 result Unmatched bracket
- Error -154 result String size is beyond limit
- Error -153 result Parameter is not an unquoted string type
- Error -152 result Parameter is not an quoted string type
- Error -150 result Invalid string data
- Error -140 result Parameter is not a character type
- Error -138 result Too many suffixes in command header
- Error -137 result Invalid suffix in command header
- Error -130 result Suffix Error. Wrong units for parameter

Error -127 result Invalid dimensions in a channel list  
Error -126 result Numeric value is real  
Error -125 result Numeric value is negative  
Error -124 result Numeric value overflowed its storage  
Error -122 result Parameter is not a numeric type  
Error -120 result Numeric value is invalid  
Error -117 result Wrong type of parameter(s)  
Error -115 result Missing or wrong number of parameters  
Error -102 result Syntax error  
Error 1000 result Illegal Parameter  
Error 1001 result Failed to save data to non-volatile storage  
Error 1002 result Failed to read data from non-volatile storage  
Error 1003 result Remote Port Configuration Invalid  
Error 1004 result Units Must Be The Same  
Error 1005 result Limit Too Small or Large  
Error 1006 result Cannot Get Range Data  
Error 1007 result Cannot Find Range  
Error 1008 result Cannot Send Sync Pulse  
Error 1009 result Writing PCA serial number failed  
Error 1201 result Feature not available  
Error 1202 result Failed self-test [VALUE]  
Error 1203 result Command presently unavailable (in response to TRG command when in some scope functions [\*TRG can be used in MEASR and MEASC])  
Error 1300 result Cannot change the LAN settings now  
Error 1500 result Failed to set DAC to desired value  
Error 1501 result Cannot change the monitor now  
Error 1502 result Cannot find that cal constant  
Error 1503 result Cannot save cal constant  
Error 1504 result Cannot Store, Cal is Secured  
Error 1506 result Cannot Change the Date While Instrument is Secured  
Error 1507 result Continue command ignored  
Error 1508 result Backup command ignored  
Error 1509 result Cannot execute procedure backup request now  
Error 1510 result Cannot execute procedure abort request now  
Error 1511 result Cannot execute procedure start request now  
Error 1512 result Cannot execute procedure step skip request now  
Error 1513 result Cannot execute procedure section jump request now  
Error 1514 result Cannot start diagnostics now  
Error 1515 result Cannot Change the Temperature While Instrument is Secured  
Error 1516 result Cannot Change the Report String While Instrument is Secured  
Error 1517 result Cannot sync scope capacitance offset  
Error 1600 result Invalid Time or Time Setting  
Error 1601 result Invalid Date or Date Setting

Error 1700 result Cannot communicate with 52120  
Error 4001 result Overvoltage on the 12V amplifier  
Error 4002 result Overvoltage on the millivolt output  
Error 4003 result Power up, line power fault  
Error 4004 result External clock failure  
Error 4005 result Overcurrent on the 12V amplifier  
Error 4006 result PLL unlocked, missing 10 MHz reference  
Error 4007 result Excess output current or common mode voltage on the guard terminal  
Error 4008 result Overvoltage or overcurrent condition  
Error 4009 result Scope Option PLL unlocked  
Error 4100 result Compliance voltage exceeded  
Error 4101 result Specification exceeded  
Error 4102 result Compliance current limit exceeded  
Error 4103 result Output settling timed out  
Error 4200 result Temperature monitoring has failed  
Error 4201 result Compliance voltage monitoring has failed  
Error 4202 result Compliance voltage above threshold  
Error 4300 result Zero Cal nulling operation exceeded maximum attempts to converge  
Error 4301 result Zero Cal convergence write failed  
Error 4302 result Zero Cal failed to take measurement  
Error 4303 result Zero Cal no starting value provided  
Error 4304 result Zero Cal pre-checkpoint sequence failed  
Error 4305 result Zero Cal failed to take checkpoint measurement  
Error 4404 result Unknown hardware fault  
Error 4500 result Cannot open 52120 control port  
Error 4501 result DAC counts out of range  
Error 4502 result Out current limit has been exceeded  
Error 4503 result External voltage detected on Output post  
Error 4504 result External voltage detected on VI AUX post  
Error 4505 result Thermocouple output voltage exceeds hardware limits  
Error 4506 result Could not start LED test  
Error 4507 result Json deserialization failed  
Error 5000 result Error while reading 52120A cal store  
Error 5001 result Expected a 52120A but it was gone  
Error 5002 result 52120A cal store corrupted  
Error 5003 result Value out of range of 52120A  
Error 5004 result Unknown error reported by 52120A  
Error 5005 result 52120A added or removed  
Error 5006 result 52120A forcibly turned off  
Error 5007 result 52120A detected over compliance  
Error 5008 result 52120A detected over range  
Error 5009 result 52120A detected over temperature  
Error 6001 result Cal constant does not exist

Error 6002 result Cal correction is missing an input value  
Error 6003 result Attempted to divide by zero  
Error 6004 result Attempted to reverse an irreversible calculation  
Error 6005 result Cal parameter does not exist  
Error 6006 result Cal correction is value only  
Error 6007 result Calculated corrector out of tolerance  
Error 7001 result Frequency must be > 0.0 Hz  
Error 7002 result Function does not permit a frequency below [VALUE]  
Error 7003 result Cannot specify more than one frequency  
Error 7004 result Cannot specify more than two magnitudes  
Error 7005 result Units are required for multiple entries  
Error 7006 result Not applicable  
Error 7007 result Cannot set Duty Cycle in this configuration  
Error 7008 result Cannot set Offset in this configuration  
Error 7009 result Range Lock disabled in this configuration  
Error 7010 result Compensation not available for this function  
Error 7011 result Cannot enable compensation in this configuration  
Error 7012 result Harmonic not available for this function  
Error 7013 result Fundamental not available for this function  
Error 7014 result Setting Range not available for this function  
Error 7015 result Cannot change polarity for this function  
Error 7016 result This value cannot be slewed  
Error 7017 result Cannot change Phase for this function  
Error 7018 result Validation of requested attributes failed  
Error 7019 result Offset range not found  
Error 7020 result Read only mode for calibration control  
Error 7021 result Must be in read only mode to execute this command  
Error 7022 result Cannot enter watts by itself  
Error 7023 result Value not available  
Error 7024 result Harmonic not available for non-sine waveforms  
Error 7025 result TC offset can only be set while in TC Measurement function  
Error 7026 result Temperature Scale can only be set while sourcing or measuring temperature  
Error 7027 result RTD type can only be set while in RTD Source function  
Error 7028 result TC type can only be set while in TC Source/Measure function  
Error 7029 result Coupled command queue limit exceeded  
Error 7500 result Cannot have magnitude above [VALUE] in function [FUNCTION]  
Error 7501 result Cannot have magnitude below [VALUE] in function [FUNCTION]  
Error 7502 result No appropriate range found in function  
Error 7503 result Magnitude exceeds boundaries of selected range  
Error 7504 result Incorrect units for selected function [FUNCTION]

- Error 7505 result Invalid second range selected for function [FUNCTION]
- Error 7506 result Current post/range mismatch for function [FUNCTION]
- Error 7507 result Cannot have frequency above [VALUE] in this configuration
- Error 7509 result Cannot have both Duty Cycle and DC Offset
- Error 7510 result Duty Cycle must be between 1 and 99
- Error 7511 result Duty Cycle is only available with Square Wave
- Error 7512 result Requested offset exceeds the maximum allowed for this output range and waveform
- Error 7513 result Cannot accept non-coupled command while coupled-commands are queued
- Error 7514 result External sense not available for this function
- Error 7515 result Harmonic must be greater than zero
- Error 7516 result Cannot enable 2 wire compensation below [VALUE] in function [FUNCTION]
- Error 7517 result Thermocouple reference must be specified as a temperature
- Error 7518 result Thermocouple offset must be specified as a temperature
- Error 7519 result Cannot have reference below [VALUE] in function [FUNCTION]
- Error 7520 result Cannot have reference above [VALUE] in function [FUNCTION]
- Error 7521 result Thermocouple offset is limited to +/- [VALUE]
- Error 7522 result Cannot use external sense on selected range
- Error 7523 result Function not available
- Error 7524 result Line Marker can range from 1 through [VALUE] with the selected frame format in function [FUNCTION]
- Error 7525 result Cannot enable external reference in this function
- Error 7526 result Trigger Option not available with given primary magnitude
- Error 7527 result Cannot change Power Factor for this function
- Error 7528 result Cannot change Phase Angle Sign for this function
- Error 7530 result The magnitude representation cannot be changed in this function
- Error 7531 result Cannot set wave now
- Error 7532 result Cannot enable 2 wire compensation above [VALUE] in function [FUNCTION]
- Error 7533 result Watts requires AC Power and a sine waveform
- Error 7534 result Power factor must be  $\geq -1.0$  and  $\leq 1.0$
- Error 7535 result Cannot have magnitude between -1mV and 1mV in SACV
- Error 7536 result Cannot have magnitude above [VALUE] in function [FUNCTION] with this impedance setting
- Error 7537 result Cannot have magnitude below [VALUE] in function [FUNCTION] with this impedance setting
- Error 7538 result Feature not available
- Error 7539 result Cannot set requested impedance value (in response to the OUT\_IMP {Z50 | Z1M} command)
- Error 7540 result Cannot have secondary magnitude in function [FUNCTION]
- Error 7541 result Cannot have primary magnitude in function [FUNCTION]
- Error 7542 result Cannot have frequency in function [FUNCTION]
- Error 7543 result dBm only allowed in single sine ACV
- Error 7544 result Requested waveform not available in this configuration
- Error 7545 result Offset cannot be greater than 50 % of the primary output in function [FUNCTION]

Error 7600 result Cannot use boost amplifier now  
Error 7601 result Cannot select boost amplifier post now  
Error 7602 result Can only output that current on the HIGH post  
Error 7603 result Valid Pulse amplitudes are 2.5V, 1V, 250mV, 100mV, 25mV, 10mV  
Error 8001 result Power up was less than 30 minutes ago  
Error 8002 result Zero adjustment is required every [VALUE] days  
Error 8003 result Ohms zero adjustment is required every [VALUE] hours  
Error 8012 result Zero adjustment is required every [VALUE] days  
Error 8013 result Ohms zero adjustment is required every [VALUE] hours  
Error 8101 result Size of X and Y should be the same for Polyfit  
Error 8102 result Failed matrix reduction using Gauss-Jordan elimination  
Error 8103 result Cannot read coefficients from the matrix  
Error 8104 result Missing required input for calculation  
Error 8106 result Failed to read matrix coefficients  
Error 8107 result TC Measurement is invalid  
Error 8108 result Lag bath input needs to be between -10 °C and 70 °C  
Error 8109 result Entered value out of bounds  
Error 8110 result Wrong unit for reference  
Error 8111 result Cannot store cal constants during this step  
Error 10001 result Exception happened during json serialization  
Error 10002 result Exception happened during RPC communication  
Error 10003 result Unhandled exception:  
Error 10101 result Memory allocation error:  
Error 10201 result Unknown command:  
Error 10301 result Unknown string Id:  
Error 11001 result Duplicate Setting  
Error 11002 result Setting not found  
Error 11003 result Unable to read clock  
Error 11004 result Unable to set clock  
Error 11005 result Entered value is outside allowable limits  
Error 11006 result Invalid password  
Error 11007 result The passcode must be 1 to 8 digits in length  
Error 65535 result Unknown Error  
Error 65536 result Default Error