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Model DMM7510
7½ Digit Graphical Sampling Multimeter

Calibration Manual

DMM7510-905-01 Rev. A / March 2015

DMM7510-905-01A

A Greater Measure of Confidence

KEITHLEY
A Tektronix Company

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7½ Digit Graphical Sampling Multimeter

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Document number: DMM7510-905-01 Rev. A / April 2015

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Safety precautions

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

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

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

The types of product users are:

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

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

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

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

Keithley Instruments products are designed for use with electrical signals that are measurement, control, and data I/O connections, with low transient overvoltages, and must not be directly connected to mains voltage or to voltage sources with high transient overvoltages. Measurement Category II (as referenced in IEC 60664) connections require protection for high transient overvoltages often associated with local AC mains connections. Certain Keithley measuring instruments may be connected to mains. These instruments will be marked as category II or higher.

Unless explicitly allowed in the specifications, operating manual, and instrument labels, do not connect any instrument to mains.

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

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

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

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

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

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

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

For safety, instruments and accessories must be used in accordance with the operating instructions. If the instruments or accessories are used in a manner not specified in the operating instructions, the protection provided by the equipment may be impaired.

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

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

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

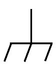
If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

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

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

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

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

The  symbol indicates a connection terminal to the equipment frame.

If this 

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

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

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

Instrumentation and accessories shall not be connected to humans.

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

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

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

Safety precaution revision as of January 2013.

Table of Contents

Section 1

Introduction

In this section:

Welcome

Thank you for choosing a Keithley Instruments product. The Model DMM7510 is a 7½ digit graphical sampling multimeter that expands standard DMM functions with high-speed digitizing and large graphical color touchscreen display. This DMM offers a broad range of measurement capabilities, including 17 measurement functions. In addition to industry-leading DC accuracies, functions such as capacitance, 10 amp current, and 18-bit current and voltage digitizing are included. Tying all these features together is a large 5-inch color touchscreen display that brings users an unprecedented combination of data visualization and interaction, enabling users to gain deeper insight into their measurements.

The Model DMM7510 provides superior measurement accuracy and the speed necessary for a broad range of applications, from system applications and production testing to benchtop applications. The Model DMM7510 meets application requirements for production engineers, research and development engineers, test engineers, and scientists.

Introduction to this manual

This manual provides instructions to help you verify and adjust the calibration of your Keithley Instruments Model DMM7510.

This manual presents verification information, adjustment information, and command descriptions for the calibration commands.

NOTE

For additional command descriptions, refer to the *Model DMM7510 Reference Manual* (part number DMM7510-901-01). This manual is on the Product Information CD-ROM that came with your instrument. It is also available on the Keithley website (*http://www.keithley.com*).

Extended warranty

Additional years of warranty coverage are available on many products. These valuable contracts protect you from unbudgeted service expenses and provide additional years of protection at a fraction of the price of a repair. Extended warranties are available on new and existing products. Contact your local Keithley Instruments office, sales partner, or distributor for details.

Contact information

If you have any questions after you review the information in this documentation, please contact your local Keithley Instruments office, sales partner, or distributor. You can also call Keithley Instruments corporate headquarters (toll-free inside the U.S. and Canada only) at 1-800-935-5595, or from outside the U.S. at +1-440-248-0400. For worldwide contact numbers, visit the Keithley website (*http://www.keithley.com*).

Section 2

Performance verification

In this section:

Introduction

Use the procedures in this section to verify that Model DMM7510 accuracy is within the limits stated in the instrument's one-year accuracy specifications. Specifications and characteristics are subject to change without notice; please refer to the Keithley website (*http://www.keithley.com*) for the most recent specifications. You can perform these verification procedures:

- When you first receive the instrument to make sure that it was not damaged during shipment.
- To verify that the instrument meets factory specifications.
- To determine if calibration adjustment is required.
- After calibration to make sure it was adjusted properly.

WARNING

The information in this section is intended for qualified service personnel only. Do not attempt these procedures unless you are qualified to do so. Some of these procedures may expose you to hazardous voltages, which could cause personal injury or death if contacted. Use appropriate safety precautions when working with hazardous voltages.

NOTE

If the instrument is still under warranty and its performance is outside specified limits, please contact your local Keithley Instruments office, sales partner, or distributor. You can also call Keithley Instruments corporate headquarters (toll-free inside the U.S. and Canada only) at 1-800-935-5595, or from outside the U.S. at +1-440-248-0400. For worldwide contact numbers, visit the Keithley website (*http://www.keithley.com*).

Factory service

If the instrument is to be returned to Keithley Instruments for repair, perform the following:

- Call the Repair Department at 1-800-833-9200 or send an email to RMAREQUEST@tek.com for a Return Material Authorization (RMA) number.
- Carefully pack the instrument in the original packing carton.
- Write `ATTENTION REPAIR DEPARTMENT` and the RMA number on the shipping label.

Verification test requirements

Be sure that you perform these verification tests:

- Under the proper environmental conditions
- After the specified warmup period
- Using the correct line voltage
- Using the proper test equipment
- Using the specified output signal and reading limits

Environmental conditions

Conduct your performance verification procedures in a test environment with:

- An ambient temperature of 18 °C to 28 °C (65 °F to 82 °F).
- A relative humidity of less than or equal to 80 percent, unless otherwise noted.

Warmup period

Allow the Model DMM7510 to warm up for at least 90 minutes before conducting the verification procedures.

If the instrument has been subjected to temperature extremes (those outside the ranges stated above), allow additional time for the internal temperature of the instrument to stabilize. Typically, allow one extra hour to stabilize a unit that is 10 °C (18 °F) outside the specified temperature range.

Also, allow the test equipment to warm up for the minimum time specified by the manufacturer.

Line power

The Model DMM7510 requires a line voltage of 100 V to 240 V and a line frequency of 50 Hz or 60 Hz. Verification tests should be performed within this range.

NOTE

The instrument automatically senses the line frequency at power up.

Recommended test equipment

The following table summarizes the recommended verification equipment. You can use alternate equipment if that equipment has specifications that meet or exceed those listed in the table below. Test equipment uncertainty adds to the uncertainty of each measurement. Generally, test equipment uncertainty should be at least four times more accurate than corresponding Model DMM7510 specifications. The following table lists the uncertainties of the recommended test equipment.

Manufacturer	**Model**	**Description**	**Used for:**	**Uncertainty**
Fluke	5720A or 5730A	High Performance Multifunction Calibrator	DCV, ACV, ACI, and resistance	See Note.
Fluke	5725A	Amplifier	DCI and ACI	See Note.
Fluke	8508A	8.5 Digit Reference Multimeter	DCV and resistance	See Note.
Keysight Technologies	33250A	Function/Arbitrary Waveform Generator	Frequency	See Note.
IET Labs, Inc.	1423-A	Precision Decade Capacitor	Capacitance, 1 nF to 1 μF	See Note.
IET Labs, Inc.	HACS-Z-A-2E-1uF	Series HACS-Z High Accuracy Decade Capacitance Box	Capacitance, 1 μF to 100 μF	See Note.
Keithley Instruments	8610 or 8620	4-Wire DMM Shorting Plug	DCV, Digitize DCV, and resistance	N/A
Caddock Electronics	USF240-200k	200 kΩ, 0.01 % tolerance, 2 PPM/ °C resistor	10 μA and 100 μA DCI	See Note.
Vishay	CMF65	10 MΩ, 0.25 % tolerance, 50 PPM/ °C resistor	10 μA and 100 μA DCI	See Note.
HYMEG Corporation	FA-65-1G and FA-65-10G	1 GΩ and 10 GΩ, 2 % tolerance, 25 PPM/ °C resistor	910 MΩ, parallel 1 GΩ and 10 GΩ	See Note.

NOTE

Refer to the manufacturer's specifications to calculate the uncertainty, which varies for each function and range test point.

NOTE

In this manual, the Model 8610 shorting plug is shown in the graphics. However, you can use either the Model 8610 or Model 8620.

Auto calibration

Automatic calibration removes measurement errors that are caused by the performance drift on the components used in the DMM as a result of temperature and time. Auto calibration improves short-term accuracy of the Model DMM7510. However, you must still perform regular full calibration with metrology equipment to maintain overall accuracy.

To maintain accuracy, run auto calibration when the instrument temperature changes by more than ±5 °C since the last auto calibration. To check the temperature difference, you can view the temperature change on the Calibration menu. You can also use remote commands to retrieve the temperature difference.

The instrument regularly monitors the internal temperature for the voltage, current, 2-wire resistance, 4-wire resistance, diode, temperature, and DC voltage ratio function when autozero is enabled. Temperature checking begins after the warm-up time completes. If there is a more than ±5 °C difference between this temperature and the temperature when the last auto calibration was run, the instrument generates an event in the event log and a warning message.

The auto calibration constants are stored through a power cycle. You do not need to run auto calibration because power has been cycled.

You can run auto calibration with input cables connected. At the start of the auto calibration process, the front terminals are monitored. If more than 30 V DC or 1 V AC is detected on the front-panel inputs, auto calibration is not run and an event message is displayed.

Auto calibration also monitors the temperature at the start and end of auto calibration. If the start and end temperature differs by more than ±1 °C, the auto calibration values are not stored and a warning message is generated.

Running auto calibration

You can run auto calibration as needed by using the front panel or remote command. If the instrument has completed the warm up period, auto calibration takes about six minutes to run. During auto calibration, you cannot use the instrument. A status message is displayed on the front panel of the instrument while auto calibration is running. At completion, a status message is generated.

CAUTION

To prevent instrument damage, verify that no test voltages are connected to the input terminals when performing auto calibration.

Do not cycle power during the auto calibration routine. Doing so could affect the accuracy of the instrument.

To prepare for auto calibration:

1. Disable voltage sources on any test cables that are connected to the front-panel or rear-panel terminals.
2. Place the Model DMM7510 in a temperature-stable location.
3. Turn on instrument power and allow the instrument to warm up for at least 90 minutes. When the instrument has completed the warm-up period, a message is displayed and an information event is generated in the event log.

To run auto calibration from the front panel:

1. Press the **MENU** key.
2. Under System, select **Calibration**.
3. Select **Start ACAL**. A prompt is displayed.
4. Select **Yes**. A progress bar is displayed while the calibration runs.

To run auto calibration using SCPI commands:

Send:

```
ACAL:RUN
```

To run auto calibration using TSP commands:

Send:

```
acal.run()
```

NOTE

Once auto calibration has started, you cannot stop it. After completion, however, you can use remote commands to revert to the previous auto calibration settings. If you are using SCPI, refer to :ACAL:REVert for detail. If you are using TSP, refer to acal.revert() (on page 4-6).

Scheduling auto calibration

You can set up your instrument to run auto calibration automatically. You can also set up the instrument to prompt you to run auto calibration at regular intervals. To determine the best schedule for your application, see the Model DMM7510 specifications for detail on the accuracy with and without auto calibration.

Autocalibration does not start until all actions that are active on the instrument are complete. When the scheduled time occurs, the autocalibration run command is placed in the command queue and will be executed after any previously sent commands or actions have executed. For example, if a trigger model is running when autocalibration is scheduled to run, autocalibration does not start until the trigger model stops.

If there is a command or action that is waiting a long time for an event, the autocalibration will not run until the event occurs, the action is aborted, or the instrument power is cycled.

If the scheduled time for autocalibration occurs before the warmup period completes, the instrument will not start autocalibration. The instrument waits until the warmup period is complete before starting a scheduled autocalibration. A message is displayed when warmup is complete and autocalibration is going to run.

If the instrument is powered off when an autocalibration was scheduled, autocalibration is run as soon as the warmup period is complete when the instrument is powered on.

You can run autocalibration manually even if a scheduled autocalibration is set.

When autocalibration is scheduled to run at a scheduled interval, but it runs at a time other than the scheduled interval, subsequent scheduled intervals are adjusted according to the actual autocalibration start time.

From the front panel:

1. Press the **MENU** key.
2. Under System, select **Calibration**.
3. Select **Scheduling Action**. To have the instrument:
   - Prompt you to run auto calibration: Select **Notify**.
   - Run auto calibration at a specific time: Select **Run**.
   - To stop scheduling: Select **None**. If you select None, you do not need to make additional settings.
4. Select **Scheduling Interval**.
5. Select the interval.
6. Select **Scheduled Time** to select the time when the auto calibration will run or when you will be prompted to run it.

To review the next schedule time and date, see the information listed next to Next Run.

Using SCPI commands:

Refer to :ACAL:SCHedule.

Using TSP commands:

Refer to acal.schedule() (on page 4-7).

Reviewing calibration information

The Calibration screen displays information about the last autocalibration and factory calibrations that were run and the present status. For detail on this screen, refer to System Calibration menu.

For autocalibration, you can also access this information from the commands in the SCPI ACAL subsystem or the TSP `acal.*` commands.

Monitoring internal temperature

You can monitor the temperature difference between the actual internal temperature and the temperature when auto calibration ran through the panel or by using remote commands. With remote commands, you can also check the present internal temperature and the internal temperature when auto calibration was last run. Temperature is returned in Celsius (°C).

The internal temperature is not updated on the Calibration screen until the warmup period is complete. The remote commands always return the present temperature.

From the front panel:

1. Press the **MENU** key.
2. Under System, select **Calibration**.
3. The Temperature Difference is displayed.

Using SCPI commands:

For the present internal temperature, send:

```
:SYSTem:TEMPerature:INTernal?
```

For the temperature difference, send:

```
:ACAL:LASTrun:TEMPerature:DIFFerence?
```

For the temperature when auto calibration was last run, send:

```
:ACAL:LASTrun:TEMPerature:INTernal?
```

Using TSP commands:

For the present internal temperature, send:

```
print(localnode.internaltemp)
```

For the temperature difference, send:

```
print(acal.lastrun.tempdiff)
```

For the temperature when auto calibration was last run, send:

```
print(acal.lastrun.internaltemp)
```

Verification limits

The verification limits stated in this section have been calculated using only the Model DMM7510 one-year accuracy specifications, within 30 days of auto calibration and T_{oper} ±5 °C from T_{acal}. They do not include test equipment uncertainty. If a particular measurement falls outside the allowable range, recalculate new limits based on both the Model DMM7510 specifications and corresponding test equipment specifications. The Customer Calibration Data Report does not include zero verification or analog trigger tests.

Specifications and characteristics are subject to change without notice; please refer to the Keithley website (*http://www.keithley.com*) for the most recent specifications.

Example reading limit calculation

Assume you are testing the 10 VDC range using a 10 V input value. Using the Model DMM7510 one-year accuracy specification for 10 VDC of ± (14 ppm of reading + 1.2 ppm of range), the calculated limits are:

Reading limits = 10 V ± [(10 V × 14 ppm) + (10 V × 1.2 ppm)]

Reading limits = 10 V ± (0.00014 + 0.000012) V

Reading limits = 10 V ± 0.000152 V

Reading limits = 9.999848 V to 10.000152 V

Calculating resistance reading limits

Resistance reading limits must be recalculated based on the actual calibration resistance values supplied by the equipment manufacturer. Calculations are performed in the same manner as shown in the preceding example. Use the actual calibration resistance values instead of the nominal values in the example when performing your calculations.

For example, assume that you are testing the 10 kΩ range using an actual 10.03 kΩ calibration resistance value. Using Model DMM7510 one-year 10 kΩ range accuracy of ± (30 ppm of reading + 3 ppm of range), the calculated reading limits are:

Reading limits = 10.03 kΩ ± [(10.03 kΩ x 30 ppm) + (10 kΩ x 3 ppm)]

Reading limits = 10.03 kΩ ± [(0.3009) + (0.03)] Ω

Reading limits = 10.03 kΩ ± 0.3309 Ω

Reading limits = 10.029669 kΩ to 10.030331 kΩ

Performing the verification test procedures

The following topics provide a summary of verification test procedures and items to take into consideration before performing any verification test.

Test summary

Front-panel tests:

Rear-panel tests:

If the Model DMM7510 is not within specifications and is not under warranty, see the calibration procedures in Calibration (on page 3-1) for information about calibrating the unit.

Test considerations

When performing the verification procedures:

- Be sure to restore factory front-panel defaults. From the front panel, select the **MENU** key, select **Info/Manage**, and select **System Reset**.
- Make sure that the test equipment is properly warmed up for 90 minutes and is connected to the Model DMM7510 input/output terminals.
- Ensure that the correct Model DMM7510 terminals are selected with the TERMINALS FRONT/REAR button.
- Be sure the test equipment is set up for the proper function and range.
- Do not connect test equipment to the Model DMM7510 through a scanner, multiplexer, or other switching equipment.

NOTE

Ensure Auto Calibration has been performed with 30 days and that the Temperature Difference is less than ±5 °C. To check Auto Calibration, press the **MENU** key and select **Calibration**. If either time is more than 30 days or the Temperature Difference is more than ±5 °C, run Auto Calibration before verifying the Model DMM7510.

⚠ WARNING

The front and rear terminals of the instrument are rated for connection to circuits rated Measurement Category II up to 300 V, as described in International Electrotechnical Commission (IEC) Standard IEC 60664. This range must not be exceeded. Do not connect the instrument terminals to CAT III or CAT IV circuits. Connection of the instrument terminals to circuits higher than CAT II can cause damage to the equipment and severe personal injury.

Front-panel verification

The following topics describe verification procedures that are done with connections attached to the front-panel terminals.

DC voltage verification

⚠ WARNING

The maximum input voltage between INPUT HI and INPUT LO is 1000 V_{peak}. Exceeding this value may create a shock hazard.

The maximum common-mode voltage (the voltage between INPUT LO and chassis ground) is 500 V_{peak}. Exceeding this value may cause a breakdown in insulation that can create a shock hazard.

100 mV to 1000 V DC voltage verification setup

To check 100 mV to 1000 V DC voltage accuracies, you will:

- Apply accurate DC voltages from the calibrator to the Model DMM7510 front-panel terminals
- Verify that the displayed readings fall within specified limits

Use the values in the following tables to verify the performance of the Model DMM7510. Actual values depend on the published specifications (see Example reading limit calculation (on page 2-8)).

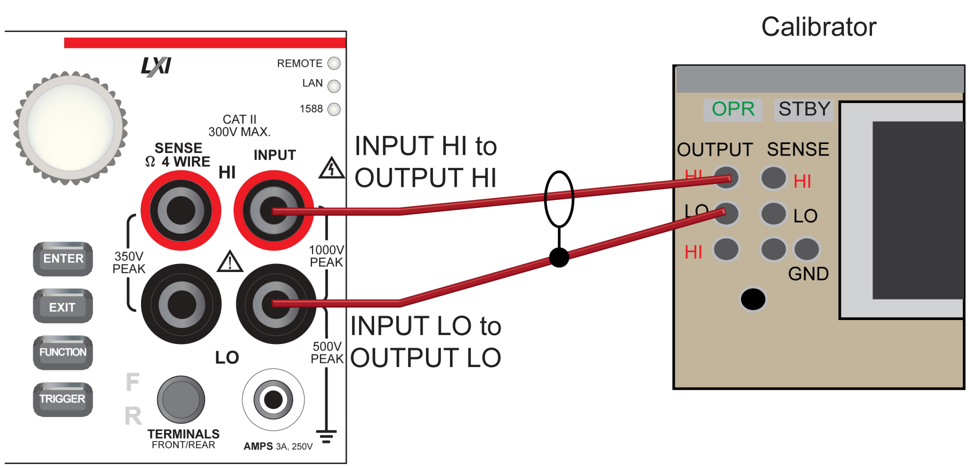
NOTE

Use shielded low-thermal connections when testing the 100 mV and 1 V ranges to avoid errors caused by noise or thermal effects. Connect the shield to the output LO terminal of the calibrator.

To verify DC voltage accuracy:

1. Set the calibrator to **OPERATE**.
2. Set the calibrator output to **0 V**.
3. Use a low-thermal cable to connect the Model DMM7510 HI and LO INPUT terminals to the calibrator HI and LO terminals as shown in the following figure.

Figure 1: DC voltage 100 mV to 1000 V verification connections



4. Allow 5 minutes of settling time.
5. On the Model DMM7510, press the **FUNCTION** key and select **DC voltage**.
6. Press the **HOME** key.
7. Select **Range** and select **100 mV**.
8. Press **MENU** key. Under **Measure**, select **Settings**.
9. Set Input Impedance to **Auto**.
10. Press the **MENU** key.
11. Select **Calculations**.
12. Select **Rel Acquire**.
13. Source positive and negative full-scale and half-scale voltages and allow for proper settling, as listed in Verify the DC voltage 100 mV range (on page 2-12).
14. Select each range on the Model DMM7510, allow for proper settling, and verify the 1 V to 1000 V ranges according to the following tables.

Verify the DC voltage 100 mV range

Description	Verification point	Lower limit	Upper limit
Perform rel offset	0.0	n/a	n/a
Full scale (+)	1.0000000E-01	9.9997300E-02	1.0000270E-01
Half scale (+)	5.0000000E-02	4.9998200E-02	5.0001800E-02
Half scale (-)	-5.0000000E-02	-5.0001800E-02	-4.9998200E-02
Full scale (-)	-1.0000000E+02	-1.0000270E-01	-9.9997300E-02

Verify the DC voltage 1 V range

Description	Verification point	Lower limit	Upper limit
Full scale (+)	1.0000000E+00	9.9998300E-01	1.0000170E+00
Half scale (+)	5.0000000E-01	4.9999050E-01	5.00009500E-01
Half scale (-)	-5.0000000E-01	-5.0000950E-01	-4.9999050E-01
Full scale (-)	-1.0000000E+00	-1.0000170E+00	-9.9998300E-01

Verify the DC voltage 10 V range

Description	Verification point	Lower limit	Upper limit
Full scale (+)	1.000000E+01	9.999848E+00	1.0000152E+01
Half scale (+)	5.000000E+00	4.9999180E+00	5.0000820E+00
Half scale (-)	-5.0000000E+00	-5.0000820E+00	-4.9999180E+00
Full scale (-)	1.0000000E+01	-1.0000152E+01	-9.999848E+00

Verify the DC voltage 100 V range

⚠ WARNING

The information in this section is intended for qualified service personnel only. Do not attempt these procedures unless you are qualified to do so. Some of these procedures may expose you to hazardous voltages, which could cause personal injury or death if contacted. Use appropriate safety precautions when working with hazardous voltages.

Description	Verification point	Lower limit	Upper limit
Full scale (+)	1.000000E+02	9.999730E+01	1.0000270E+02
Half scale (+)	5.000000E+01	4.999840E+01	5.000160E+01
Half scale (-)	-5.0000000E+01	-5.0001600E+01	-4.999840E+01
Full scale (-)	1.0000002E+01	-1.0000270E+02	-9.999730E+01

Verify the DC voltage 1000 V range

Description	Verification point	Lower limit	Upper limit
Full scale (+)	1.0000000E+03	9.9997200E+02	1.0000280E+03
Half scale (+)	5.000000+02	4.9998350E+02	5.0001650E+02
Half scale (-)	-5.000000+02	-5.0001650E+02	-4.9998350E+02
Full scale (-)	-1.0000000E+03	-1.0000280E+03	-9.9997200E+02

AC voltage verification

To verify AC voltage accuracy:

- For the 100 mV to 100 V ranges, apply accurate voltages from the calibrator to the Model DMM7510 front-panel terminals.
- For the 700 V range, connect the Fluke 5725A Amplifier to the calibrator. Apply accurate voltages from the calibrator terminals to the Model DMM7510 front-panel terminals.
- Verify that the displayed readings fall within specified limits

Use the values in the following tables to verify the performance of the Model DMM7510. Actual values depend on the published specifications (see Example reading limit calculation (on page 2-8)).

WARNING

The maximum input voltage between INPUT HI and INPUT LO is 1000 V_{peak}. Exceeding this value may create a shock hazard.

The maximum common-mode voltage (the voltage between INPUT LO and chassis ground) is 500 V_{peak}. Exceeding this value may cause a breakdown in insulation that can create a shock hazard.

Verify AC voltage accuracy for the 100 mV to 100 V ranges

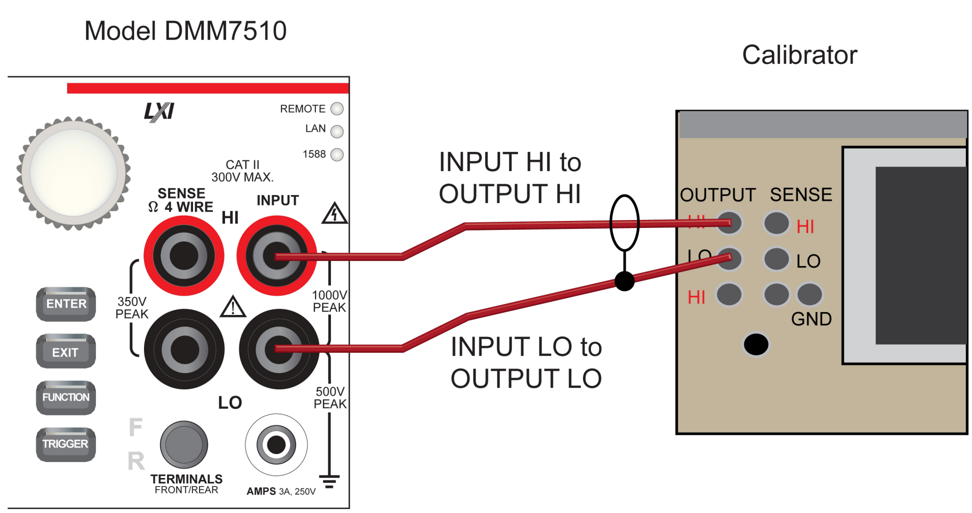
NOTE

Use shielded, low-capacitance cabling. For the 100 mV to 100 V ranges, avoid loading that exceeds 1000 ρF.

Excessive capacitance may result in additional load regulation uncertainties and could cause the calibrator output to open (go into standby).

To verify AC voltage accuracy:

1. Connect the Model DMM7510 HI and LO INPUT connectors to the calibrator as shown in the following figure.



2. On the Model DMM7510, press the **FUNCTION** key and select **AC voltage**.
3. Press the **HOME** key.
4. Select Range and select **100 mV**.
5. Press the **MENU** key.
6. Select **Settings**.
7. Ensure that Detector Bandwidth is set to **30 Hz**.

NOTE

AC voltage is specified for the detector bandwidth setting of 3 Hz. 3 Hz measures accurately for input signals from 3 Hz to 300 kHz, with reading rates ≈0.5 readings/s. To improve verification throughput to ≈3.3 readings/s, set detector bandwidth to 30 Hz for frequencies of 30 Hz to 300 kHz. To verify frequencies 1 kHz and higher, set the detector bandwidth to 300 Hz for faster ≈55 readings/s throughput.

8. Source AC voltages for each of the frequencies listed in the Verify the AC voltage 100 mV range (on page 2-14) table.
9. Repeat these steps for each range and frequency listed in the tables below. For each voltage setting, be sure that the reading is within low and high limits.

Verify the AC voltage 100 mV range

Input	Frequency	Lower limit	Upper limit
0.1	3.0E+01	9.991000E-02	1.000900E-01
0.1	1.0E+03	9.991000E-02	1.000900E-01
0.1	5.0E+04	9.981000E-02	1.001900E-01
0.1	1.0E+05	9.932000E-02	1.006800E-01

Verify the AC voltage 1 V range

Input	Frequency	Lower limit	Upper limit
1	3.0E+01	9.991000E-01	1.000900E+00
1	1.0E+03	9.991000E-01	1.000900E+00
1	5.0E+04	9.981000E-01	1.001900E+00
1	1.0E+05	9.932000E-01	1.006800E+00

Verify the AC voltage 10 V range

Input	Frequency	Lower limit	Upper limit
10	3.0E+01	9.991000E+00	1.000900E+01
10	1.0E+03	9.991000E+00	1.000900E+01
10	5.0E+04	9.981000E+00	1.001900E+01
10	1.0E+05	9.932000E+00	1.006800E+01

Verify the AC voltage 100 V range

Input	Frequency	Lower limit	Upper limit
100	3.0E+01	9.991000E+01	1.000900E+02
100	1.0E+03	9.991000E+01	1.000900E+02
100	5.0E+04	9.981000E+01	1.001900E+02
100	1.0E+05	9.932000E+01	1.006800E+02

Verify AC voltage accuracy for the 700 V range

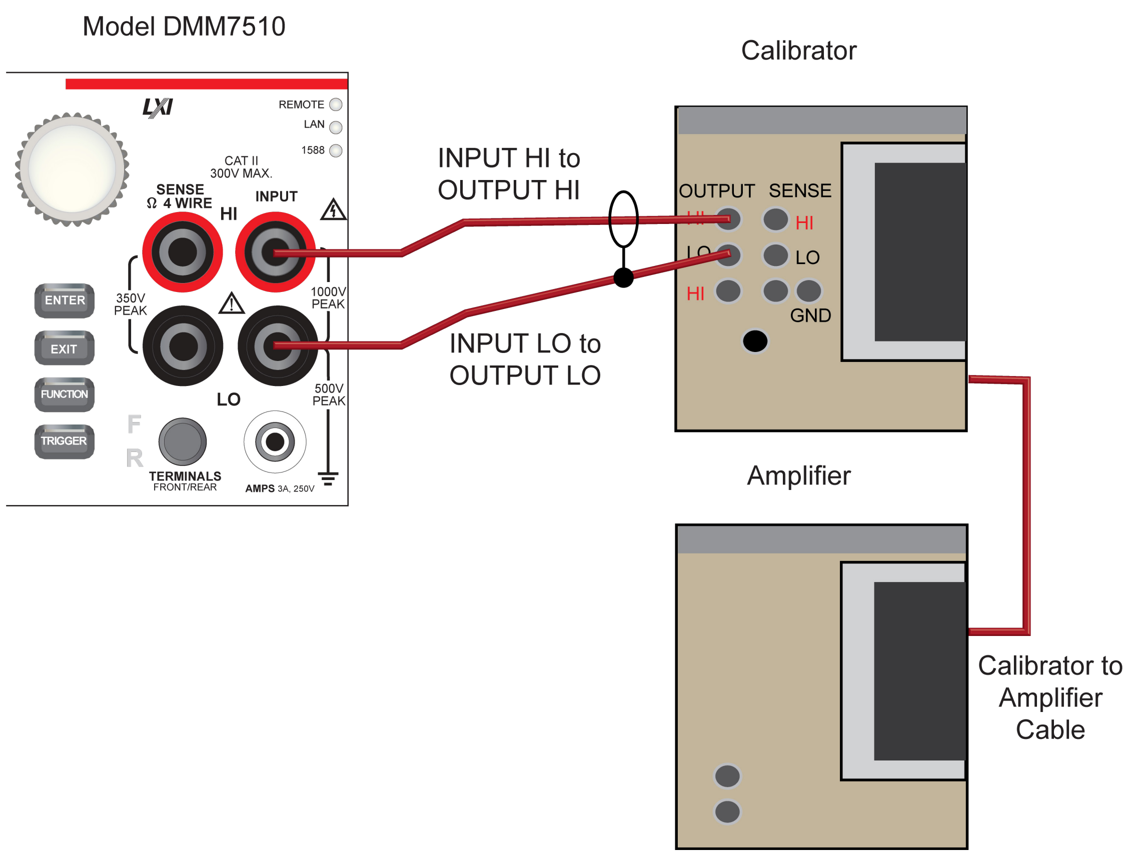
NOTE

Use shielded low capacitance cabling. For the 700 V range, avoid cable capacitances of >150 pF.

Excessive capacitance may result in additional load regulation uncertainties and could cause the calibrator output to open (go into standby).

To verify AC voltage accuracy for the 700 V range:

1. Put calibrator in Standby.
2. Connect the Model DMM7510 HI and LO INPUT connectors to the calibrator as shown in the following figure.
3. For 700 V at 50 kHz and 100 kHz outputs, connect the calibrator to the Fluke 5725A amplifier.



4. On the Model DMM7510, press the **FUNCTION** key and select **AC voltage**.
5. Press the **HOME** key.
6. Select Range and select **700 V**.
7. Press the **MENU** key.
8. Select **Settings**.
9. Ensure that Detector Bandwidth is set to **30 Hz**.

NOTE

AC voltage is specified for the detector bandwidth setting of 3 Hz. 3 Hz measures accurately for input signals from 3 Hz to 300 kHz, with reading rates ≈0.5 readings/s. To improve verification throughput to ≈3.3 readings/s, set detector bandwidth to 30 Hz for frequencies of 30 Hz to 300 kHz. To verify frequencies 1 kHz and higher, set the detector bandwidth to 300 Hz for faster ≈55 readings/s throughput.

10. Place the calibrator is in Operate.
11. Source AC voltages for each of the frequencies listed in the "Verify the AC voltage 700 V range" table, below. Be sure that the readings are within low and high limits.

Verify the AC voltage 700 V range

Input	Frequency	Lower limit	Upper limit
700	5.0E+01	6.993700E+02	7.006300E+02
700	1.0E+03	6.993700E+02	7.006300E+02
700	5.0E+04	6.986700E+02	7.013300E+02
700	1.0E+05	6.952400E+02	7.047600E+02

Digitize voltage verification

To check digitize voltage accuracy, you will:

- Apply accurate voltages from the calibrator to the Model DMM7510 front-panel terminals
- Verify that the displayed readings fall within specified limits

Use the values in the following tables to verify the performance of the Model DMM7510. Actual values depend on the published specifications (see Example reading limit calculation (on page 2-8)).

⚠ WARNING

The maximum input voltage between INPUT HI and INPUT LO is 1000 V_{peak}. Exceeding this value may create a shock hazard.

The maximum common-mode voltage (the voltage between INPUT LO and chassis ground) is 500 V_{peak}. Exceeding this value may cause a breakdown in insulation that can create a shock hazard.

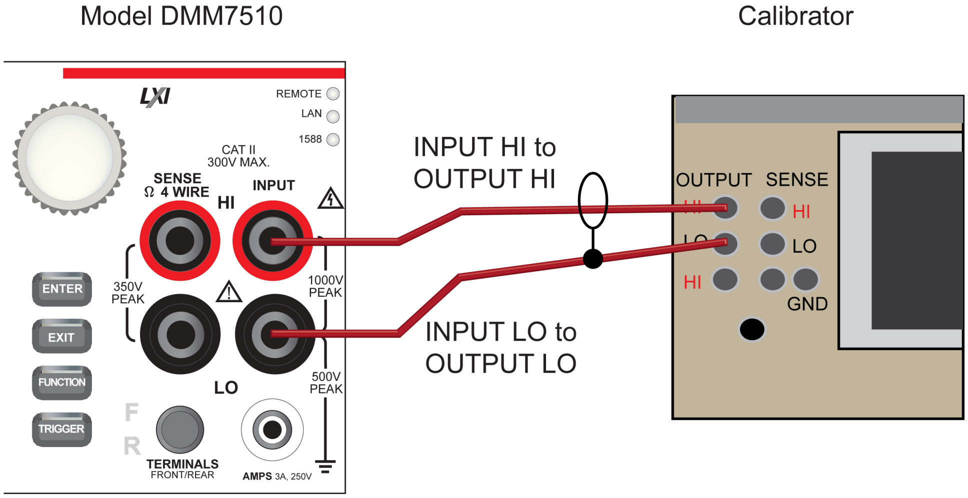
Verify the digitize voltage 100 mV to 1000 V ranges

NOTE

Use shielded low-thermal connections when testing the 100 mV and 1 V ranges to avoid errors caused by noise or thermal effects. Connect the shield to the output LO terminal of the calibrator.

To verify digitize voltage accuracy:

1. Connect the Model DMM7510 HI and LO INPUT connectors to the calibrator as shown in the following figure.



2. On the Model DMM7510, press the **FUNCTION** key, select the **Digitize Functions** tab, and select **Digitize Voltage**.
3. Press the **HOME** key.
4. Select **Range** and select **100 mV**.
5. Press the **MENU** key.
6. Select **Settings**.
7. Set the Sample Rate to **1000**.
8. Set the Aperture to **Auto**.
9. Set the Count to **100**.
10. Set the calibrator output to 0.00000 mVDC and allow the reading to settle.
11. Press the **MENU** key.
12. Select **Calculations**.
13. Select **Rel Acquire**.
14. Source positive and negative full-scale and half-scale voltages, as listed in Verify the digitize voltage 100 mV range (on page 2-18). Verify the 1 V to 100 V range settings listed in the tables below. For each voltage setting, verify that the STATISTICS swipe screen reading for Average is within low and high limits.

NOTE

The Fluke 5720A or 5730A calibrator 1000 V range 0.0 V setting is not verified.

Verify the digitize voltage 100 mV range

Description	Input	Lower limit	Upper limit
Perform rel offset	0.0	n/a	n/a
Full scale (+)	0.1	9.99680E-02	1.00032E-01
Half scale (+)	0.05	4.99790E-02	5.00210E-02
Half scale (-)	-0.05	-5.00210E-02	-4.99790E-02
Full scale (-)	-0.1	-1.00032E-01	-9.99680E-02

Verify the digitize voltage 1 V range

Description	Input	Lower limit	Upper limit
Verify zero	0	-7.50E-05	7.50E-05
Full scale (+)	1	9.99805E-01	1.00020E+00
Half scale (+)	0.5	4.99865E-01	5.00135E-01
Half scale (-)	-0.5	-5.00135E-01	-4.99865E-01
Full scale (-)	-1	-1.00020E+00	-9.99805E-01

Verify the digitize voltage 10 V range

Description	Input	Lower limit	Upper limit
Verify zero	0	-7.50E-04	7.50E-04
Full scale (+)	10	9.99805E+00	1.00020E+01
Half scale (+)	5	4.99865E+00	5.00135E+00
Half scale (-)	-5	-5.00135E+00	-4.99865E+00
Full scale (-)	-10	-1.00020E+01	-9.99805E+00

Verify the digitize voltage 100 V range

Description	Input	Lower limit	Upper limit
Verify zero	0	-7.50E-03	7.50E-03
Full scale (+)	100	9.99805E+01	1.00020E+02
Half scale (+)	50	4.99865E+01	5.00135E+01
Half scale (-)	-50	-5.00135E+01	-4.99865E+01
Full scale (-)	-100	-1.00020E+02	-9.99805E+01

Verify the digitize voltage 1000 V range

Description	Input	Lower limit	Upper limit
Full scale (+)	1000	9.99805E+02	1.00020E+03
Half scale (+)	500	4.99865E+02	5.00135E+02
Half scale (-)	-500	-5.00135E+02	-4.99865E+02
Full scale (-)	-1000	-1.00020E+03	-9.99805E+02

Analog trigger voltage verification

You must perform analog trigger voltage verification through a remote interface (USB, LAN, or GPIB) using the TSP command language.

For verification connections, use the same connections that you used to verify the digitize voltage. Refer to Digitize voltage verification (on page 2-16) for drawings. See the example code for remote measure and digitize setup, trigger model, and front-panel user swipe displayed accuracy (Example code for verifying analog trigger voltage performance).

Use the following values to verify the performance of the Model DMM7510. Actual values depend on the published specifications (see Example reading limit calculation (on page 2-8)).

NOTE

Analog trigger verifications are not included in the Customer Calibration Data Report.

Set up to verify the analog trigger measure DC voltage

To check DC voltage accuracy of the analog trigger feature, you will:

- Apply accurate voltages from the calibrator to the Model DMM7510 front-panel terminals
- Verify that the displayed readings fall within specified limits

Use the values in the following tables to verify the performance of the Model DMM7510. Actual values depend on the published specifications (see Example reading limit calculation (on page 2-8)).

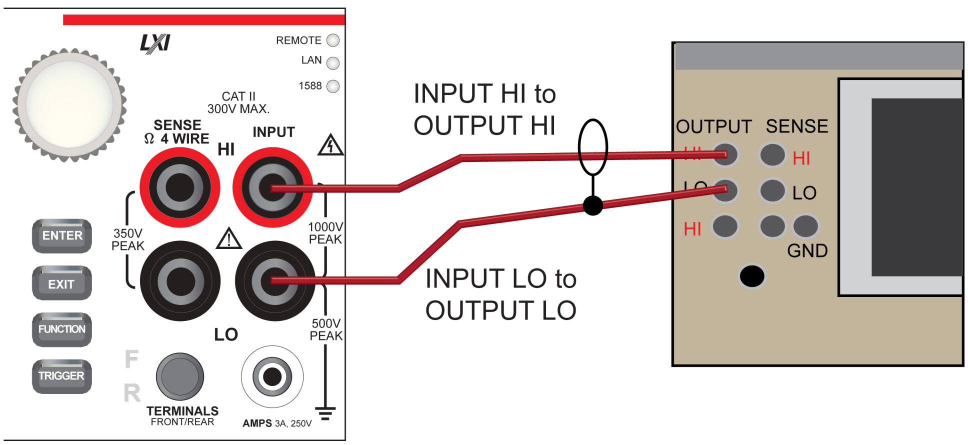
⚠ WARNING

The maximum input voltage between INPUT HI and INPUT LO is 1000 V_{peak}. Exceeding this value may create a shock hazard.

The maximum common-mode voltage (the voltage between INPUT LO and chassis ground) is 500 V_{peak}. Exceeding this value may cause a breakdown in insulation that can create a shock hazard.

To verify DC voltage accuracy:

1. Connect the Model DMM7510 HI and LO INPUT connectors to the calibrator as shown in the following figure.



2. Enable the calibrator output to 100 Hz sine wave with a peak level of 100 % of the Model DMM7510 measure range. For example, if the Model DMM7510 is set to the 10 V range, set calibrator amplitude to 7.07 V_{rms}.
3. Verify 1 % accuracy for each range, 100 mV to 1000 V, rising and falling analog edge triggering, as listed in the verify analog trigger voltage tables. Verify accuracies on the User screen on the Model DMM7510 front-panel. Use the remote commands in the following for verification.

```
localnode.prompts = 1
localnode.showerrors = 1

-- ********************************************
-- ****  Setup for measure DCV             ****
-- ****  Rising edge slope                ****
-- ********************************************

dmm.measure.func = dmm.FUNC_DC_VOLTAGE
dmm.measure.inputimpedance = dmm.IMPEDANCE_AUTO
dmm.measure.autozero.enable = dmm.OFF
dmm.measure.autodelay = dmm.DELAY_OFF
dmm.measure.nplc = 0.0005
dmm.measure.range = 100e-3
dmm.measure.analogtrigger.mode = dmm.MODE_EDGE
dmm.measure.analogtrigger.edge.slope = dmm.SLOPE_RISING
dmm.measure.analogtrigger.highfreqreject = dmm.OFF
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
dmm.measure.analogtrigger.edge.level = 50e-3
digio.line[1].mode = digio.MODE_TRIGGER_OUT
trigger.digout[1].pulsewidth = 30E-6
trigger.digout[1].stimulus = trigger.EVENT_ANALOGTRIGGER
```

```
-- *******************************************
-- ****  Falling Edge slope               ****
-- *******************************************
dmm.measure.analogtrigger.edge.slope = dmm.SLOPE_FALLING
dmm.measure.analogtrigger.edge.level = -50e-3

-- *******************************************
-- **** For Measure Functions            ****
-- **** Trigger Model setup and          ****
-- ****   start of triggering            ****
-- *******************************************

samp_count=10
buf=buffer.make(samp_count)
trigger.model.setblock(1,trigger.BLOCK_BUFFER_CLEAR, buf)
trigger.model.setblock(2,trigger.BLOCK_WAIT, trigger.EVENT_ANALOGTRIGGER)
trigger.model.setblock(3,trigger.BLOCK_MEASURE, buf, samp_count)
trigger.model.initiate()

-- *******************************************
-- **** Display 1st Reading from Buffer     ****
-- *******************************************

display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Analogtrigger")
num7 = buf.readings[1]
str7 = string.format('%3.4e', num7)
display.settext(display.TEXT2, str7) print(num7)
```

Set up to verify the analog trigger digitize DC voltage, DC coupling

Use the connections described in the previous topic (Set up to verify the analog trigger measure DC voltage (on page 2-19)).

To verify analog trigger digitize voltage with DC coupling accuracy:

1. Enable the calibrator output to 100 Hz sine wave with a peak level of 100 % of the Model DMM7510 measure range. For example, if the Model DMM7510 is set to the 10 V range, set calibrator amplitude to 7.07 V_{rms}.
2. Verify DC-coupled 1 % accuracy for each range, 100 mV to 1000 V, rising and falling analog edge triggering, as listed in the "Verify the analog trigger voltage" tables. Verify accuracies on the User screen on the Model DMM7510 front-panel. Use the remote commands in the following for verification.

```
localnode.prompts = 1
localnode.showerrors = 1

-- ********************************************
-- ****  Setup for Digitize DCV            ****
-- ********************************************

-- ********************************************
-- ****  Digitize DCV DC Coupling          ****
-- ****  Rising Edge slope                 ****
-- ********************************************
dmm.digitize.func = dmm.FUNC_DIGITIZE_VOLTAGE
dmm.digitize.aperture = 1e-6
dmm.digitize.samplerate = 1e6
dmm.digitize.coupling.type = dmm.COUPLING_DC
dmm.digitize.inputimpedance = dmm.IMPEDANCE_AUTO
dmm.digitize.range = 100e-3
dmm.digitize.analogtrigger.mode = dmm.MODE_EDGE
dmm.digitize.analogtrigger.edge.slope = dmm.SLOPE_RISING
dmm.digitize.analogtrigger.highfreqreject = dmm.OFF
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
dmm.digitize.analogtrigger.edge.level = 50e-3
digio.line[1].mode = digio.MODE_TRIGGER_OUT
trigger.digout[1].pulsewidth = 30E-6
trigger.digout[1].stimulus = trigger.EVENT_ANALOGTRIGGER

-- ********************************************
-- ****  Falling Edge slope                ****
-- ********************************************
dmm.digitize.analogtrigger.edge.slope = dmm.SLOPE_FALLING
dmm.digitize.analogtrigger.edge.level = -50e-3
```

Set up to verify the analog trigger digitize DC voltage, AC coupling

Use the connections described in Set up to verify the analog trigger digitize DC voltage, DC coupling (on page 2-21).

To verify analog trigger digitize voltage with AC coupling accuracy:

1. Enable the calibrator output to 100 Hz sine wave with a peak level of 100 % of the Model DMM7510 digitize range. For example, if the Model DMM7510 is set to the 10 V range, set calibrator amplitude to 7.07 V_{rms}.
2. Verify AC-coupled 1.5 % accuracy for each range, 100 mV to 1000 V, rising and falling analog edge triggering, as listed in the following "Verify the analog trigger voltage" tables. Verify accuracies on the User screen on the Model DMM7510 front-panel. Use the remote commands in the following for verification.

```
localnode.prompts = 1
localnode.showerrors = 1

-- *********************************************
-- ****  Digitize DCV AC Coupling           ****
-- ****  Slow AC Filter                     ****
-- *********************************************
dmm.digitize.func = dmm.FUNC_DIGITIZE_VOLTAGE
dmm.digitize.coupling.type = dmm.COUPLING_AC      -- dmm.COUPLING_DC
dmm.digitize.coupling.acfilter = dmm.AC_FILTER_SLOW  --- dmm.AC_FILTER_FAST
-- Set input freq AC coupling amplitude compensation.
dmm.digitize.coupling.acfrequency = 1e2
dmm.digitize.aperture = 1e-6
dmm.digitize.samplerate = 1e6
dmm.digitize.range = 100e-3
dmm.digitize.analogtrigger.mode = dmm.MODE_EDGE
dmm.digitize.analogtrigger.edge.slope = dmm.SLOPE_FALLING
dmm.digitize.analogtrigger.highfreqreject = dmm.OFF
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
dmm.digitize.analogtrigger.edge.level = -50e-3
digio.line[1].mode = digio.MODE_TRIGGER_OUT
trigger.digout[1].pulsewidth = 30E-6
trigger.digout[1].stimulus = trigger.EVENT_ANALOGTRIGGER

-- *********************************************
-- ****  Fast AC Filter                     ****
-- *********************************************
dmm.digitize.coupling.acfilter = dmm.AC_FILTER_FAST  --- dmm.AC_FILTER_SLOW

-- *********************************************
-- **** For Digitize Functions              ****
-- **** Trigger Model setup and             ****
-- ****     start of Triggering             ****
-- *********************************************

samp_count = 1e3
buf = buffer.make(samp_count)
trigger.model.setblock(1,trigger.BLOCK_BUFFER_CLEAR, buf)
trigger.model.setblock(2,trigger.BLOCK_WAIT,  trigger.EVENT_ANALOGTRIGGER)
trigger.model.setblock(3,trigger.BLOCK_DIGITIZE, buf, samp_count)
trigger.model.initiate()

-- *********************************************
-- **** Display 1st Reading from Buffer     ****
-- *********************************************

display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Analogtrigger")
num7 = buf.readings[1]
str7 = string.format('%3.4e', num7)
display.settext(display.TEXT2, str7) print(num7)
```

Verify the analog trigger voltage 100 mV range

Description	Verification point	Lower limit	Upper limit
Measure or Digitize DC-coupled 50 % scale rising	0.05	0.0490	0.0510
Measure or Digitize DC-coupled 50 % scale falling	-0.05	-0.0510	-0.0490
Digitize AC-coupled 50 % scale rising	0.05	0.0485	0.0515
Digitize AC-coupled 50 % scale falling	-0.05	-0.0515	-0.0485

Verify the analog trigger voltage 1 V range

Description	Verification point	Lower limit	Upper limit
Measure or Digitize DC-coupled 50 % scale rising	0.5	0.4900	0.5100
Measure or Digitize DC-coupled 50 % scale falling	-0.5	-0.5100	-0.4900
Digitize AC-coupled 50 % scale rising	0.5	0.4850	0.5150
Digitize AC-coupled 50 % scale falling	-0.5	-0.5150	-0.4850

Verify the analog trigger voltage 10 V range

Description	Verification point	Lower limit	Upper limit
Measure or Digitize DC-coupled 50 % scale rising	5	4.900	5.100
Measure or Digitize DC-coupled 50 % scale falling	-5	-5.100	-4.900
Digitize AC-coupled 50 % scale rising	5	4.850	5.150
Digitize AC-coupled 50 % scale falling	-5	-5.150	-4.850

Verify the analog trigger voltage 100 V range

Description	Verification point	Lower limit	Upper limit
Measure or Digitize DC-coupled 50 % scale rising	50	49.00	51.00
Measure or Digitize DC-coupled 50 % scale falling	-50	-51.00	-49.00
Digitize AC-coupled 50 % scale rising	50	48.50	51.50
Digitize AC-coupled 50 % scale falling	-50	-51.50	-48.50

Verify the analog trigger voltage 1000 V range

Description	**Verification point**	**Lower limit**	**Upper limit**
Measure or Digitize DC-coupled 50 % scale rising	500	490.0	510.0
Measure or Digitize DC-coupled 50 % scale falling	-500	-510.0	-490.0
Digitize AC-coupled 50 % scale rising	500	485.0	515.0
Digitize AC-coupled 50 % scale falling	-500	-515.0	-485.0

Analog trigger current verification

You must perform analog trigger voltage verification through a remote interface (USB, LAN, or GPIB) using the TSP command language.

To check analog trigger AC current accuracy, you will:

- Apply accurate current to the Model DMM7510 front-panel terminals
- Verify that the displayed readings fall within specified limits

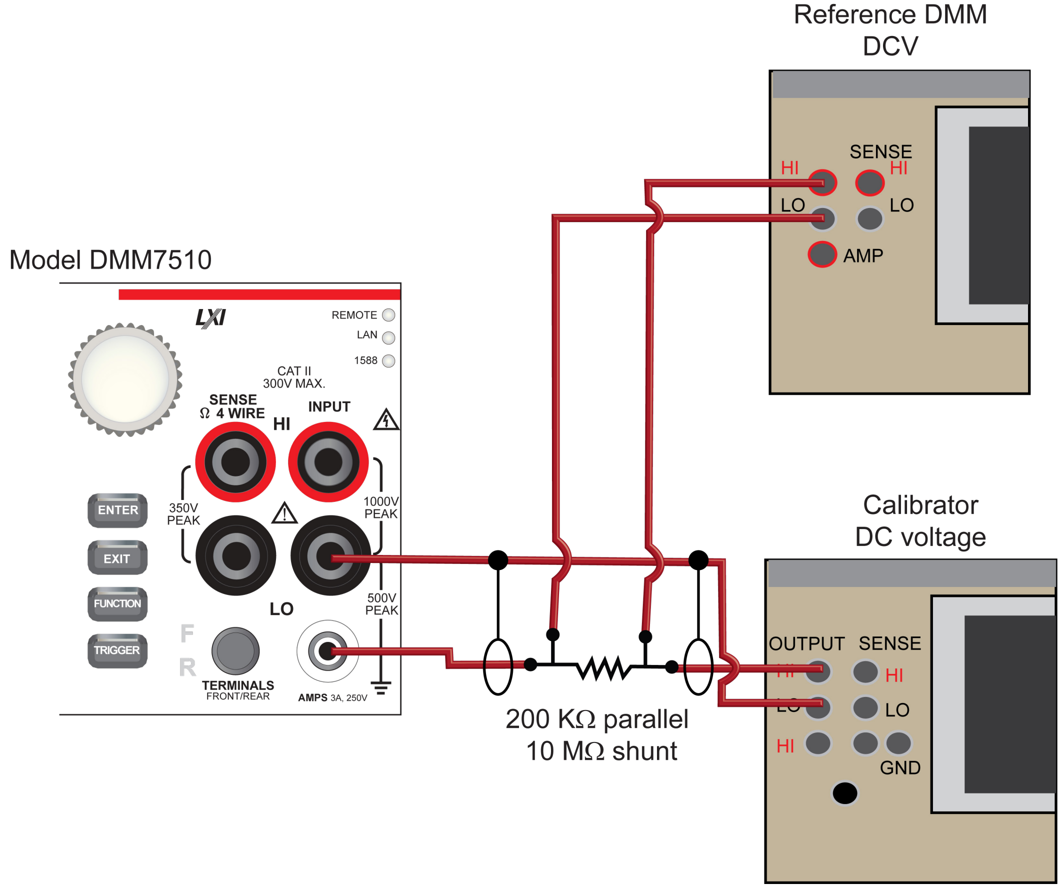
Use the values in the following tables to verify the performance of the Model DMM7510. Actual values depend on the published specifications (see Example reading limit calculation (on page 2-8)).

Verify the analog trigger DC current 10 µA and 100 µA ranges

To verify the analog trigger current 10 µA and 100 µA ranges:

1. Connect the Model DMM7510 to the calibrator as shown in the following figures.
2. Set the calibrator output to 100 Hz sine wave with a peak level of 100 % of the Model DMM7510 measure range. For example, if the Model DMM7510 is set to the 10 µA range, set the calibrator amplitude to 1.39355 V_{rms} across the 190 kΩ // 10 MΩ shunt. For the 100 µA range, set the calibrator amplitude to 13.8719 V_{rms}.
3. Source AC voltage through the shunt resistor, creating currents as listed in the following tables.
4. Follow the example commands provided in Example code for verifying analog trigger current performance (on page 2-30) for each range. Set the level to 50 % of the selected range.

10 µA and 100 µA verification connections



Verify the analog trigger current 10 µA range

Description	Verification point	Lower limit	Upper limit
Measure or Digitize 50 % scale rising	5.0000E-06	4.90E-06	5.10E-06
Measure or Digitize 50 % scale falling	-5.0000E-06	-5.10E-06	-4.90E-06

Verify the analog trigger current 100 µA range

Description	Verification point	Lower limit	Upper limit
Measure or Digitize 50 % scale rising	5.0000E-05	4.90E-05	5.10E-05
Measure or Digitize 50 % scale falling	-5.0000E-05	-5.10E-05	-4.90E-05

Verify the analog trigger DC current and digitize current 10 µA to 1 A ranges

To verify analog trigger current accuracy:

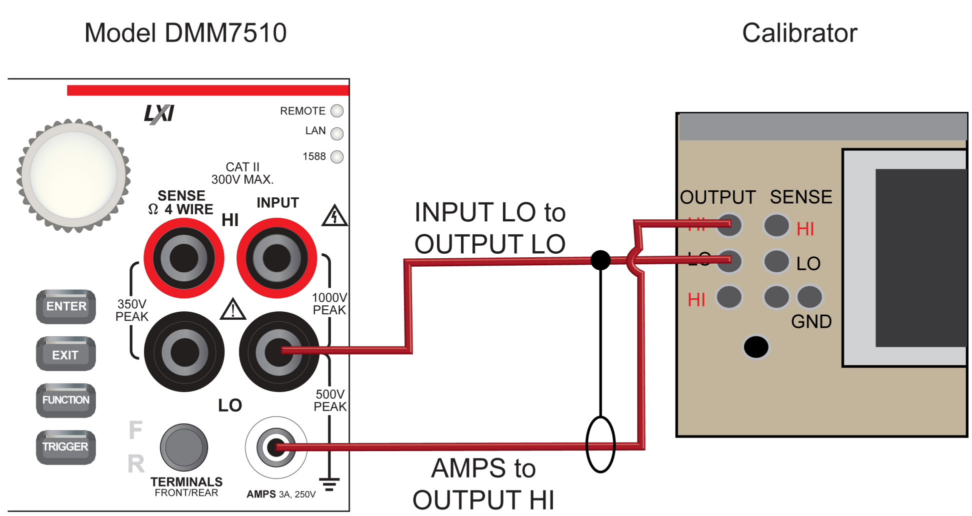
1. Connect the Model DMM7510 to the calibrator as shown in the following figure.
2. Digitize current function only: On the Model DMM7510, press the **FUNCTION** key, select the **Digitize Functions** tab, and select **Digitize Current**.
3. Measure function only: Set the Level to **50 %** of the selected range. For example, if the measure range is 100 mA, set the analog level to 50 mA using the remote command `dmm.measure.analogtrigger.edge.level = 50 e-3`.
4. Measure function only: Set the frequency to 100 Hz.
5. Verify DC current to 1 % accuracy for rising and falling analog edge triggering.

Verify the analog trigger DC current 1 mA to 3 A ranges

To verify analog trigger current accuracy:

1. Connect the Model DMM7510 to the calibrator as shown in the following figure.
2. Verify DC current and Digitize Current for rising and falling analog-edge triggering as follows:
   - 1 mA to 1 A to 1 % of range accuracy
   - 3 A to 3 % of range
3. Follow the example commands provided in Example code for verifying analog trigger current performance (on page 2-30) for each range. Set the level to 50 % of the selected range.

1 mA to 3 A verification connections



Verify the analog trigger current 1 mA to 3 A ranges

To verify the analog trigger current 1 mA to 3 A ranges:

1. Set the calibrator output to 100 Hz sine wave with a peak level of 100 % of the Model DMM7510 measure range. For example, if the Model DMM7510 is set to the 1 mA range, set the calibrator amplitude to 707 µA$_{rms}$. For the 3 A range, set calibrator amplitude to 2 A$_{rms}$.
2. Source AC currents as listed in the following tables.

Verify the analog trigger current 1 mA range

Description	Verification point	Lower limit	Upper limit
Measure or Digitize 50 % scale rising	5.0000E-04	4.90E-04	5.10E-04
Measure or Digitize 50 % scale falling	-5.0000E-04	-5.10E-04	-4.90E-04

Verify the analog trigger current 10 mA range

Description	Verification point	Lower limit	Upper limit
Measure or Digitize 50 % scale rising	5.0000E-03	4.90E-03	5.10E-03
Measure or Digitize 50 % scale falling	-5.0000E-03	-5.10E-03	-4.90E-03

Verify the analog trigger current 100 mA range

Description	Verification point	Lower limit	Upper limit
Measure or Digitize 50 % scale rising	-4.9500E-03	4.90E-02	5.10E-02
Measure or Digitize 50 % scale falling	-5.0000E-02	-5.10E-02	-4.90E-02

Verify the analog trigger current 1 A range

Description	Verification point	Lower limit	Upper limit
Measure or Digitize 50 % scale rising	5.0000E-01	4.90E-01	5.10E-01
Measure or Digitize 50 % scale falling	-5.0000E-01	-5.10E-01	-4.90E-01

Verify the analog trigger current 3 A range

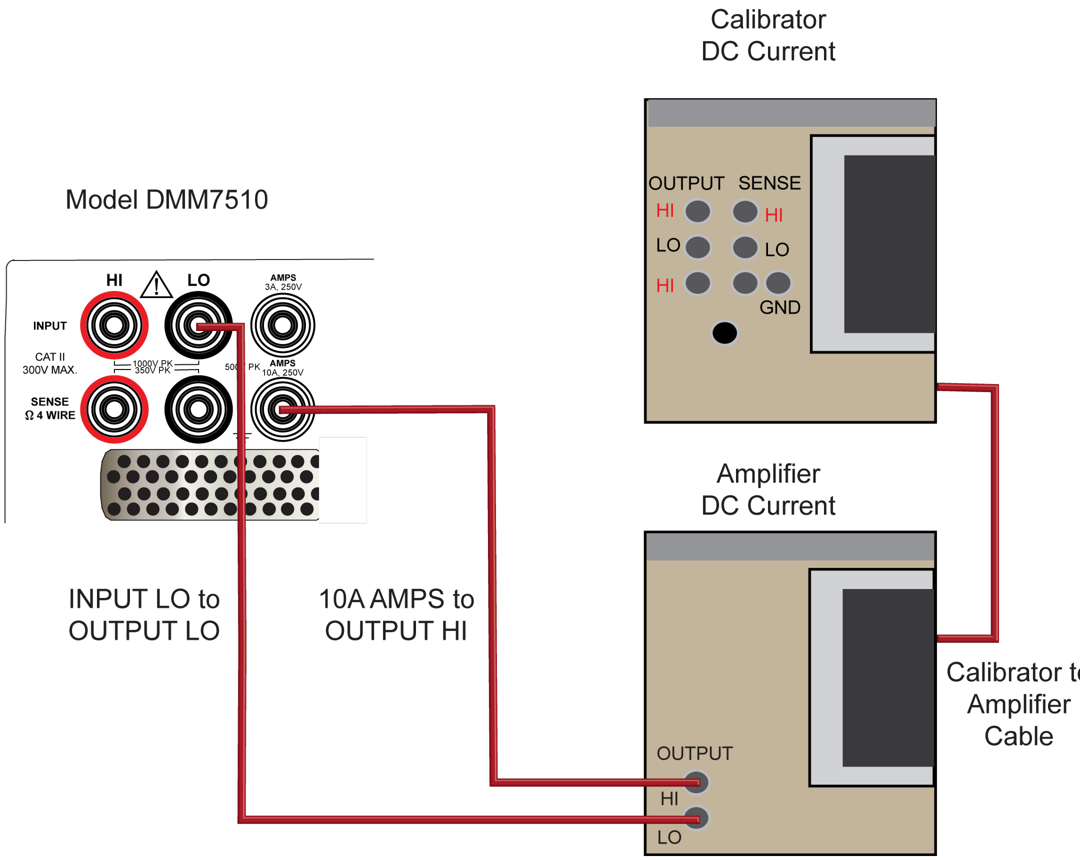
Description	Verification point	Lower limit	Upper limit
Measure or Digitize 50 % scale rising	1.5000E+00	1.410E+00	1.590E+00
Measure or Digitize 50 % scale falling	-1.5000E+00	-1.590E+00	-1.410E+00

Verify the analog trigger DC current 10 A range

To verify analog trigger current accuracy:

1. Connect the Model DMM7510 to the calibrator as shown in the following figure.
2. Set the frequency the calibrator output frequency to 100 Hz and 7.07 A_{rms}.
3. Verify DC current to 3 % accuracy for rising and falling analog edge triggering.

10 A verification connections



CAUTION

Ensure that the gauge of the cabling is sufficient to handle 10 A.

Verify the analog trigger current 10 A range

To verify the analog trigger current 10 A range:

1. Set the TERMINALS switch to **REAR**. Ensure that the orange R is displayed.
2. Set the calibrator and Model DMM7510 as shown in 10 A verification connections (on page 2-29).

Use the following values to verify the performance of the Model DMM7510.

Verify the analog trigger current 10 A range

Description	Verification point	Lower limit	Upper limit
Measure or digitize 50 % scale rising	5.0000E+00	4.70E+00	5.30E+00
Measure or digitize 50 % scale falling	-5.0000E+00	-5.30E+00	-4.70E+00

Example code for verifying analog trigger current performance

The following example code sets the functions and other settings for the verification of both the DC current and digitize current. It also sets up the trigger model, retrieves the data, and displays the first reading on the front panel of the instrument.

```
localnode.prompts = 1
localnode.showerrors = 1

-- *********************************************
-- ****  Setup for measure DC current       ****
-- ****  Rising edge slope                  ****
-- *********************************************

dmm.measure.func = dmm.FUNC_DC_CURRENT
dmm.measure.autozero.enable = dmm.OFF
dmm.measure.autodelay = dmm.DELAY_OFF
dmm.measure.nplc = 0.0005
dmm.measure.range = 3
dmm.measure.analogtrigger.mode = dmm.MODE_EDGE
dmm.measure.analogtrigger.edge.slope = dmm.SLOPE_RISING
dmm.measure.analogtrigger.highfreqreject = dmm.OFF
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
dmm.measure.analogtrigger.edge.level = 1.5
digio.line[1].mode = digio.MODE_TRIGGER_OUT
trigger.digout[1].pulsewidth = 30E-6
trigger.digout[1].stimulus = trigger.EVENT_ANALOGTRIGGER

-- *********************************************
-- ****  Falling Edge slope                 ****
-- *********************************************
dmm.measure.analogtrigger.edge.slope = dmm.SLOPE_FALLING
dmm.measure.analogtrigger.edge.level = -1.50

-- *********************************************
-- **** For Measure Functions               ****
-- **** Trigger model setup and             ****
-- ****    start of triggering              ****
-- *********************************************

samp_count = 10
buf=buffer.make(samp_count)
trigger.model.setblock(1,trigger.BLOCK_BUFFER_CLEAR, buf)
trigger.model.setblock(2,trigger.BLOCK_WAIT, trigger.EVENT_ANALOGTRIGGER)
trigger.model.setblock(3,trigger.BLOCK_MEASURE, buf, samp_count)
trigger.model.initiate()
```

```
-- *******************************************
-- **** Display 1st reading from buffer     ****
-- *******************************************

display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Analogtrigger")
num7 = buf.readings[1]
str7 = string.format('%3.4e', num7)
display.settext(display.TEXT2, str7) print(num7)

-- *******************************************
-- ****  Setup for Digitize DC current      ****
-- *******************************************

-- *******************************************
-- ****  Rising edge slope                  ****
-- *******************************************
dmm.digitize.func = dmm.FUNC_DIGITIZE_CURRENT
dmm.digitize.aperture = 1e-6
dmm.digitize.samplerate = 1e6
dmm.digitize.range = 3
dmm.digitize.analogtrigger.mode = dmm.MODE_EDGE
dmm.digitize.analogtrigger.edge.slope = dmm.SLOPE_RISING
dmm.digitize.analogtrigger.highfreqreject = dmm.OFF
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
dmm.digitize.analogtrigger.edge.level = 1.50
digio.line[1].mode = digio.MODE_TRIGGER_OUT
trigger.digout[1].pulsewidth = 30E-6
trigger.digout[1].stimulus = trigger.EVENT_ANALOGTRIGGER

-- *******************************************
-- **** Falling edge slope                  ****
-- *******************************************
dmm.digitize.analogtrigger.edge.slope = dmm.SLOPE_FALLING
dmm.digitize.analogtrigger.edge.level = -1.50

-- *******************************************
-- **** For digitize functions              ****
-- **** Trigger model setup and             ****
-- ****     start of triggering             ****
-- *******************************************

samp_count = 1e3
buf=buffer.make(samp_count)
trigger.model.setblock(1,trigger.BLOCK_BUFFER_CLEAR, buf)
trigger.model.setblock(2,trigger.BLOCK_WAIT,  trigger.EVENT_ANALOGTRIGGER)
trigger.model.setblock(3,trigger.BLOCK_DIGITIZE, buf, samp_count)
trigger.model.initiate()
```

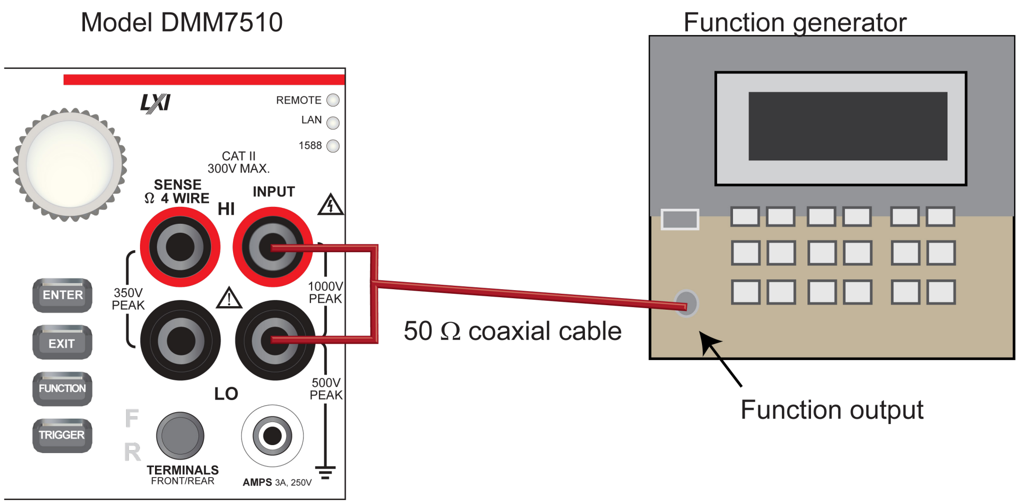
```
-- ********************************************
-- **** Display first reading from buffer   ****
-- ********************************************

display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Analog trigger")
num7 = buf.readings[1]
str7 = string.format('%3.4e', num7)
display.settext(display.TEXT2, str7) print(num7)
```

Frequency verification

To verify the Model DMM7510 frequency function:

1. Connect the Keysight Technologies 33250A function generator to the Model DMM7510 INPUT HI and LO terminals, as shown in the following figure.



2. Set the function generator output impedance to **High**, amplitude of **5 V_{RMS}**, waveform to **square wave**.
3. Enable the output.
4. On the Model DMM7510, press the **FUNCTION** key, select the **Measure Functions** tab, and select **Frequency**.
5. Select the **MENU** key.
6. Select Measure **Settings**.
7. Set the Aperture to **250 ms**.
8. Set the Threshold Range to **10 V**.
9. Set the Threshold Level to **0 V**.
10. Press the **HOME** key.
11. Source the voltage and frequency values as listed in Verify the frequency (on page 2-33). For each setting, be sure that the reading is within low and high limits.

Verify the frequency

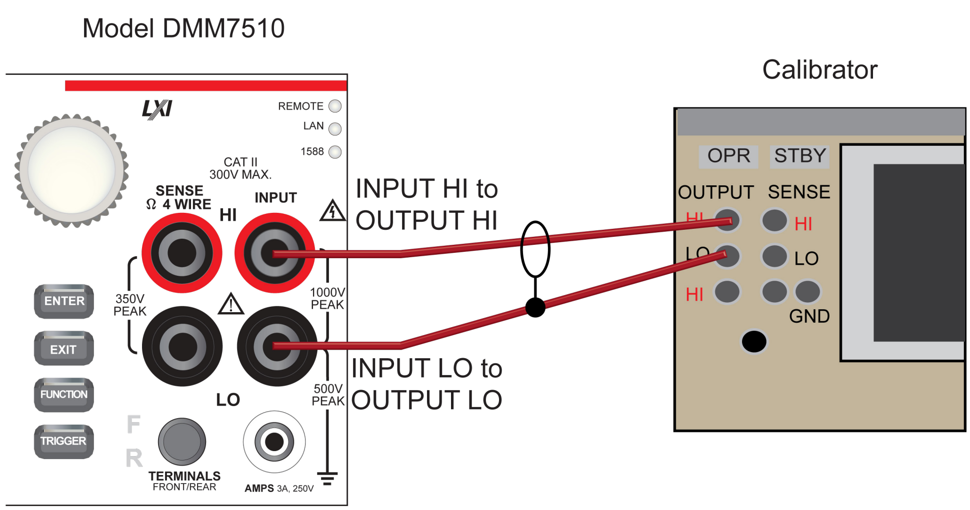
Use the following values to verify the performance of the Model DMM7510. Actual values depend on published specifications (see Example reading limit calculation (on page 2-8)).

Description	Frequency (Hz)	Lower limit (Hz)	Upper limit (Hz)
10 Hz @ 5 V	1.00E+01	9.999197E+00	1.000080E+01
1 kHz @ 5 V	1.00E+03	9.999197E+02	1.000080E+03
10 kHz @ 5 V	1.00E+04	9.999197E+03	1.000080E+04
100 kHz @ 5 V	1.00E+05	9.999197E+04	1.000080E+05
250 kHz @ 5 V	2.50E+05	2.499799E+05	2.500201E+05
500 kHz @ 5 V	5.00E+05	4.999598E+05	5.000402E+05

Simulated thermocouple type J temperature verification

1. Connect the Model DMM7510 HI and LO INPUT terminals to the calibrator HI and LO terminals as shown in the following figure.

Figure 2: DC voltage 100 mV and thermocouple connections



2. Set the calibrator to **0 V** and enable the output.
3. Allow 5 minutes of settling time.
4. On the Model DMM7510, press the **FUNCTION** key and select **DC voltage**.
5. Press the **HOME** key.
6. Select **Range** and select **100 mV**.
7. Press **MENU** key. Under **Measure**, select **Settings**.
8. Set Input Impedance to **Auto**.
9. Record the voltage offset reading.
10. Subtract the DCV 100 mV reading from the calibrator source value.
11. On the Model DMM7510, press the **FUNCTION** key and select **Temperature**.
12. Press **MENU** key. Under **Measure**, select **Settings**.
13. Set Thermocouple to **Type J**.
14. Set the Simulated Temperature to **0°C**.
15. Set the output DC Voltage to value shown in the following tables.
16. Subtract the DCV 100 mV calibrator and cable offset voltage.

Verify the simulated thermocouple Type J temperature

Table calibrator source values based on NIST Monograph 175, reference data 60, version 2.0.

Use the following values to verify the performance of the Model DMM7510. Actual values depend on published specifications (see Example reading limit calculation (on page 2-8)).

Description	**Typical calibrator source value (V)**	**Lower limit**	**Upper limit**
-190 °C	-7.659 E-03	-190.200 °C	-189.800 °C
0 °C	0.0000 E-03	-0.200 °C	0.200 °C
750 °C	4.2281 E-02	749.800 °C	750.200 °C

Simulated RTD temperature verification

Use the following to verify the performance of the Model DMM7510. Actual calibrator source values will vary. RTD verification is based on the calibrator sourcing resistance and the Model DMM7510 conversion of the resistance measurement to calculated temperature based on the Callendar-Van Dusen equation.

RTD equations

The temperature vs. resistance readings listed in the RTD reference tables are calculated using the Callendar-Van Dusen equation. There are two equations, which are based on different temperature ranges. There is an equation for the -200 °C to 0 °C range and one for the 0 °C to 850 °C range.

Equation for -200° to 0°C temperature range

$R_{RTD} = R_0 [1 + AT + BT^2 + CT^3(T-100)]$

where:

- R_{RTD} is the calculated resistance of the RTD
- R_0 is the known RTD resistance at 0 °C
- T is the temperature in °C
- A = alpha [1 + (delta/100)]
- B = -1 (alpha)(delta)(1e-4)
- C = -1 (alpha)(beta)(1e-8)

The alpha, beta, and delta values are listed in the following table.

Equation for 0 °C to 850 °C temperature range

$R_{RTD} = R_0 (1 + AT + BT^2)$

where:

- R_{RTD} is the calculated resistance of the RTD
- R_0 is the known RTD resistance at 0 °C
- T is the temperature in °C
- A = alpha [1 + (delta/100)]
- B = -1 (alpha)(delta)(1e-4)

The alpha and delta values are listed in the following table.

RTD parameters for equations

The RTD parameters for the Callendar-Van Dusen equations are listed in the following table.

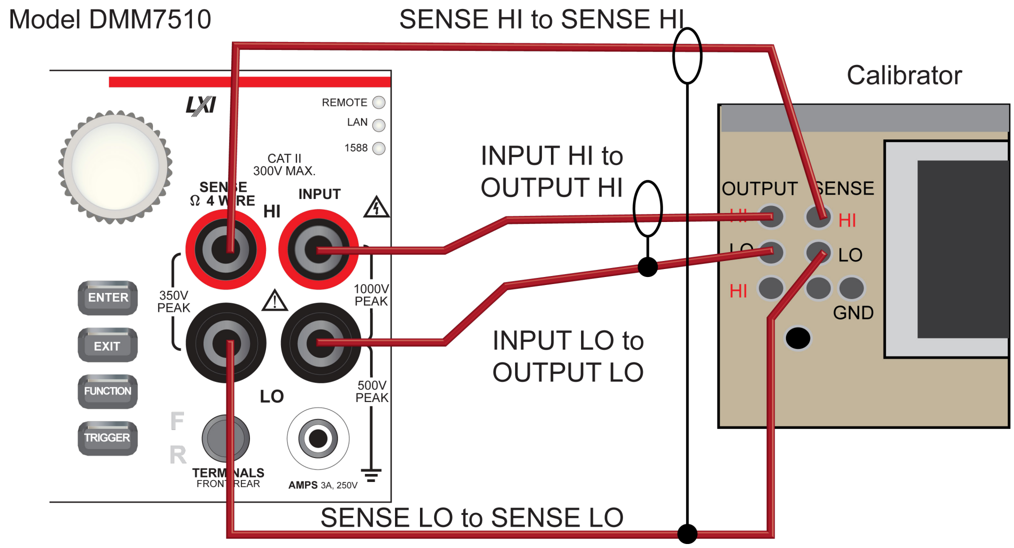
Model DMM7510 resistance to temperature device (RTD)

Type	Standard	Alpha	Beta	Delta	R_0 at 0 °C (Ω)
PT100	ITS-90	0.00385055	0.10863	1.49990	100.0000
D100		0.003920	0.10630	1.49710	
F100		0.003900	0.11000	1.49589	
PT385	IPTS-68	0.003850	0.11100	1.50700	
PT3916		0.003916	0.11600	1.50594	

Verify the simulated RTD temperature

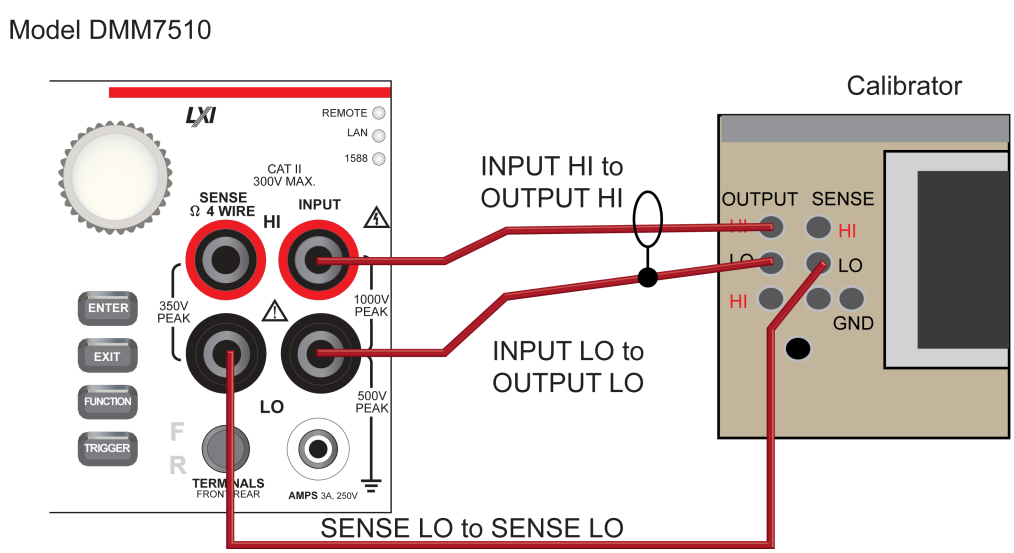
To verify RTD accuracy, use the following setup:

1. For 4-wire accuracy, connect the Model DMM7510 INPUT and SENSE terminals to the calibrator as shown in the following figure.



2. For 3-wire accuracy, connect the Model DMM7510 INPUT and SENSE terminals to the calibrator as shown in the following figure.

> **NOTE**
>
> The SENSE HI wire is not required for 3-wire RTD measurements. For 3-wire RTD, accuracy is for < 0.1 Ω lead resistance mismatch for input HI and LO. Add 0.25 °C per 0.1 Ω of HI-LO lead resistance mismatch.



3. On the Model DMM7510, press the **FUNCTION** key and select **Temperature**.
4. Press the **MENU** key. Under **Measure**, select **Settings**.
5. Select **Transducer**.
6. Set the Type to either **4-wire RTD** or **3-Wire RTD**.
7. Set the RTD Type to **PT100**.
8. Press the **HOME** key.
9. On the calibrator, select **19 Ω** source resistance
10. Select the **OPER** and **EX SNS** keys.
11. Record Model DMM7510 accuracies.
12. Refer to the table for PT100 accuracies.

NOTE

Fluke 5720 and 5730 resistance source values vary and may require new resistance-to-temperature target accuracy values.

13. Repeat for 100 Ω and 190 Ω source values.

Example	**PT100**	
	Ro	1.000000E+02
	alpha	3.850550E-03
	beta	1.086300E-01
	delta	1.499900E+00
	A	3.908304E-03
	B	-5.775440E-07
	C	-4.182852E-12

Nominal calibrator value (Ω)	**Actual calibrator value (Ω)**	**Temperature (°C)**	**4-wire RTD**	**3-wire RTD**
			±0.06 °C accuracy (±Ω from actual calibrator value)	**±0.75 °C accuracy (±Ω from actual calibrator value)**
19	18.999520	-198.8900	0.0259	0.3241
100	99.99707	-0.0075	0.0235	0.2932
190	189.99234	238.6775	0.0218	0.2725

Dry circuit resistance verification

To check the dry circuit resistance function, you will:

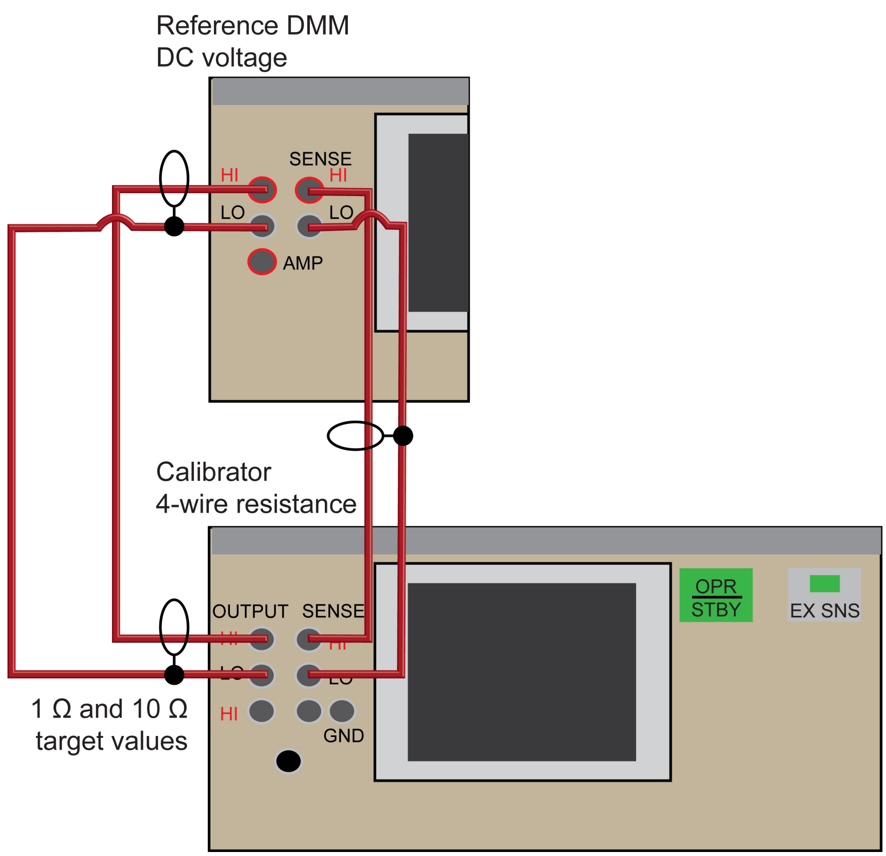
- Use shielded, Teflon-insulated or equivalent cables in a 4-wire configuration
- Characterize the calibrator 1 Ω and 10 Ω nominal values with the external reference DMM
- Verify that the displayed readings fall within specified limits
  - For the 1 Ω and 10 Ω ranges, verify accuracy from the reference DMM readings
  - For the 100 Ω to 10 kΩ ranges, verify accuracy from actual calibrator source values

Characterize the calibrator for 1 Ω and 10 Ω

To characterize the calibrator:

1. Connect the calibrator and the reference DMM as shown in the figure below.
2. On the calibrator, enable the **OPR** key and the **EX SNS** key.
3. Ensure that the **OPERATE** display and **EX SNS** key are illuminated.
4. Source **0 Ω**.
5. On the reference DMM, enable **4-wire resistance** and **2 Ω range**.
6. Select **Ω PLUS**, then **TruΩ**, Resl to **RESL '7'**, and Fast **OFF**.
7. Verify **0 Ω**.
8. Perform range **ZERO** as required.
9. On the calibrator, source **1 Ω**.
10. On the reference DMM, record **1 Ω** reading.
11. Use the reading as the target for the Model DMM7510 1 Ω verification.
12. Repeat these steps for 10 Ω characterization.

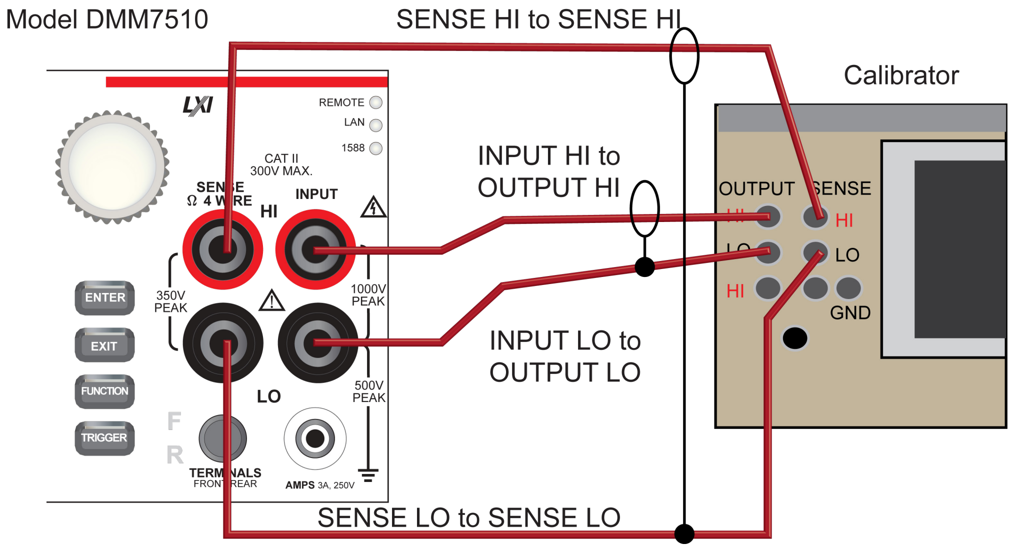
Figure 3: Characterize the calibrator



Verify dry circuit accuracy

To verify dry circuit resistance accuracy:

1. Connect the Model DMM7510 INPUT and SENSE terminals to the calibrator as shown in the following figure.



2. Set the calibrator for 4-wire resistance with external sense on.
3. On the Model DMM7510, press the **FUNCTION** key and select **4W Res**.
4. Press the **HOME** key.
5. Set the range to **1 Ω**.
6. Press the **MENU** key.
7. Select Measure **Settings**.
8. Set Dry Circuit **On**. Verify that Offset Compensation is on. (Selecting Dry Circuit should automatically enable Offset Compensation.)
9. Source the nominal full-scale resistance values for the 1 Ω to 2 kΩ ranges as shown in the following tables.
10. For the 10 kΩ range, verify with 1.9 kΩ. Overrange is 2.4 kΩ for the 10 kΩ range.
11. Verify that the readings are within calculated limits.

Verify dry circuit resistance values

Use the following values to verify the performance of the Model DMM7510. Actual values depend on published specifications (see Calculating resistance reading limits (on page 2-8)).

Range	Nominal calibrator value (Ω)	Typical reference DMM reading (Ω)	Lower limit (Ω)	Upper limit (Ω)
1	0		-8.00E-05	8.00E-05
	1.000000	1.0001568E+00	1.000027E+00	1.000287E+00
10	0		-8.00E-04	8.00E-04
	10.00000	9.9994500E+00	9.998150E+00	1.000075E+01

Range	Nominal calibrator value (Ω)	Actual calibrator value (Ω)	Lower limit (Ω)	Upper limit (Ω)
100	0		-8.00E-03	8.00E-03
	100.0000	9.9996340E01	9.997934E+01	1.000133E+02
1000	0		-8.00E-02	8.00E-02
	1000.000	9.9998410E+02	9.997241E+02	1.000244E+03
1.0E+04	0		-8.00E-01	8.00E-01
	1900.000	1.8999910E+03	1.898583E+03	1.901399E+03

Resistance verification

To check the resistance function, you will:

- Use shielded, Teflon-insulated or equivalent cables in a 4-wire configuration
- Characterize the calibrator 1 Ω, 10 Ω, and 909 MΩ nominal values with external reference DMM
- Verify that the displayed readings fall within specified limits
- For the 1 Ω, 10 Ω, and 1 GΩ ranges, verify accuracy from reference DMM readings
- For the 100 Ω to 100 MΩ ranges, verify accuracy from actual calibrator source values

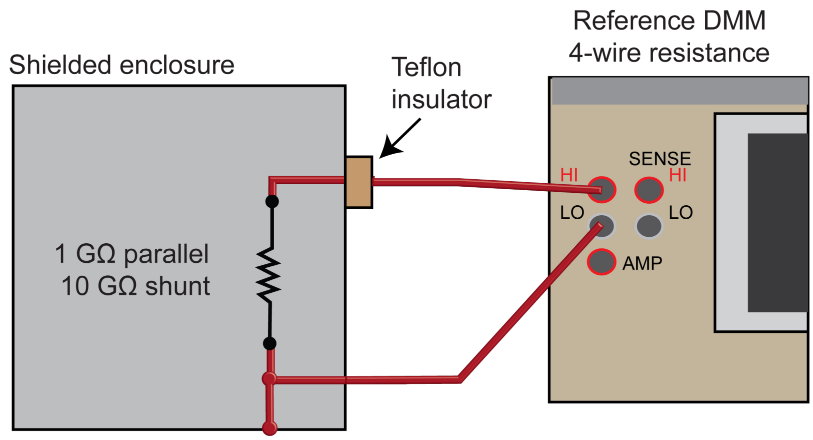
Characterize the calibrator and 909 MΩ resistor

If not already done, complete the procedure for characterizing the calibrator for dry circuit verification. Refer to Characterize the calibrator for 1 Ω and 10 Ω (on page 2-38).

To characterize the resistor:

1. Make connections between the resistor and the reference DMM as shown in the figure below.

Figure 4: 909 MΩ resistor characterization

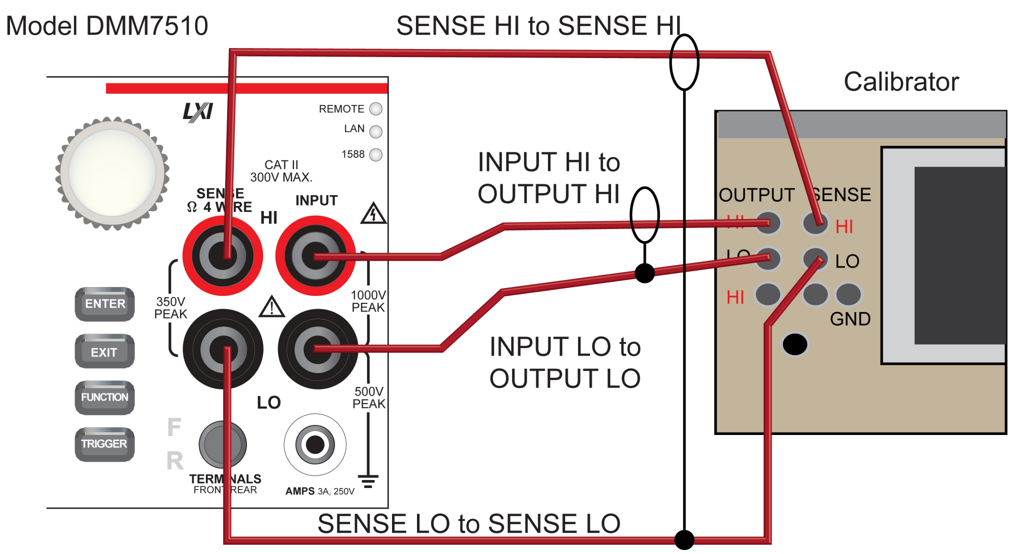


2. Source **909.09 MΩ**.
3. On the reference DMM, enable **2-wire resistance**.
4. Enable the **2 GΩ** range.
5. Select **Res1**.
6. Set to **RESL '7'**.
7. Verify **909 MΩ**.
8. On the reference DMM, record the 909 MΩ reading. Use this reading as the target for Model DMM7510 1 GΩ verification.

Verifying 4-wire resistance accuracy

To verify 4-wire resistance accuracy:

1. Connect the Model DMM7510 INPUT and SENSE terminals to the calibrator as shown in the following figure.



2. Set the calibrator for 4-wire resistance with external sense on.
3. On the Model DMM7510, press the **FUNCTION** key and select **4W Res**.
4. Press the **MENU** key.
5. Select Measure **Settings**.
6. Set Offset Compensation **On**.
7. Verify that Open Lead Detector is **Off**.

8. Press the **HOME** key.
9. Set the range to **1 Ω**.
10. Source the nominal zero and full-scale resistance values for the 1 Ω to 10 kΩ ranges. Source the nominal zero for the 100 kΩ range. Refer to the following tables.
11. For the 100 kΩ range, only verify 0 Ω with Offset Compensation set to **On**.
12. Set Offset Compensation to **Off**.
13. Verify full-scale 100 kΩ on the 100 kΩ range and 0 and full-scale for the 1 MΩ and 10 MΩ ranges.
14. Verify that the readings are within calculated limits.

NOTE

When Offset Compensation is set to On, ranges are limited to 1 Ω to 100 kΩ. When Offset Compensation is set to Off, all ranges (1 Ω to 1 GΩ) are available from all interfaces.

You can use either the front-panel controls or remote interface commands to set measurement parameters for verification. For calibration, you must use remote interface commands. The example below is an example of remote interface commands, which will generate event messages.

To do the same steps over the remote interface, send the commands:

```
dmm.measure.func=dmm.FUNC_4W_RESISTANCE
dmm.measure.offsetcompensation.enable=dmm.ON
dmm.measure.range=1e6
```

The following warning message is displayed:

```
1131, Parameter, measure range, expected value from 1 to 100000
```

Set `dmm.measure.offsetcompensation.enable=dmm.OFF`, and then `dmm.measure.range=1e6` to run without warnings.

Verify that the readings are within calculated limits.

Calculated limits

Use the following values to verify the performance of the Model DMM7510. Actual values depend on published specifications (see Calculating resistance reading limits (on page 2-8)).

Range (Ω)	Nominal calibrator values (Ω)	Typical reference DMM reading (Ω)	Lower limit (Ω)	Upper limit (Ω)
1	0		-5.00E-05	5.00E-05
	1.00E+00	1.0001568E+00	1.000077E+00	1.000237E+00
10	0.00E+00		-5.00E-05	5.00E-05
	1.00E+01	9.9994500E+00	9.9991000E+00	9.9998000E+00

Range (Ω)	Nominal calibrator values (Ω)	Actual calibrator value (Ω)	Lower limit (Ω)	Upper limit (Ω)
100	0.00E+00		-4.00E-04	4.00E-04
	1.00E+02	9.9996340E+01	9.9993240E+01	9.9999440E+01
1000	0.00E+00		-3.00E-03	3.00E-03
	1.00E+03	9.9998410E+02	9.9995710E+02	1.0000111E+03

Range (Ω)	Nominal calibrator values (Ω)	Actual calibrator value (Ω)	Lower limit (Ω)	Upper limit (Ω)
1.0E+04	0.00E+00		1.0E+04	0.00E+00
	1.00E+04	9.9999050E+03		1.00E+04
1.0E+05	0.00E+00		-3.00E-01	3.00E-01

4-wire resistance verification with Offset Compensation Off

Use the following values to verify the performance of the Model DMM7510. Actual values depend on published specifications (see Calculating resistance reading limits (on page 2-8)).

NOTE

For 10 MΩ verification, the Sense HI cable is optional. Measurement is with Input HI and LO and Sense LO only.

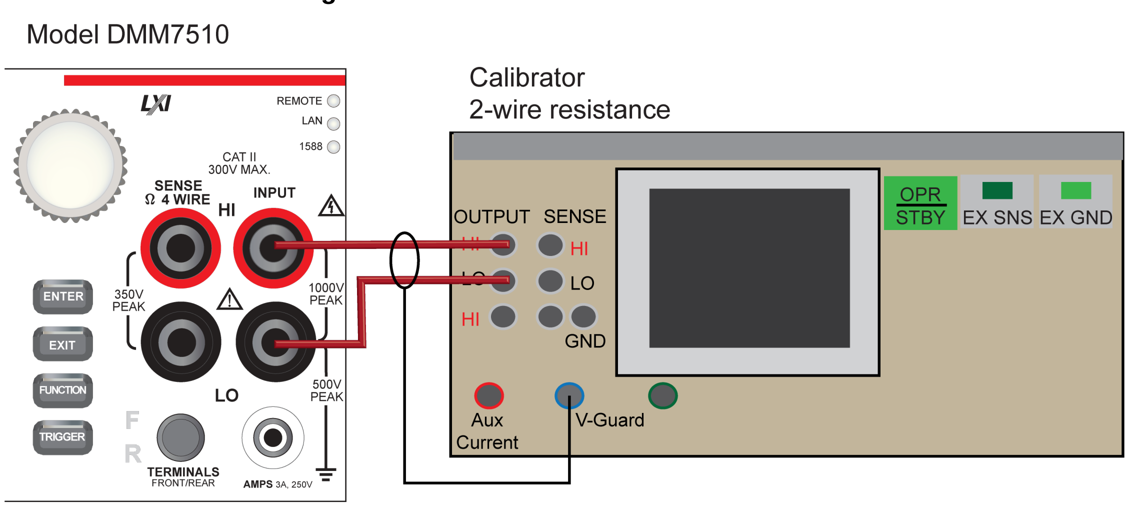
Range (Ω)	Nominal calibrator values (Ω)	Actual calibrator value (Ω)	Lower limit (Ω)	Upper limit (Ω)
1.0E+05	1.00E+05	1.0000060E+05	9.9997300E+04	1.0000390E+05
1.0E+06	0.00E+00		-4.00E+00	4.00E+00
	1.00E+06	9.9995720E+05	9.9992320E+05	1.0000340E+06
1.0E+07	0.00E+00		-1.00E+02	1.00E+02
	1.00E+07	9.9989960E+06	9.9968962E+06	1.0001096E+07

Verify resistance 100 MΩ range

To verify the 100 MΩ range:

1. Connect the Model DMM7510 INPUT to the calibrator as shown in the following figure.

Figure 5: 100 MΩ verification connections



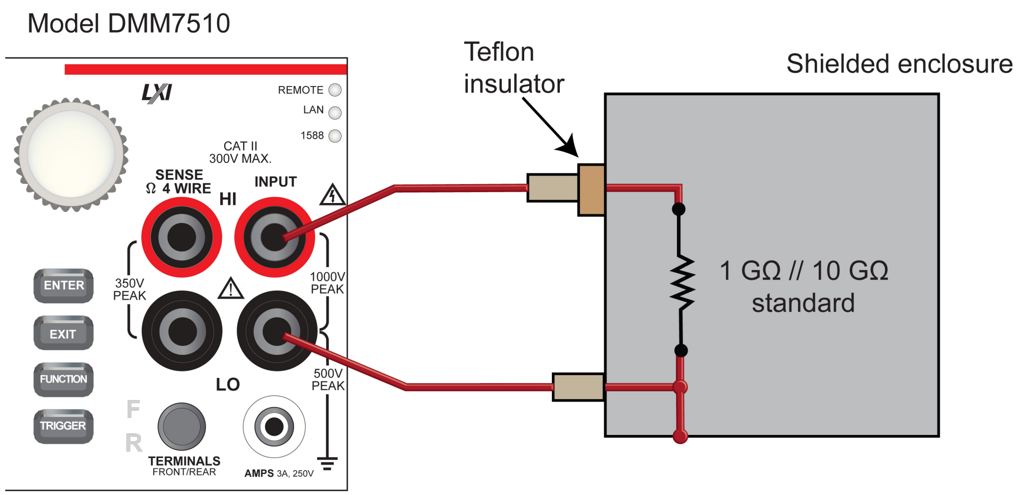
2. Set the calibrator for 2-wire resistance with external sense off.
3. On the Model DMM7510, press the FUNCTION key and select **2W Res**.
4. Press the **HOME** key.
5. Set the range to **100 MΩ**.
6. Source the nominal full-scale resistance values for the 100 MΩ range as shown in the following table.

Range	Nominal calibrator values (Ω)	Actual calibrator (Ω)	Lower limit (Ω)	Upper limit (Ω)
1.0E+08	0.00E+00		-3.00E+03	3.00E+03
	1.00E+08	1.0000380E+08	9.980079E+07	1.002068E+08

Verify resistance 909 MΩ on the 1 GΩ range

1. Connect the Model DMM7510 INPUT to the discrete shielded 909 MΩ reference resistor.

Figure 6: 1 GΩ verification connections



2. On the Model DMM7510, press the **FUNCTION** key and select **2W Res**.
3. Press the **HOME** key.
4. Set the range to **1GΩ.**
5. Verify the 1 GΩ range as shown in the following table.

Range	Nominal calibrator value (Ω)	Typical reference DMM reading (Ω)	Lower limit (Ω)	Upper limit (Ω)
1.0E+09	9.09E+08	9.081948E+08	8.999210E+08	9.164686E+08

DC current verification

For DC current verification, you use different connections and procedures to test the 10 μA and 100 μA ranges, 1 mA and 10 mA, and the 100 mA to 3 A ranges.

DC current 10 μA and 100 μA range verification

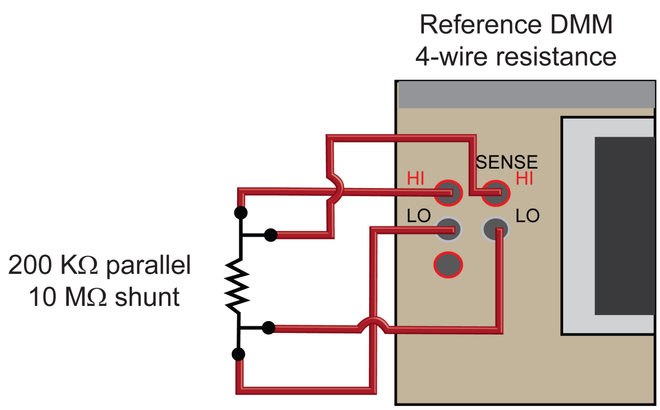
To verify DC current accuracy for the 10 μA to 100 μA ranges, you will:

- Apply accurate DC voltage from the calibrator through a precision shunt resistor to the Model DMM7510 front terminals.
- Sense the voltage across the shunt with a reference DMM.
- Verify that the readings displayed on the Model DMM7510 fall within the calculated reference DMM voltage and precision shunt limits.

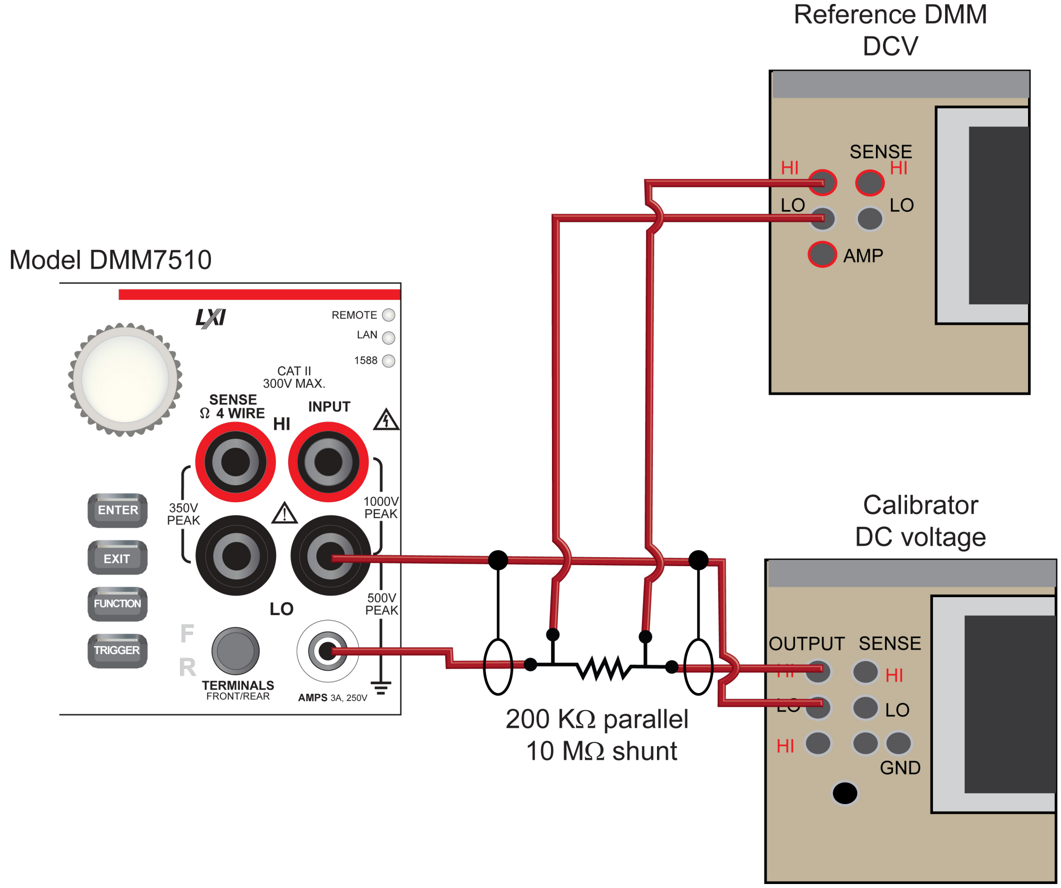
Configuring DC current for the 10 μA and 100 μA ranges:

1. Set up the Model DMM7510 for DC current and the range being tested.
2. Make sure relative offset is disabled.
3. Verify shunt. With a shunt characterization of 200 kΩ parallel 10 MΩ, the reference DMM typical measurement is 196.07843 kΩ.

Figure 7: Connections for the 10 μA and 100 μA shunt characterization



4. Connect the calibrator, shunt, Model DMM7510, and reference DMM as shown in the following figure.



5. Set up the Model DMM7510 to the DC current function and range.
6. On the calibrator, select the **OPR/STBY** key. Ensure that the front panel displays **STANDBY**.
7. On the reference DMM, disconnect internal connects using the `Input OFF` command, minimizing measurement noise across the shunt.
8. Verify the Model DMM7510 zero reading for each range.
9. Rel the Model DMM7510.
10. On the calibrator, select the **OPR/STBY** key. Ensure that the front panel displays **OPERATE**.
11. Set the reference DMM to **DC Voltage**, **2 V** range.
12. Set the calibrator to source **0 V**.
13. On the reference DMM, enable internal terminals using the `Input FRONT` command.
14. Perform Zero Range for system offset removal. Note that for the 10 µA and 100 µA Model DMM7510 verification measurement, ensure the reference DMM `Input OFF` command is used to reduce measurement and system noise.
15. Set the calibrator to source the voltage identified in the 10 µA procedure, verifying the Model DMM7510 accuracy from calculated reference DMM Voltage/Characterized shunt.
16. For 100 µA verification, set the reference DMM to the 20 V range.
17. Repeat steps 6 to 14 for 100 µA verification.

Verify DC current 10 µA and 100 µA range

Characterized shunt (Ω): 1.9607843E+05

Range	Nominal input	Calibrator setpoint (V)	Shunt measure-ment (V)	Calculated input (A)	Lower limit (A)	Upper limit (A)
Ref DMM Zero	0.00E+00	0	8.00E-07	0	n/a	n/a
1.00E-05	0	STANDBY	n/a	n/a	-3.00E-10	3.00E-10
	0.00001	1.9707843	1.9607843	1.0000000E-05	9.9989500E-06	1.0001050E-05
	0.000005	0.9853921	0.9803922	5.0000003E-06	4.9993253E-06	5.0006753E-06
	-0.000005	-1.9707843	-0.9803922	-5.0000003E-06	-5.0006753E-06	-4.9993253E-06
	-0.00001	-1.9707843	-1.9607843	-1.0000000E-05	-1.0001050E-05	-9.9989500E-06
Ref DMM Zero	0.00E+00	0 V	8.00E-07	0	n/a	n/a
1.00E-04	0			n/a	-9.00E-10	9.00E-10
	0.0001	19.617843	19.607843	1.0000000E-04	9.9994000E-05	1.0000600E-04
	0.00005	9.8089216	9.8039216	5.0000001E-05	4.9997001E-05	5.0003001E-05
	-0.00005	-9.8089216	-9.8039216	-5.0000001E-05	-5.0003001E-05	-4.9997001E-05
	-0.0001	-19.617843	-19.607843	-1.0000000E-04	-1.0000600E-04	-9.9994000E-05

DC current 1 mA and 10 mA range verification

For DC current verification, there are different connections when testing the 1 mA and 10 mA ranges.

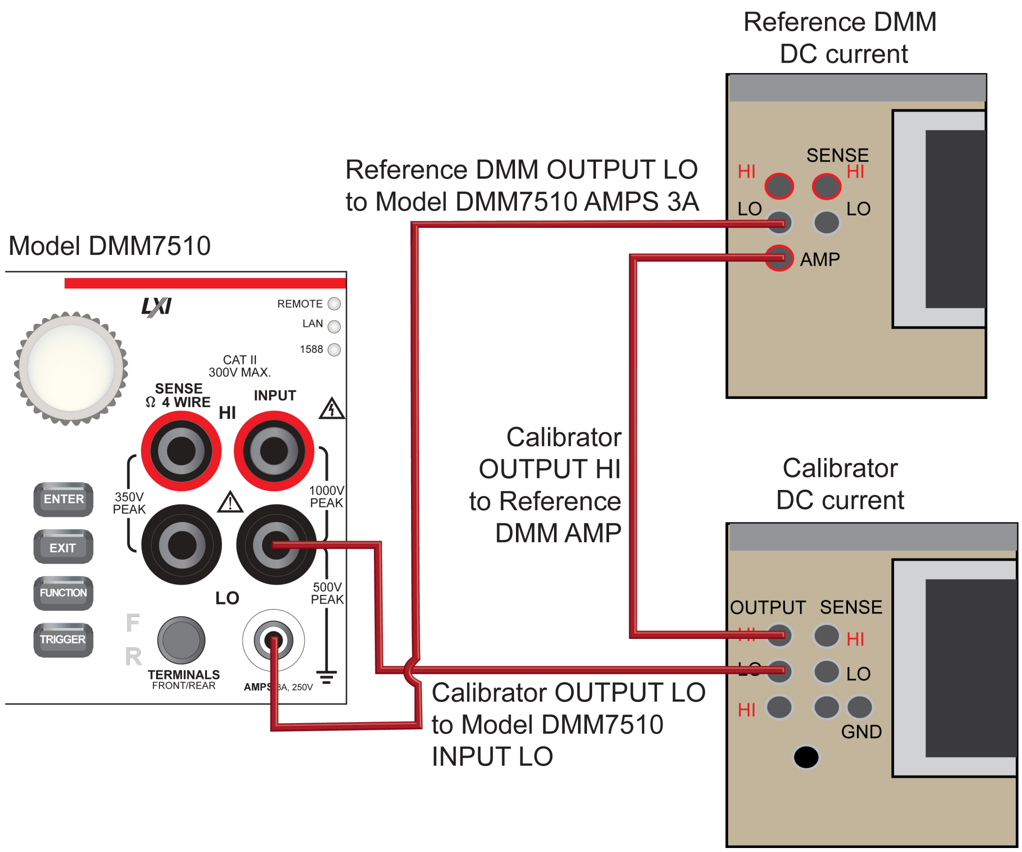
To verify DC current accuracy, you will:

- Apply accurate current from the DC current calibrator to the reference DMM Amp and LO terminals, then to the Model DMM7510 front-panel terminals
- Verify that the Model DMM7510 displayed readings fall within specified reference DMM measured limits

To verify DC current accuracy:

1. Set up the Model DMM7510 for DC current and the range being tested. Make sure relative offset is disabled.
2. Connect the calibrator, Model DMM7510, and reference DMM as shown in the following figure.

Figure 8: DC current verification 1 mA to 10 mA range



Zero verify the Model DMM7510

1. On the calibrator, select the **OPR/STBY** key. Ensure that the front panel displays **STANDBY**.
2. Verify the Model DMM7510 Zero reading for each range.

Rel the system

1. On the calibrator, select the **OPR/STBY** key. Ensure that the front panel displays **OPERATE**.
2. Set the reference DMM to **DC Current, 2 mA** range.
3. Set the calibrator to source zero current.
4. Rel the Model DMM7510.
5. Zero Range the reference DMM for system offset.
6. Set the calibrator to source the current identified in the 1 mA verification, verifying the Model DMM7510 accuracy from the calculated reference DMM current.
7. For 10 mA verification, set the reference DMM to the 20 mA range.
8. Repeat steps 1 to 6 for 10 mA verification.

Verify DC current 1 mA and 10 mA range

Range	Nominal input	Typical measured input (A)	Lower limit (A)	Upper limit (A)
1.0 e-03	standby		-9.00E-09	9.00E-09
	0.00E+00	8.00E-07	REL	REL
	1.00E-03	9.9999100E-04	9.9992200E-04	1.0000600E-03
	5.00E-04	4.9999740E-01	4.9996739E-01	5.0002741E-01
	-5.00E-04	-4.9999540E-04	-5.0003440E-04	-4.9995640E-04
	-1.00E-03	-9.9999040E-04	-1.0000594E-03	-9.9992140E-04
1.0 e-02	standby		-9.00E-08	9.00E-08
	0.00E+00	6.00E-06	REL	REL
	1.00E-02	9.9999990E+00	9.9993989E+00	1.0000599E+01
	5.00E-03	5.0000180E+00	4.9997179E+00	5.0003181E+00
	-5.00E-03	-5.0000060E+00	-5.0003061E+00	-4.9997059E+00
	-1.00E-02	-1.0000000E+01	-1.0000600E+01	-9.9993999E+00

DC current 100 mA to 3 A range verification

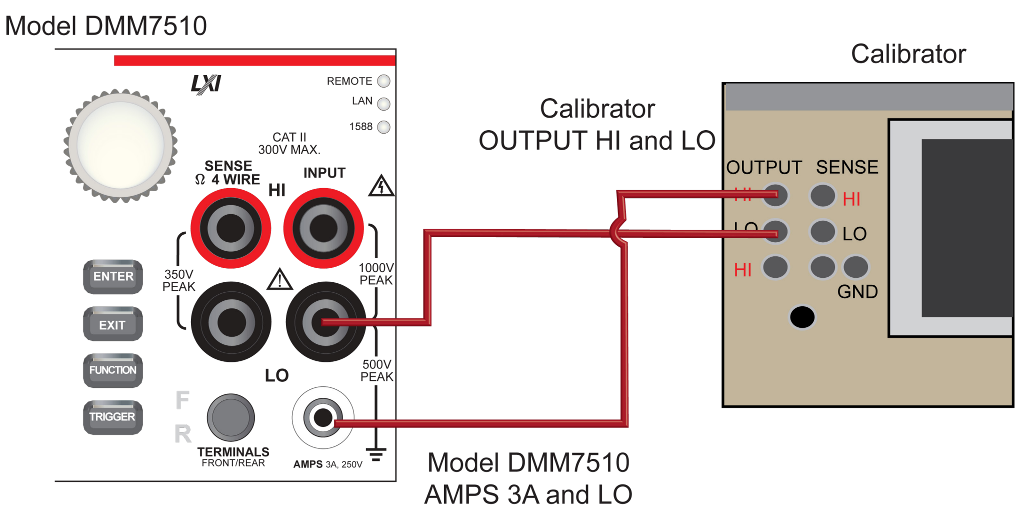
You will:

- Apply accurate current from the DC current calibrator directly to the Model DMM7510 front-panel terminals
- Verify that the displayed readings fall within specified limits

To verify DC current accuracy:

1. Set up the Model DMM7510 for DC current and the range being tested. Make sure relative offset is disabled.
2. Connect the Model DMM7510 and calibrator as shown in the following figure.

Figure 9: 100 mA to 3 A range verification



Zero verify the Model DMM7510:

1. On the calibrator, select the **OPR/STBY** key. Ensure that the front panel displays **STANDBY**.
2. Set the ranges to 100 mA.
3. Verify the Model DMM7510 zero reading for each range.

Rel the system:

1. On the calibrator, select the **OPR/STBY** key. Ensure that the front panel displays **OPERATE**.
2. Set the calibrator to source zero current and rel the Model DMM7510.
3. Source DC current from the following "Verify DC current 100 mA range" table. For each setting, be sure that the reading is within stated limits.
4. Repeat these steps for the 1 A and 3 A ranges.

Verify DC current 100 mA range

Description	Calibrator setpoint (A)	Lower limit	Upper limit
UUT Zero	STANDBY	-3.00E-06	3.00E-06
Full scale (+)	0.1	9.9982000E-02	1.0001800E-01
Half scale (+)	0.05	4.9989500E-02	5.0010500E-02
Half scale (-)	-0.05	-5.0010500E-02	-4.9989500E-02
Full scale (-)	-0.1	-1.0001800E-01	-9.9982000E-02

Verify DC current 1 A range

Description	Calibrator setpoint (A)	Lower limit	Upper limit
UUT Zero	STANDBY	-5.0000000E-05	5.0000000E-05
Full scale (+)	0	9.9955000E-01	1.0004500E+00
Half scale (+)	1	4.9975000E-01	5.0025000E-01
Half scale (-)	0.5	-5.0025000E-01	-4.9975000E-01
Full scale (-)	-0.5	-1.0004500E+00	-9.9955000E-01

Verify DC current 3 A range

Description	Calibrator setpoint (A)	Lower limit	Upper limit
UUT Zero	STANDBY	-1.20E-04	1.20E-04
⅔ scale (+)	2	1.9990800E+00	2.0009200E+00
Half scale (+)	1.5	1.4992800E+00	1.5007200E+00
Half scale (-)	-1.5	-1.5007200E+00	-1.4992800E+00
⅔ scale (-)	-2	-2.0009200E+00	-1.9990800E+00

Digitize current verification

For Digitize DC current verification, you use different connections and procedures to test the 10 µA and 100 µA ranges and the 1 mA to 3 A ranges than the measure DC current verification.

Digitize DC current 10 µA and 100 µA range verification

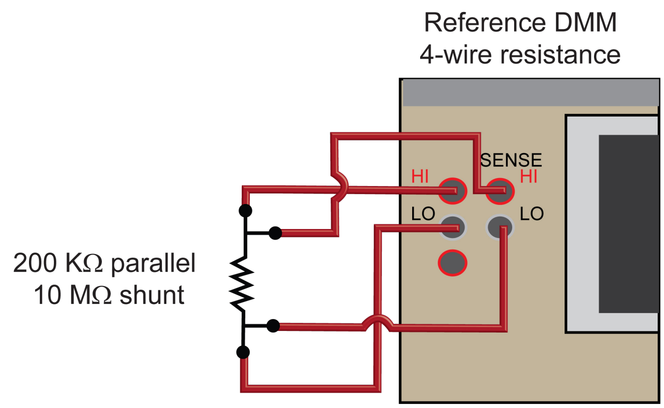
To verify digitize DC current accuracy for the 10 µA to 100 µA ranges, you will:

- Apply accurate DC voltage from the calibrator through a precision shunt resistor to the Model DMM7510 front terminals.
- Sense the voltage across the shunt with a reference DMM.
- Verify that the displayed readings of the Model DMM7510 fall within the calculated reference DMM voltage and precision shunt limits.

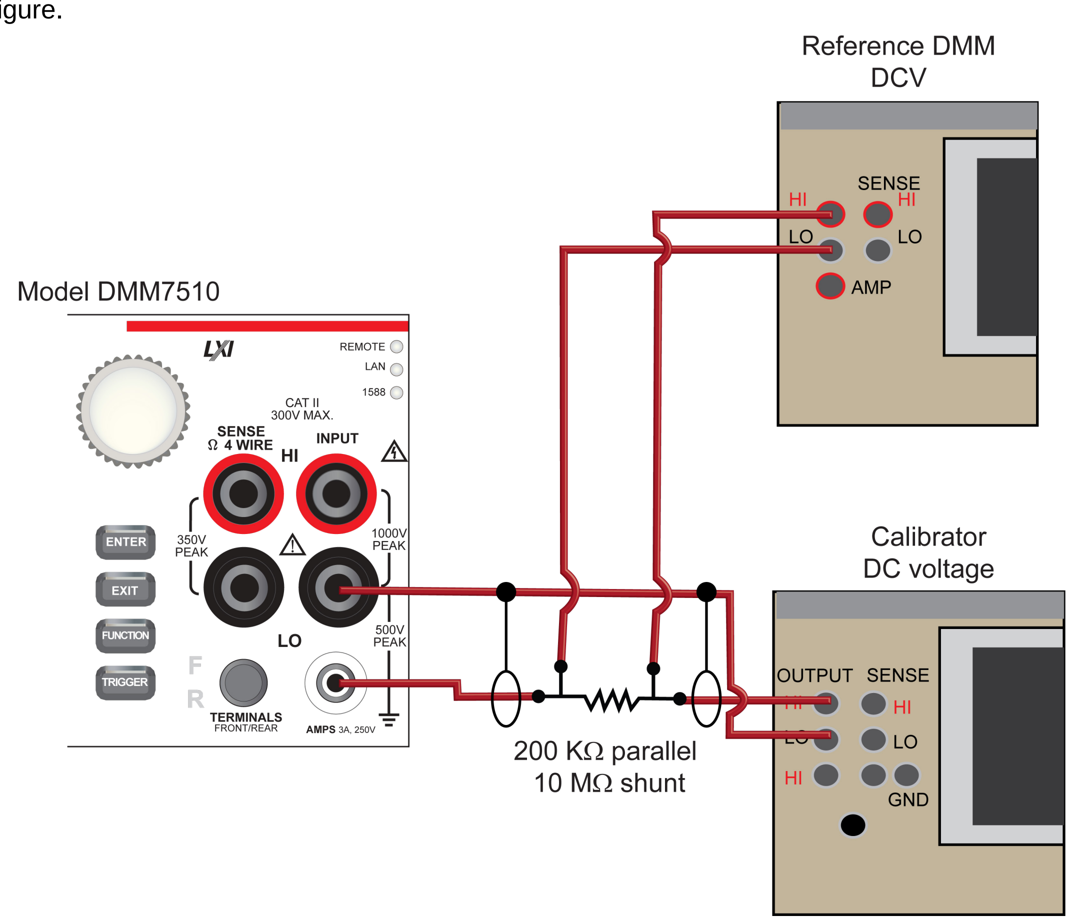
Configure Digitize DC current for the 10 µA and 100 µA ranges:

1. Set up the Model DMM7510 for digitize DC current and the range being tested. Make sure relative offset is disabled.
2. Verify the shunt. With a shunt characterization of 200 kΩ parallel 10 MΩ reference, the DMM typical measurement is 196.07843 kΩ.

Figure 10: Connections for the 10 µA and 100 µA shunt characterization



3. Connect the calibrator, shunt, Model DMM7510, and reference DMM as shown in the following figure.



4. Set up the Model DMM7510 to the Digitize DC current function.
5. Press the **HOME** key.
6. Set the Range to **10 µA**.
7. Press the **MENU** key.
8. Select **Settings**.
9. Set the Sample Rate to **1000**.
10. Set the Aperture to **Auto**.
11. Set the Count to **100**.

Zero verify the Model 7510:

1. On the calibrator, select the **OPR/STBY** key. Ensure that the front panel displays **STANDBY**.
2. Verify the Model DMM7510 Zero reading for each range.

Rel the system:

1. On the calibrator, select the **OPR/STBY** key. Ensure that the front panel displays **OPERATE**.
2. Set the reference DMM to **DC Voltage**, **2 V** range.
3. Set the calibrator to **0 V**.
4. Rel the Model DMM7510.
5. Zero Range the reference DMM system offset.
6. Set the calibrator to source the voltage identified in the following "10 µA and 100 µA range verification" table, verifying the Model DMM7510 accuracy from the calculated reference DMM Voltage/Characterized shunt. For each setting, verify that the STATISTICS swipe screen reading for Average is within low and high limits.
7. For 100 µA verification, set the reference DMM to the 20 V range.
8. Repeat steps 3 to 6 for 100 µA verification.

10 µA and 100 µA verification table

Characterized shunt (Ω): 1.9607843E+05

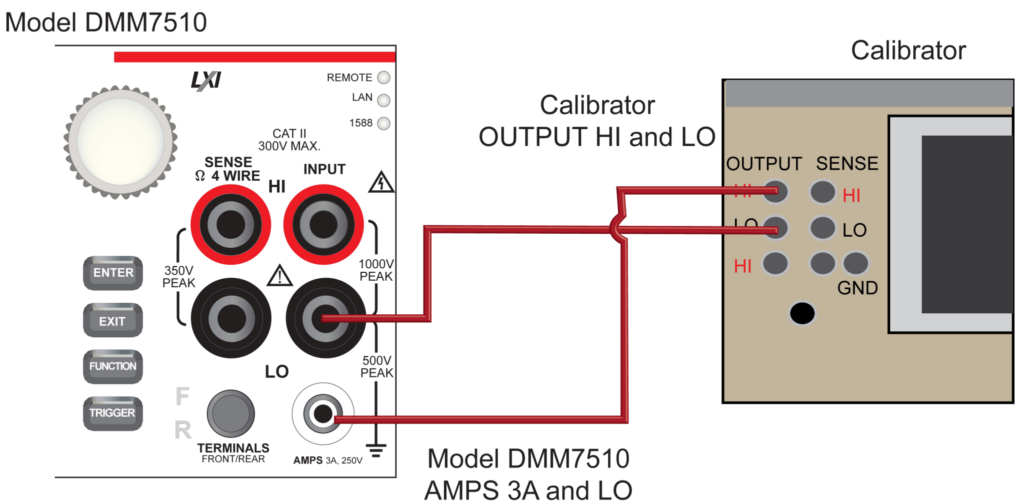
Range	Nominal input	Calibrator setpoint (V)	Shunt measurement (V)	Calculated input (A)	Lower limit (A)	Upper limit (A)
Ref DMM Zero	0.00E+00	0	8.00E-07	0	n/a	n/a
UUT Zero	0	STANDBY	n/a	n/a	-7.50E-10	7.50E-10
1.00E-05	0.00001	1.9707843	1.9607843	1.0000000E-05	9.99765E-06	1.00024E-05
	0.000005	0.9853921	0.9803922	5.0000003E-06	4.99845E-06	5.00155E-06
	-5E-06	-1.9707843	-0.9803922	-5.0000003E-06	-5.00155E-06	-4.99845E-06
	-0.00001	-1.9707843	-1.9607843	-1.0000000E-05	-1.00024E-05	-9.99765E-06
Ref DMM Zero	0.00E+00	0 V	8.00E-07	0	n/a	n/a
UUT Zero	0			n/a	-7.50E-9	9.00E-10
1.00E-04	0.0001	19.617843	19.607843	1.0000000E-04	9.99765E-05	1.00024E-04
	0.00005	9.8089216	9.8039216	5.0000001E-05	4.99845E-05	5.00155E-05
	-0.00005	-9.8089216	-9.8039216	-5.0000001E-05	-5.00155E-05	-4.99845E-05
	-0.0001	-19.617843	-19.607843	-1.0000000E-04	-1.00024E-04	-9.99765E-05

Digitize DC current verification 1 mA to 3 A ranges

To verify digitize DC current accuracy:

1. Connect the Model DMM7510 and calibrator as shown in the following figure.

Figure 11: 100 mA to 3 A range verification



2. On the Model DMM7510, press the **FUNCTION** key, select the **Digitize Functions** tab, and select **Digitize Current**.
3. Press the **HOME** key.
4. Set the Range to **1 mA**.
5. Press the **MENU** key.
6. Select **Settings**.
7. Set the Sample Rate to **1000**.
8. Set the Aperture to **Auto** or **1 ms**.
9. Set the Count to **100**.

Zero verify the Model DMM7510:

1. On the calibrator, select the **OPR/STBY** key. Ensure that the front panel displays **STANDBY**.
2. Verify the Model DMM7510 Zero reading for each range.

Rel the system:

1. On the calibrator, select the **OPR/STBY** key. Ensure that the front panel displays **OPERATE**.
2. Se thte calibration current output to **NORMAL**.
3. Set the calibrator output to **0 A** and allow the reading to settle.
4. On the Model DMM7510, press the **MENU** key.
5. Select **Calculations**.
6. Select **Rel Acquire**.
7. Source positive and negative full-scale and half-scale currents, as listed in Verify digitize current 1 mA range (on page 2-55).
8. Repeat these steps for the 10 mA to 3 A range settings listed in the tables below. For each current setting, verify that the STATISTICS swipe screen reading for Average is within low and high limits.

Verify digitize current 1 mA range

Description	Calibrator setpoint (A)	Lower limit	Upper limit
UUT Zero	STANDBY	-7.50E-08	7.50E-08
Full scale (+)	0.001	9.99765E-04	1.00024E-03
Half scale (+)	0.0005	4.99845E-04	5.00155E-04
Half scale (-)	-0.0005	-5.00155E-04	-4.99845E-04
Full scale (-)	-0.001	-1.00024E-03	-9.99765E-04

Verify digitize current 10 mA range

Description	Calibrator setpoint (A)	Lower limit	Upper limit
UUT Zero	STANDBY	-7.50E-07	7.50E-07
Full scale (+)	0.01	9.99765E-03	1.00024E-02
Half scale (+)	0.005	4.99845E-03	5.00155E-03
Half scale (-)	-0.005	-5.00155E-03	-4.99845E-03
Full scale (-)	-0.01	-1.00024E-02	-9.99765E-03

Verify digitize current 100 mA range

Description	Calibrator setpoint (A)	Lower limit	Upper limit
UUT Zero	STANDBY	-1.00E-05	1.00E-05
Full scale (+)	0.1	9.99450E-02	1.00055E-01
Half scale (+)	0.05	4.99675E-02	5.00325E-02
Half scale (-)	-0.05	-5.00325E-02	-4.99675E-02
Full scale (-)	-0.1	-1.00055E-01	-9.99450E-02

Verify digitize current 1 A range

Description	Calibrator setpoint (A)	Lower limit	Upper limit
UUT Zero	STANDBY	-1.10E-04	1.10E-04
Full scale (+)	1	9.99390E-01	1.00061E+00
Half scale (+)	0.5	4.99640E-01	5.00360E-01
Half scale (-)	-0.5	-5.00360E-01	-4.99640E-01
Full scale (-)	-1	-1.00061E+00	-9.99390E-01

Verify digitize current 3 A range

Description	Calibrator setpoint (A)	Lower limit	Upper limit
UUT Zero	STANDBY	-4.50E-04	4.50E-04
⅔ scale (+)	2	1.99775E+00	2.00225E+00
Half scale (+)	1.5	1.49820E+00	1.50180E+00
Half scale (-)	-1.5	-1.50180E+00	-1.49820E+00
⅔ scale (-)	-2	-2.00225E+00	-1.99775E+00

AC current verification

To check AC current accuracy, you will:

- Apply accurate voltages from the Fluke 5720A or 5730A multifunction calibrator to the Model DMM7510 front-panel terminals
- Verify that the displayed readings fall within specified limits

Use the values in the following tables to verify the performance of the Model DMM7510. Actual values depend on the published specifications (see Example reading limit calculation (on page 2-8)).

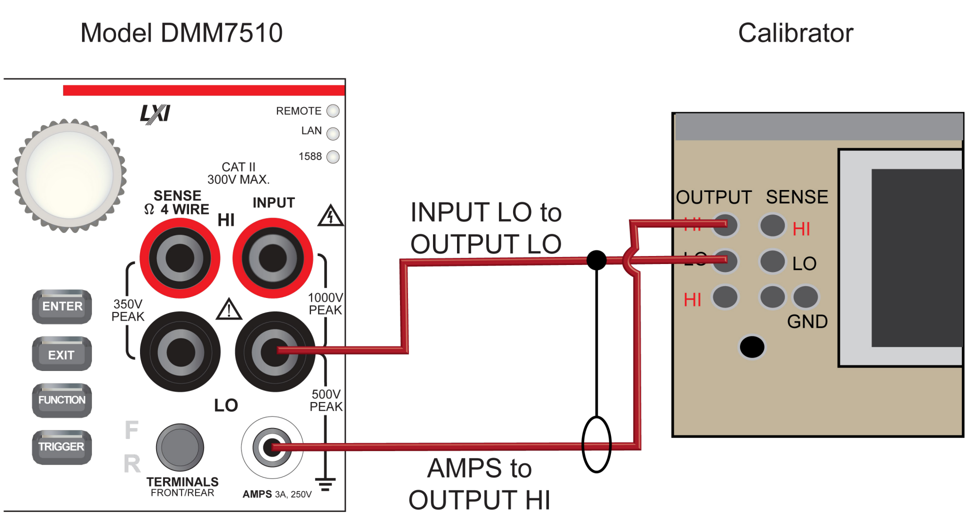
To verify AC current accuracy:

1. On the Model DMM7510, press the **FUNCTION** key and select **AC Current**.
2. Press the **HOME** key.
3. Select Range and set the range you are verifying.
4. Press the **MENU** key.
5. Select **Settings**.
6. Ensure that Detector Bandwidth is set to **30 Hz**.

NOTE

AC current is specified for the detector bandwidth setting of 3 Hz. 3 Hz measures accurately for input signals from 3 Hz to 10 kHz, with reading rates of ≈0.5 readings/s. To improve verification throughput to ≈3.3 readings/s, set detector bandwidth to 30 Hz for frequencies of 30 Hz to 10 kHz. To verify frequencies 1 kHz and higher, set the detector bandwidth to 300 Hz for faster ≈55 readings/s throughput.

7. Connect the Model DMM7510 to the calibrator as shown in the following figure.



8. Source AC currents for each of the frequencies listed in the following tables.
9. For each setting, be sure that the reading is within low and high limits.

Verify AC current 1 mA range

Description	Verification point	Lower limit	Upper limit
@ 40 Hz	0.001	9.989000E-04	1.001100E-03
@ 1 kHz	0.001	9.989000E-04	1.001100E-03
@ 5 kHz	0.001	9.988000E-04	1.001200E-03

Verify AC current 10 mA range

Description	Verification point	Lower limit	Upper limit
@ 40 Hz	0.010	9.989000E-03	1.001100E-02
@ 1 kHz	0.010	9.989000E-03	1.001100E-02
@ 5 kHz	0.010	9.988000E-03	1.001200E-02

Verify AC current 100 mA range

Description	Verification point	Lower limit	Upper limit
@ 40 Hz	0.1	9.989000E-02	1.001100E-01
@ 1 kHz	0.1	9.989000E-02	1.001100E-01
@ 5 kHz	0.1	9.988000E-02	1.001200E-01

Verify AC current 1 A range

Description	Verification point	Lower limit	Upper limit
@ 40 Hz	1.000	9.976000E-01	1.002400E+00
@ 1 kHz	1.000	9.976000E-01	1.002400E+00
@ 5 kHz	1.000	9.908000E-01	1.009200E+00

Verify AC current 3 A range

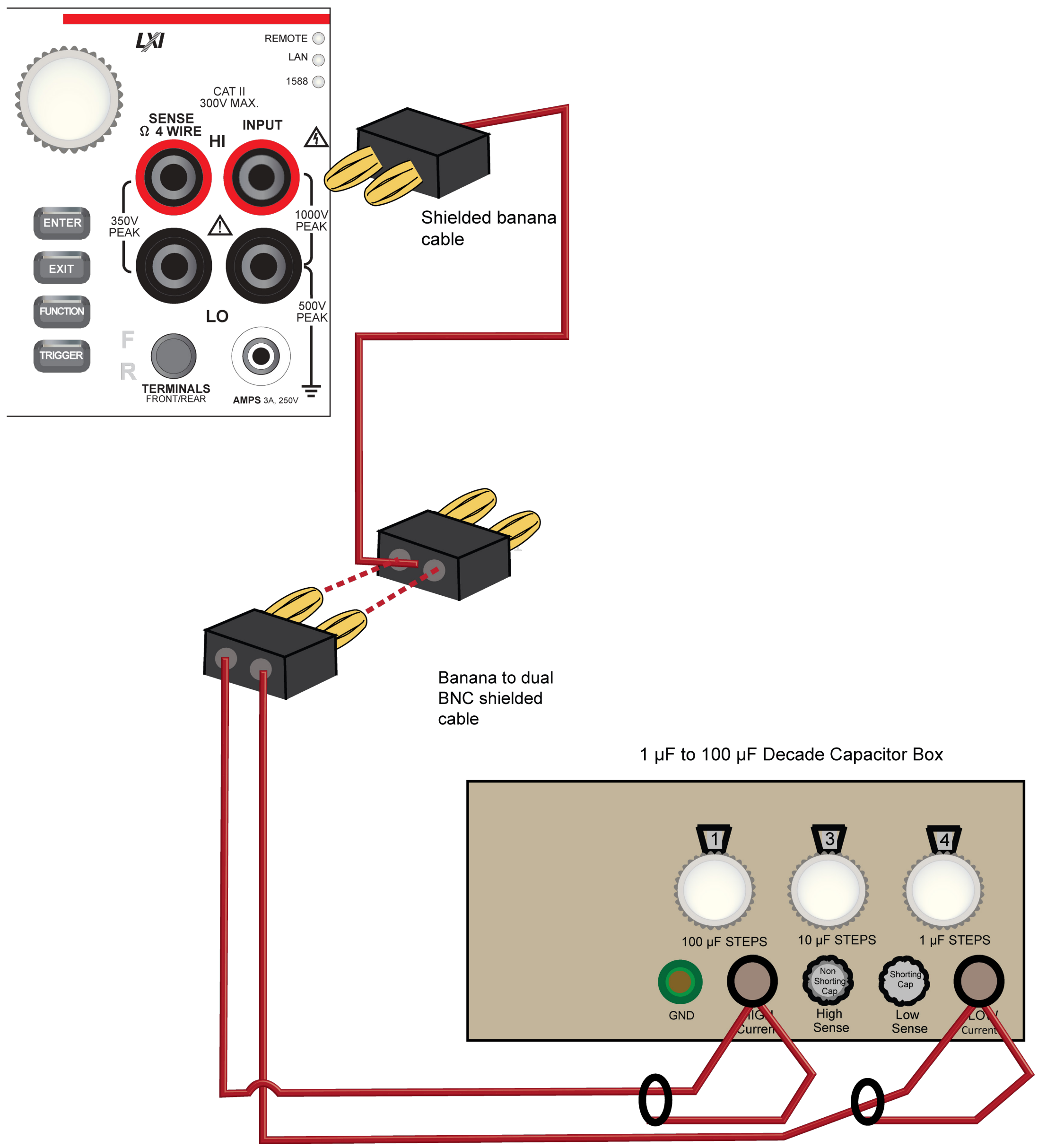
Description	Verification point	Lower limit	Upper limit
2 A @ 40 Hz	2.000	1.994500E+00	2.005500E+00
2 A @ 1 kHz	2.000	1.994500E+00	2.005500E+00
2 A @ 5 kHz	2.000	1.980900E+00	2.019100E+00

Capacitance verification

To rel the cable and 1 µF thru 100 µF decade box:

1. Connect the Model DMM7510, shielded banana cable, banana to dual BNC cable, and 1 µF thru 100 µF decade capacitor box as shown in the following diagram.

Model DMM7510



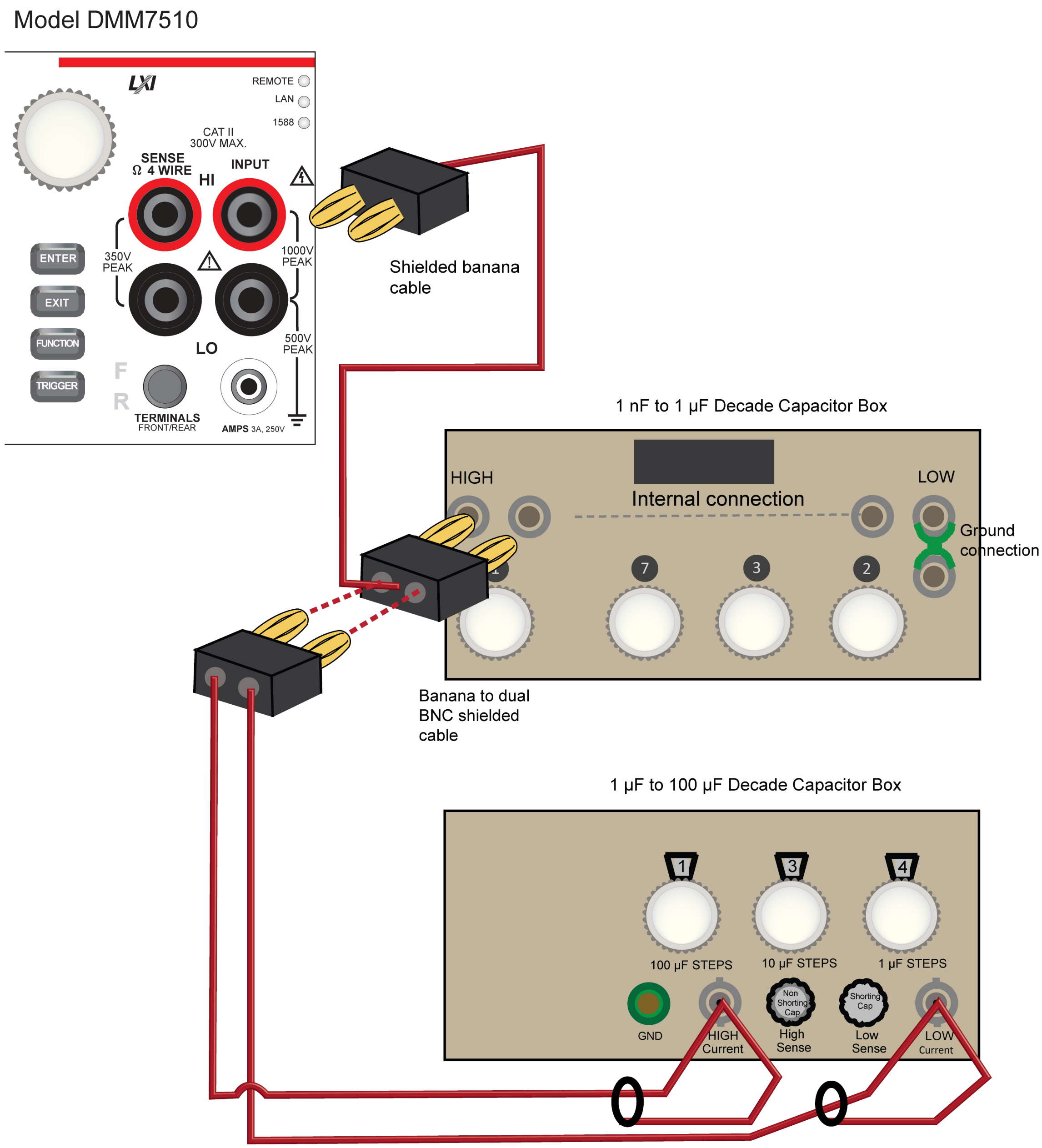
2. Set the decade capacitor box to 0 F.
3. On the Model DMM7510, press the **FUNCTION** key, select the **Measure Functions** tab, and select **Capacitance**.
4. Press the **MENU** key.
5. Select **Settings**.
6. Set the Range to **1 nF**.
7. Press the **MENU** key.
8. Select **Calculations** and select **Rel**, then **Acquire**.

NOTE

Cabling is ≈ 300 ρF, which will prevent full-scale verification due to the large cable capacitance offset. Cable lengths should be minimized to reduce cable capacitance as much as possible.

9. Connect the shielded banana cable to the 1 nF to 1 µF Decade Capacitance Box, as shown in the figure below.

Figure 12: Capacitance verification connections



10. Verify capacitance following the verification points and accuracies from the table below.

Verify the capacitance

Description	Verification point	Lower limit (F)	Upper limit (F)
1 nF range cable REL	3.00E-10		
10 % 1 nF range	1.0000E-10	9.7000E-11	1.0300E-10
70 % 1 nF range	7.0000E-10	6.9100E-10	7.0900E-10
10 %10 nF range	1.0000E-09	9.8000E-10	1.0200E-09
100 % 10 nF range	1.0000E-08	9.8900E-09	1.0110E-08
10 % 100 nF range	1.0000E-08	9.8600E-09	1.0140E-08
100 % 100 nF range	1.0000E-07	9.9500E-08	1.0050E-07
10 % 1 µF range	1.0000E-07	9.8600E-08	1.0140E-07
100 % 1 µF range	1.0000E-06	9.9500E-07	1.0050E-06
10 % 10 µF range	1.0000E-06	9.8600E-07	1.0140E-06
100 % 10 µF range	1.0000E-05	9.9500E-06	1.0050E-05
10 %100 µF range	1.0000E-05	9.8600E-06	1.0140E-05
100 %100 µF range	1.0000E-04	9.9500E-05	1.0050E-04
10 % 1 mF range	1.0000E-04	9.8500E-05	1.0150E-04

Verifying zeros using a 4-wire short

NOTE

Four-wire short verifications are not included in the Customer Calibration Data Report.

Check the zeros of various test points with 4-wire connections to the Model DMM7510 front or rear terminals. Verify that the displayed readings fall within specified limits.

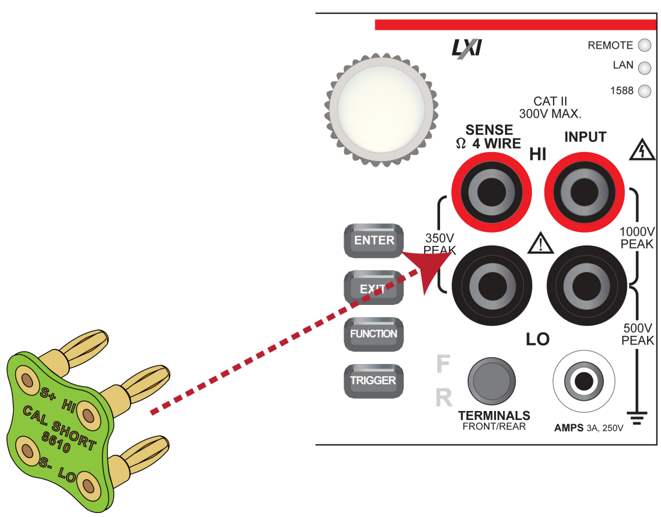
Verify resistance zeros using a 4-wire short

To verify resistance zeros:

1. Select the **4W Res** function.
2. Set the Model DMM7510 to the **1Ω** range.
3. Press the **MENU** key.
4. Select **Settings**.
5. Set the Offset Compensation to **On**.
6. Connect the Model 8610 or 8620 4-wire short to the front panel, as shown in the following figure.
7. Allow to settle for 5 minutes. Do not use relative offset.

Figure 13: Front panel 4-wire shorting plug orientation

Model DMM7510



8. Verify the 1Ω range is within specification (see the 4-wire short applied verification data table).
9. Repeat verification for the 1 Ω to 100 kΩ range ranges.

Verify 4-wire resistance zeros

Range	Lower limit	Upper limit
1	-5.00E-05	5.00E-05
10	-5.00E-05	5.00E-05
100	-4.00E-04	4.00E-04
1 K	-3.00E-03	3.00E-03
10 k	-3.00E-02	3.00E-02
100 k	-3.00E-01	3.00E-01

Verify DC voltage zeros using the 4-wire short

To verify DC voltage:

1. Leave the short applied as described in Verify resistance zeros using a 4-wire short (on page 2-62).
2. Select the **DC Voltage** function.
3. Set the range to **1000 V**.

NOTE

DC Voltage verification is from descending range order, starting with the 1000 V range and finishing on the 1 V range.

4. Verify that the 1000 V range zero is within specification. See the table below.
5. Verify that the 100 V to 1 V range zero is within specification.

Verify DC Voltage zeroes

Range	Lower limit	Upper limit
1000	-5.00E-03	5.00E-03
100	-5.00E-04	5.00E-04
10	-1.20E-05	1.20E-05
1	-2.00E-06	2.00E-06

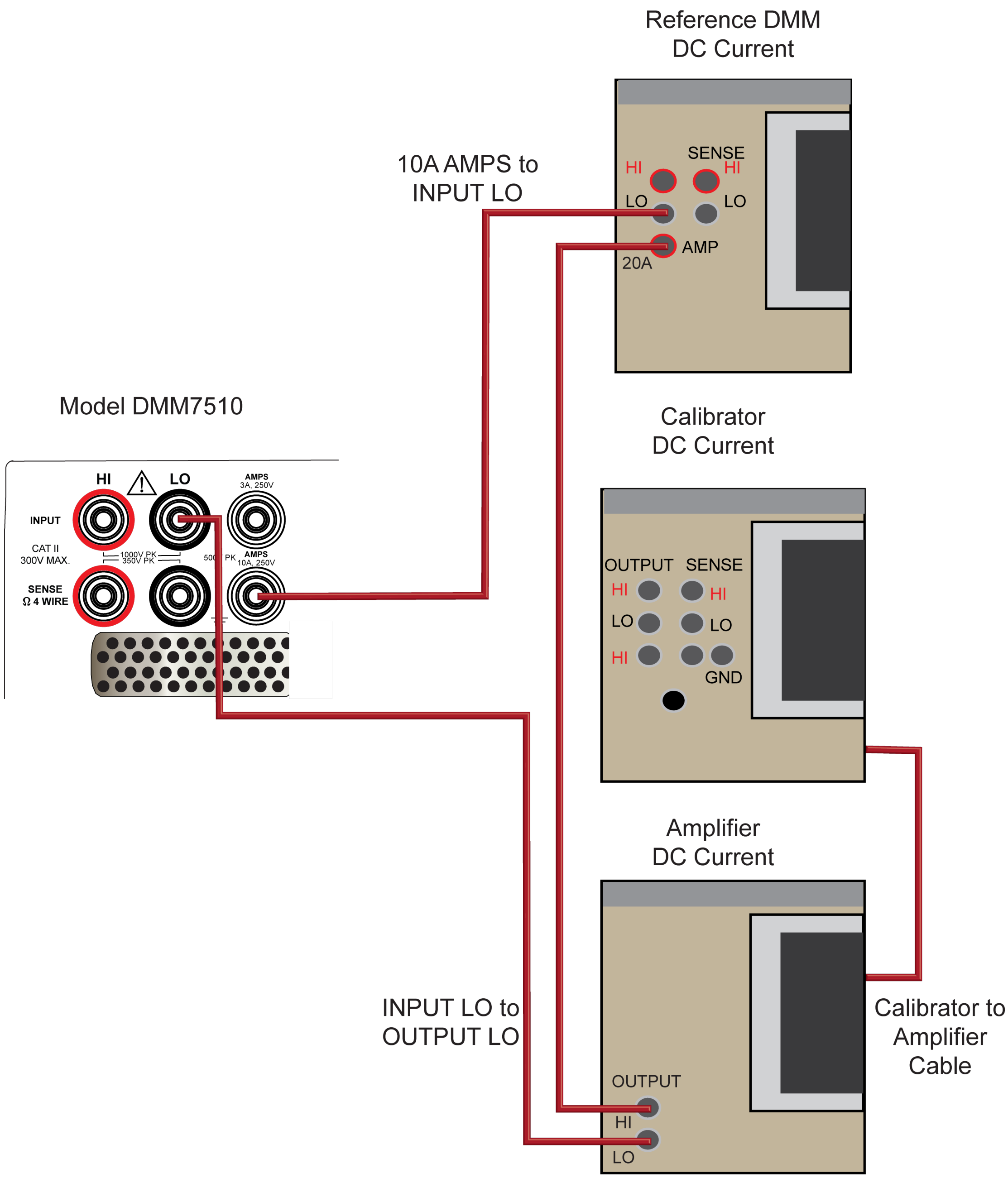
Rear-panel verification

DC current 10 A range verification

To verify 10 A range:

1. Set the TERMINALS switch to **REAR**. Ensure that the orange **R** is displayed.
2. Press the **FUNCTION** key and select **DC Current**.
3. Press the **HOME** key.
4. Set the range to **10A**.
5. Connect Model DMM7510, reference DMM, calibrator, and amplifier as shown in the following figure.

Figure 14: 10 A range connections



Rel the Model DMM7510:

1. On the calibrator, select the **OPR/STBY** key. Ensure that the front panel displays **STANDBY**.
2. Verify the Model DMM7510 Zero reading.

Rel the system:

1. On the calibrator, select **OPR/STBY** key. Ensure that the front panel displays **OPERATE**.
2. Enable the calibrator Amplifier and select the **BOOST** key.
3. On the calibrator, set the amplifier range lock **ON**.
4. Source **0.0 A**.
5. On the reference DMM, select **DCA**, **20A** range.
6. On the 20A range, rel the reference DMM offsets using **Zero Range**.
7. On the Model DMM7510, rel the system offsets.
8. Verify the DC current verification points and reference DMM readings from the following table.

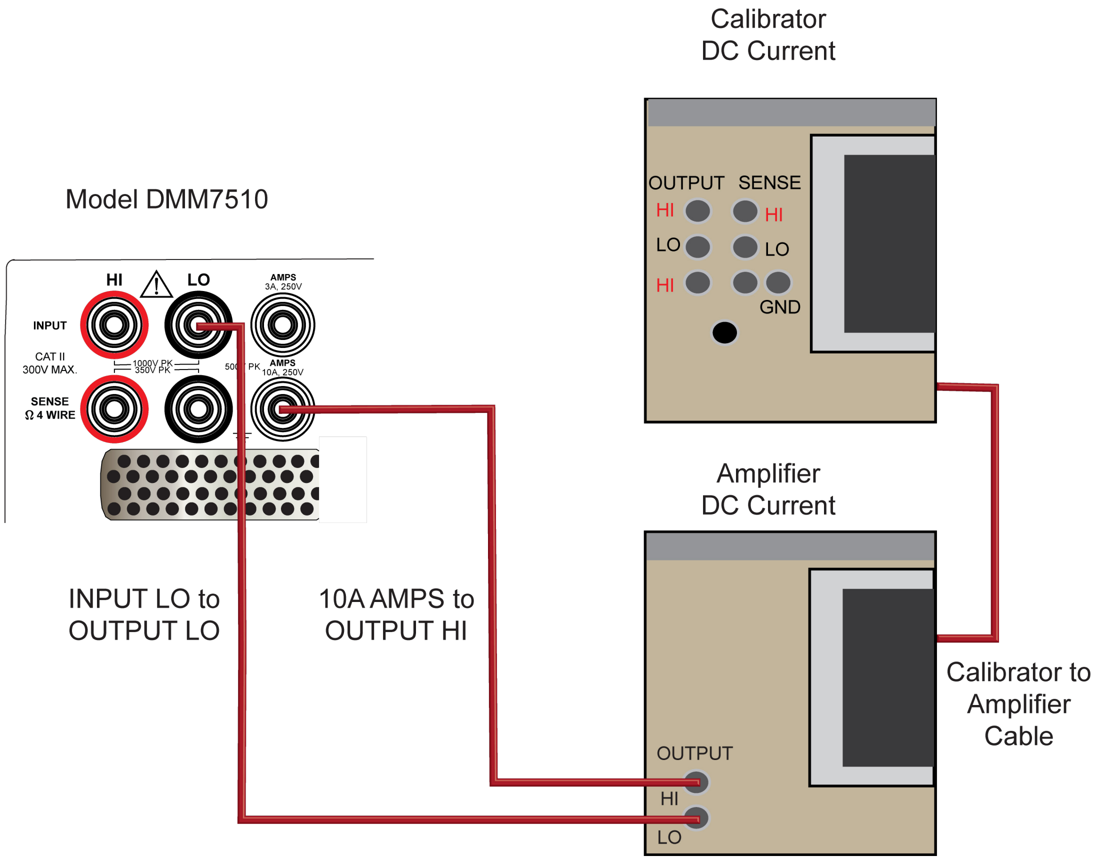
Verify DC current 10 A range

Description	Nominal input	Typical measured input (A)	Lower limit	Upper limit
UUT Zero	STANDBY		-2.750E-03	2.750E-03
System zero	0.00E+00	4.80E-04	REL	REL
Full scale (+)	10	9.99961	9.9818606E+00	1.0017359E+01
Half scale (+)	5	4.99984	4.9895902E+00	5.0100898E+00
Half scale (-)	-5	-5.00079	-5.0110412E+00	-4.9905388E+00
Full scale (-)	-10	-10.0016	-1.0019352E+01	-9.9838476E+00

Digitize current 10 A range verification

To verify the 10 A range:

1. Connect Model DMM7510, calibrator, and amplifier as shown in the following figure.



⚠ CAUTION

Ensure that the gauge of the cabling is sufficient to handle 10 A.

2. Set the TERMINALS switch to REAR. Ensure that the orange **R** is displayed.
3. Press the **FUNCTION** key, select the **Digitize Functions** tab, and select **Digitize Current**.
4. Press the **HOME** key.
5. Set the Range to **10A**.
6. Press the **MENU** key.
7. Select **Settings**.
8. Set the Sample Rate to **1000**.
9. Set the Aperture to **Auto** or **1 ms**.
10. Set the Count to **100**.

Verify the Model DMM7510 zero:

1. On the calibrator, select the **OPR/STBY** key. Ensure that the front panel displays **STANDBY**.
2. Verify the Model DMM7510 Zero reading for each range.

Rel the system:

1. On the calibrator, select the **OPR/STBY** key. Ensure that the front panel displays **OPERATE**.
2. Enable the calibrator Amplifier and select the **BOOST** key.
3. On the calibrator, set the amplifier range lock **ON**.
4. Set the calibrator output to **0.00000 ADC** and allow the reading to settle.
5. Press the **MENU** key.
6. Select **Calculations**.
7. Select **Rel** and **Acquire**.
8. Source positive and negative full-scale and half-scale currents, as listed in Verify digitize current 10 A range (on page 2-67).
9. Verify that the STATISTICS swipe screen reading for Average is within low and high limits.

Verify digitize current 10 A range

Description	Calibrator setpoint (A)	Lower limit	Upper limit
UTT Zero	STANDBY	-3.50E-03	3.50E-03
Full scale (+)	10	9.98150E+00	1.00185E+01
Half scale (+)	5	4.98900E+00	5.01100E+00
Half scale (-)	-5	-5.01100E+00	-4.98900E+00
Full scale (-)	-10	-1.00185E+01	-9.98150E+00

AC current 10 A verification

Verify that the displayed readings fall within specified limits.

Use the values in the following tables to verify the performance of the Model DMM7510. Actual values depend on the published specifications (see Example reading limit calculation (on page 2-8)).

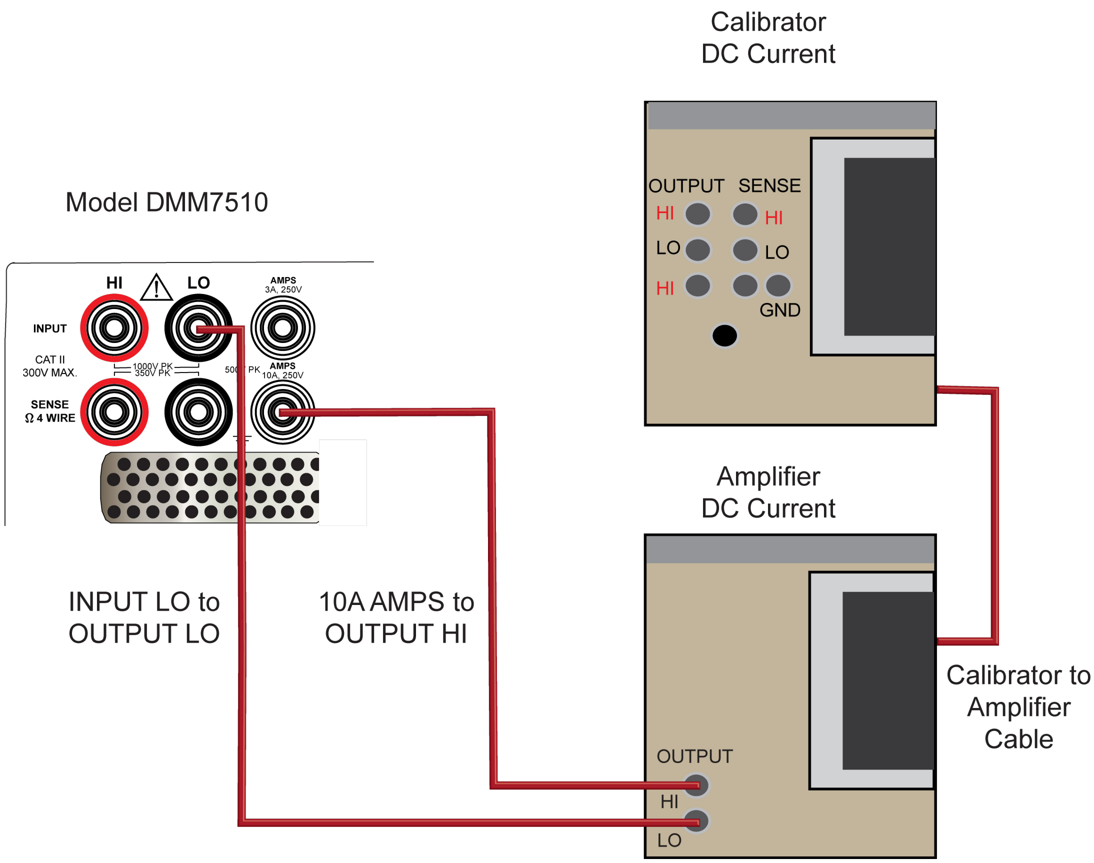
To verify the AC current accuracy:

1. Set the TERMINALS switch to REAR. Ensure that the orange **R** is displayed.
2. Press the **FUNCTION** key, select the **Measure Functions** tab, and select **AC Current**.
3. Press the **HOME** key.
4. Set the Range to **10A**.
5. Press the **MENU** key.
6. Select **Settings**.
7. Ensure that Detector Bandwidth is set to **30 Hz**.

NOTE

AC current is specified for the detector bandwidth setting of 3 Hz. 3 Hz measures accurately for input signals from 3 Hz to 10 kHz, with reading rates of ≈0.5 readings/s. To improve verification throughput to ≈3.3 readings/s, set detector bandwidth to 30 Hz for frequencies of 30 Hz to 10 kHz. To verify frequencies 1 kHz and higher, set the detector bandwidth to 300 Hz for faster ≈55 readings/s throughput.

8. Connect the Model DMM7510 to the calibrator and amplifier as shown in the following figure.



CAUTION

Ensure that the gauge of the cabling is sufficient to handle 10 A.

9. Enable the calibrator amplifier and select the **BOOST** key.
10. On the calibrator, set the amplifier range lock **ON**.
11. Source AC current for each of the frequencies listed in the following table.
12. On the calibrator, select **OPR/STBY** key. Ensure that the front panel displays **OPERATE**.
13. For each setting, allow the calibrator and amplifier to properly settle and verify the reading is within low and high limits.

Verify AC current 10 A range

Description	Verification point	Lower limit	Upper limit
40 Hz	10.000	9.955000E+00	1.004500E+01
1 kHz	10.000	9.955000E+00	1.004500E+01
5 kHz	10.000	9.907000E+00	1.009300E+01

Section 3

Calibration

In this section:

Introduction

Use the procedures in this section to calibrate the Model DMM7510.

You must calibrate using the Test Script Processor (TSP®) commands provided in this manual. Calibration commands are not available through SCPI.

All procedures in this section require accurate equipment calibration to supply precise DC and AC voltages, DC and AC currents, and resistance values. Calibration can be performed at any time by an operator using the remote commands sent over the IEEE-488 bus, ethernet, or USB device (type B).

WARNING

The information in this section is intended for qualified service personnel only. Do not attempt these procedures unless you are qualified to do so. Some of these procedures may expose you to hazardous voltages, which could cause personal injury or death if contacted. Use appropriate safety precautions when working with hazardous voltages.

Environmental conditions

To ensure accurate results, the calibration environment must meet the following conditions.

Temperature and relative humidity

Conduct the calibration procedures in a test environment with:

- An ambient temperature of 22 °C to 24 °C (72 °F to 75 °F)
- A relative humidity of less than or equal to 40 percent, unless otherwise noted.

Line power

The Model DMM7510 requires a line voltage of 100 V to 240 V and a line frequency of 50 Hz or 60 Hz.

The instrument must be calibrated within this range.

NOTE

The instrument automatically senses the line frequency at power-up.

Warmup period

Allow the Model DMM7510 to warm up for at least 90 minutes before conducting the calibration procedures.

If the instrument has been subjected to temperature extremes (those outside the ranges stated above), allow additional time for the internal temperature of the instrument to stabilize. Typically, allow one extra hour to stabilize a unit that is 10 °C (18 °F) outside the specified temperature range.

Also, allow the test equipment to warm up for the minimum time specified by the manufacturer.

Calibration considerations

When performing calibration procedures:

- Make sure that the equipment is properly warmed up.
- Make sure that the test equipment is connected to the Model DMM7510 rear-panel or front-panel input and output terminals as shown in the connection diagrams. Also be certain that the correct terminals are selected with the TERMINALS FRONT/REAR switch.
- Always let the source signal settle before calibrating each point.
- Make sure the calibrator is in OPERATE mode before you complete each calibration step.
- If an error occurs during calibration, the Model DMM7510 generates an appropriate event log message.
- Be sure to set adjustment and calibration dates and save calibration after adjustment.

WARNING

The front and rear terminals of the instrument are rated for connection to circuits rated Measurement Category II up to 300 V, as described in International Electrotechnical Commission (IEC) Standard IEC 60664. This range must not be exceeded. Do not connect the instrument terminals to CAT III or CAT IV circuits. Connection of the instrument terminals to circuits higher than CAT II can cause damage to the equipment and severe personal injury.

The maximum input voltage between INPUT HI and INPUT LO is 1000 V_{peak}. Exceeding this value may create a shock hazard.

The maximum common-mode voltage (the voltage between INPUT LO and chassis ground) is 500 V_{peak}. Exceeding this value may cause a breakdown in insulation that can create a shock hazard.

⚠ WARNING

The information in this section is intended for qualified service personnel only. Do not attempt these procedures unless you are qualified to do so. Some of these procedures may expose you to hazardous voltages, which could cause personal injury or death if contacted. Use appropriate safety precautions when working with hazardous voltages.

Calibration cycle

Perform calibration at least once every one or two years to ensure that the instrument meets or exceeds the specifications dictated by the customer requirements.

NOTE

Calibration constants are stored in the nonvolatile memory of the Model DMM7510.

Recommended test equipment

The following table summarizes the recommended calibration equipment. You can use alternate equipment if that equipment has specifications that meet or exceed those listed in the table below. Test equipment uncertainty adds to the uncertainty of each measurement. Generally, test equipment uncertainty should be at least four times more accurate than corresponding Model DMM7510 specifications. The following table lists the uncertainties of the recommended test equipment.

Manufacturer	Model	Description	Used for:	Uncertainty
Fluke	5720A or 5730A	High Performance Multifunction Calibrator	DCV, 10 A DCI, ACV, ACI, and 10 kΩ resistance	See Note.
Fluke	5725A	Amplifier	DCI and ACI	See Note.
Fluke	8508A	8.5 Digit Reference Multimeter	DCV	See Note.
Keysight Technologies	33250A	Function/Arbitrary Waveform Generator	Frequency	See Note.
Keithley Instruments	8610 or 8620	4-Wire DMM Shorting Plug	DCV, Digitize DCV, and resistance	N/A

NOTE

Refer to the manufacturer's specifications to calculate the uncertainty, which varies for each function and range test point.

Instrument setup

Before adjusting calibration, make sure that the instrument is set up:

- To use the rear terminals
- For remote operation and TSP commands
- To the correct date and time

You also need to unlock calibration.

Select the correct terminals

On the Model DMM7510, you must adjust calibration from both the front and rear terminals. You can verify calibration on either the front or rear terminals. To set the instrument to the rear panel terminals, press the FRONT/REAR TERMINALS switch on the front panel of the instrument until R is lit next to the switch.

Select the TSP command set

Calibration must be performed by remote control using ethernet, GPIB, or USB interfaces. No front-panel calibration commands are available.

Calibration is only available using TSP commands. See the instructions below to change the command set.

To set the command set from the front panel:

1. Press the **MENU** key.
2. Under System, select **Settings**.
3. For Command Set, select **TSP**.
4. You are prompted to reboot.

To verify which command set is selected from a remote interface:

Send the command:

```
*LANG?
```

To change to the TSP command set from a remote interface:

Send the command:

```
*LANG TSP
```

Reboot the instrument.

Verify instrument date and time

Before adjusting calibration, check the system date of the Model DMM7510.

From the front panel:

1. Press the **MENU** key.
2. Under System, select Settings. The SYSTEM SETTINGS menu opens.
3. Verify the date.
4. If necessary, set the calibration date or system time after the last successful calibration step.

Set up remote connections

NOTE

For detail on remote communications, refer to the *Model DMM7510 Reference Manual* section "Remote communications interfaces."

To perform calibration, set up remote communications as follows:

1. Connect the Model DMM7510 to the IEEE-488 bus of the computer using a shielded IEEE-488 cable, over the LAN, or directly to a computer through the RJ-45 port using a cross-over cable, or through a USB device.
2. Make sure the primary address of the Model DMM7510 is the same as the address specified in the program that you will be using to send commands (the GPIB default address is 16; the LAN default port number is 23).
3. Turn the TSP® prompt on and disable showing errors by sending the following commands:

```
localnode.prompts = localnode.ENABLE
localnode.showevents = 0
```

4. Before the start of each calibration step, clear the event log of any errors using the following command:

```
eventlog.clear()
```

5. At the end of each step, using the following commands to read any error messages:

```
code,message,severity = eventlog.next()   -- Set variables to print the
error messages.

print('Error Code =', code)

print('Error Message =', message)

print('Error Severity =', severity)
```

6. Send each calibration command with `print ("done")` appended to allow the program to know when operation is complete.
7. Some calibration steps may take up to five minutes to perform, so adjust the communication time-out setting to prevent time-out errors.

Unlock calibration

To adjust calibration, you must unlock it by sending the calibration password:

```
cal.unlock("KI000CAL")
```

NOTE

`KI000CAL` is the default password. You can change the password. Refer to cal.password (on page 4-17) for details.

Remote calibration adjustment procedure

NOTE

During remote calibration, the front-panel display shows the calibration step with a status progress bar.

Example calibration code that provides additional front-panel display prompts is provided in Example TSP calibration code (on page 3-20).

Rear terminal adjustments

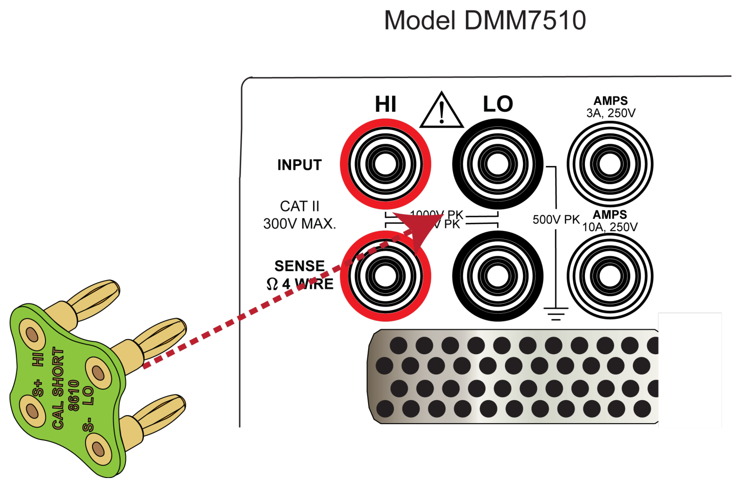
To adjust the Model DMM7510 using the rear terminals:

1. Set the TERMINALS switch to **REAR**. Ensure that the orange **R** is displayed.
2. Install the Keithley Model 8610 or 8620 shorting plug on the rear terminals of the Model DMM7510, as shown in the figure below.

CAUTION

The shorting plug terminals must be connected so that HI and LO are correctly aligned. Zero accuracy will be affected if the shorting plug terminals are not aligned correctly.

Figure 15: Rear panel 4-wire shorting plug orientation



3. Allow the instrument to settle for five minutes.
4. Perform the `cal.adjust.rear.dc` steps 0 through 3 and `cal.adjust.rear.ac` steps 1 and 2. The descriptions of these steps are:
   - DC Step 0: Internal amplifier offset adjustment
   - DC Step 1: 4-wire zero, DCA 10A, DCV, Digitize DCV, 2W Ω, and 4W Ω
   - DC Step 2: Open Terminals, Capacitance
   - DC Step 3: 2 Amp, DCA 10A range
   - AC Current Step 1, 0.5 A 1 kHz, AC current 10A range zero
   - AC Current Step 2, 2 A to 10 A 1 kHz, AC current 10A range full-scale

Rear DC adjustment step 0: amplifier offset

Send the commands:

```
cal.adjust.rear.dc(0)    -- Supports either 4-wire short or open terminals.
```

Rear DC adjustment step 1: 4-wire zero

Send the command:

```
cal.adjust.rear.dc(1)  -- Requires 4-Wire short.
```

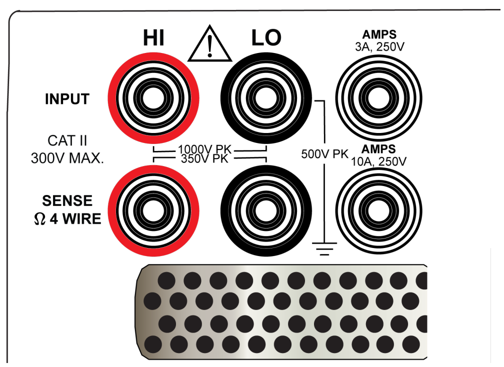
Rear DC adjustment step 2: Open circuit

Remove the four-wire short from the inputs.

NOTE

Cables cannot be attached to the Model DMM7510 during this step. At the beginning of this step, the HI and LO terminals are measured for applied voltage detection. If detected, the step will terminate, generating a warning messages. Also, any attached cables will significantly impact accuracy or cause the adjust step to fail.

Figure 16: Rear-panel terminals open



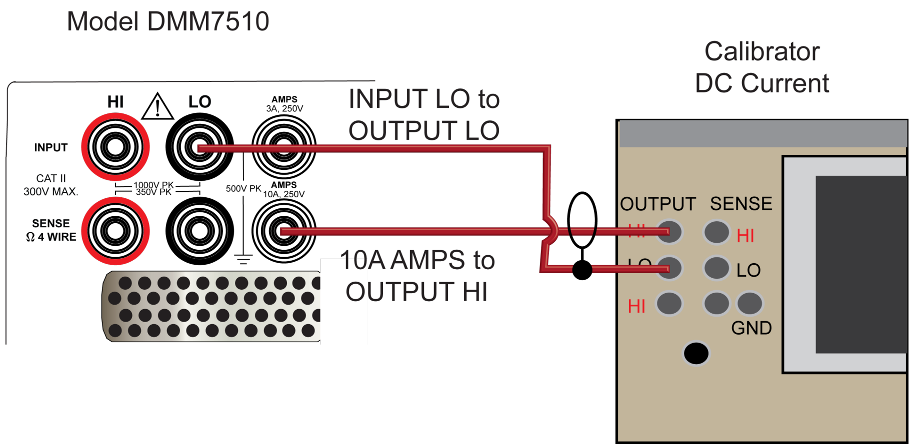
Send the command:

```
cal.adjust.rear.dc(2)  -- Requires open rear terminals.
```

Rear DC adjustment step 3: DCI 10 A full-scale adjustment

1. Connect the calibrator and Model DMM7510 as shown in the following figure.

Figure 17: Rear DC step 3 and rear AC step 1 calibrator and Model DMM7510 connections



Rel the system:

1. Ensure that the calibrator Current Output is set to **Normal**.
2. On the calibrator, set the source to **2.0 A**. Note that Calibration adjust step 3 allows 2 A ±10 % for the source level.
3. Allow the calibrator to properly settle.
4. Enter the actual calibrator output value during Step 3.

Send the command:

```
cal.adjust.rear.dc(3, 2.0)  -- Requires calibrator to source 2A.
```

Rear AC adjustment step 1: ACI 10 A Zero adjustment

1. Maintain the connections from Rear DC adjustment step 3: DCI 10 A full-scale adjustment (on page 3-8)
2. On the calibrator, set the level to **0.5 A** at **1 kHz**.

NOTE

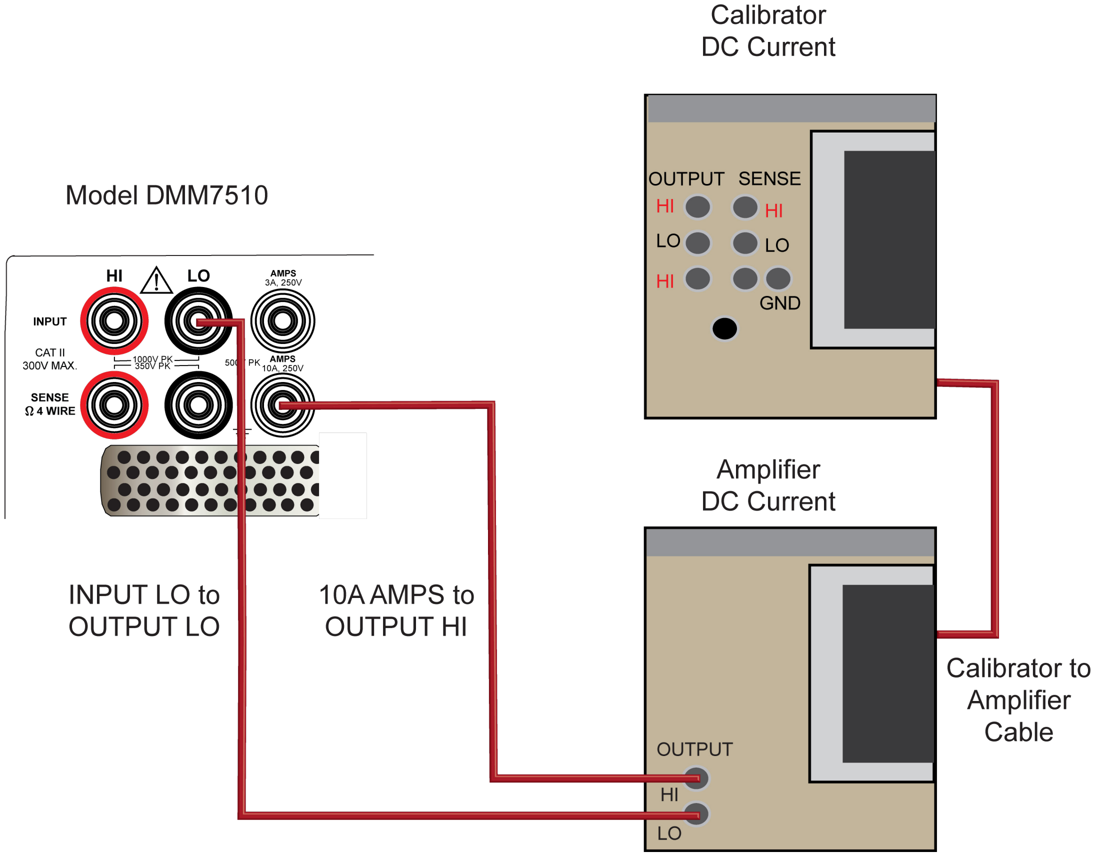
The 0.5 A source value is required. If an alternate value is used, incorrect accuracies will occur and possibly out of tolerance warning messages.

3. On the calibrator, select **OPR/STBY** key. Ensure that the front panel displays OPERATE.
4. Allow the calibrator to properly settle.
5. Send the following command.

```
cal.adjust.rear.ac(1)  -- Requires calibrator to source 0.5 A ac at 1KHz into 10A
   and Lo rear terminals.
```

Rear AC adjustment step 2: ACI 10 A Full-scale adjustment

1. Connect the calibrator, amplifier, and Model 7510 as shown in the following figure.



⚠ CAUTION

Ensure that the gauge of the cabling is sufficient to handle 10 A.

2. On the calibrator, set the level to **7 A at 1 kHz**.

NOTE

The Calibration adjust step 2 allows 2 A through 10 A; ±10 % for the source level. It is best to use 7 A for lowest full-scale uncertainty and minimize internal thermal settling.

3. Enable the calibrator amplifier and select the **BOOST** key.
4. On the calibrator, set the amplifier range lock **ON**.
5. On the calibrator, select **OPR/STBY** key. Ensure that the front panel displays **OPERATE**.
6. Allow the calibrator and amplifier to properly settle.
7. Send the following command.

```
cal.adjust.rear.ac(2, 7.0)  --  Requires Fluke Model 5720/5725 to source 7.0A ac at
   1KHz into 10A and Lo rear terminals.
```

Front terminal adjustments

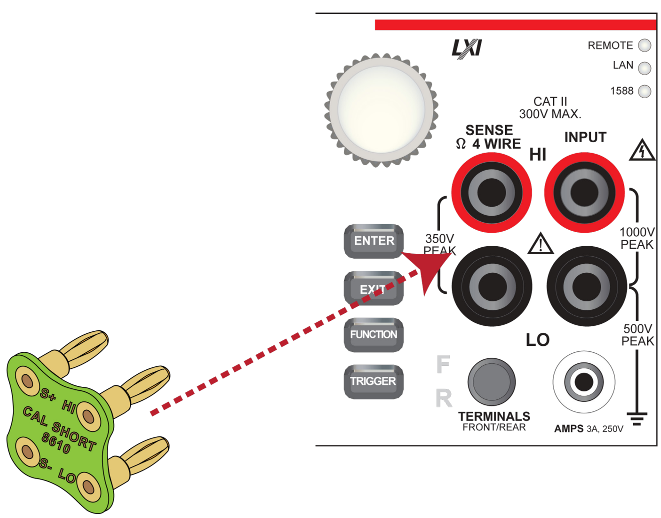
Calibration adjustment step descriptions

- DC adjustment (`cal.adjust.dc()`)
  - DC Step 0: Internal amplifier offset adjustment
  - DC Step 1: 4-wire zero for DCI 1 A to 3 A, DCV, Digitize DCV, 2W Ω, and 4W Ω
  - DC Step 2: Open Terminals:
    - DCI, zero 10 µA to 100 mA
    - DCV, 100 V and 1000 V full-scale
    - Resistance, 1 Ω to 1 GΩ full-scale
    - Digitize DCI and DCV full-scale
    - Waveform, analog trigger
    - Frequency, threshold level trigger
  - DC Step 3: 10 V, DCV 10 V range
  - DC Step 4: -10 V, DCV 10 V range
  - DC Step 5: 10 kΩ, Resistance, 4W 10 kΩ range
- ACV adjustment (`cal.adjust.ac()`)
  - ACV Step 1, 10 mV 1 kHz, ACV 100 mV range zero
  - ACV Step 2, 100 mV 1 kHz, ACV 100 mV range full-scale and 1 V range zero
  - ACV Step 3, 100 mV 50 kHz, ACV 100 mV frequency flatness adjust
  - ACV Step 4, 1 V 1 kHz, ACV 1 V range full-scale and 10 V range zero
  - ACV Step 5, 1 V 50 kHz, ACV 1 V range frequency flatness adjust
  - ACV Step 6, 10 V 1 kHz, ACV 10 V range full-scale and 100 V range zero
  - ACV Step 7, 10 V 50 kHz, ACV 10 V range frequency flatness adjust
  - ACV Step 8, 100 V 1 kHz, ACV 100 V range full-scale and 700 V range zero
  - ACV Step 9, 100 V 50 kHz, ACV 100 V range frequency flatness adjust
  - ACV Step 10, 700 V 1 kHz, ACV 700 V range full-scale
- ACI Adjustment (`cal.adjust.ac()`)
  - ACI Step 11, 100 µA 1 kHz, ACI 1 mA range zero
  - ACI Step 12, 1 mA 1 kHz, ACI 1 mA range full-scale and 10 mA range zero
  - ACI Step 13, 10 mA 1 kHz, ACI 10 mA range full-scale and 100 mA range zero
  - ACI Step 14, 100 mA 1 kHz, ACI 100 mA range full-scale, 1 A and 3 A range zero
  - ACI Step 15, 1 A 1 kHz, ACI 1 A range full-scale
- ACI Step 16, 2 A 1 kHz, ACI 3 A range full-scale
  - AC-coupling amplitude adjustment
    - ACV Step 17, 1 V 10 Hz, ACV AC coupling amplitude adjustment
  - Frequency adjustment
    - ACV Step 18, 1 V 1 kHz, Squarewave, Frequency adjustment

To adjust the Model DMM7510 using the front terminals:

1. Set the TERMINALS switch to **FRONT**. Ensure that the green **F** is displayed.
2. Install the Keithley Model 8610 or 8620 shorting plug on the front terminals of the Model DMM7510, as shown in the figure below.

Figure 18: Front panel 4-wire shorting plug orientation



3. Allow to settle for 5 minutes.
4. Perform the `cal.adjust.dc` steps 0 through 5, `cal.adjust.ac`, Voltage, steps 1 through 10, `cal.adjust.ac`, Current, step 11 through 16, `cal.adjust.ac`, coupling amplitude adjustment step 17, and `cal.adjust.ac`, Frequency step 18. The descriptions of these steps are described in the following.

DC voltage adjustment steps 0 to 5

DC voltage adjustment step 0: MUX amp offset

Send the command:

```
cal.adjust.dc(0)  -- Supports either 4-wire short or open terminals.
```

DC voltage adjustment step 1: Input 4-wire short circuit

1. Allow the instrument to settle for 30 seconds.
2. Send the command:

```
cal.adjust.dc(1)   -- Requires 4-wire short.
```

DC voltage adjustment step 2: Open circuit

NOTE

This step supports open terminals with attached cables. At the beginning of this step, the HI and LO terminals are measured for applied voltage detection. If the voltage is ≤30 V DC and 1.0 V_{peak} ≤ 1 KHz, the step will continue without a warning message

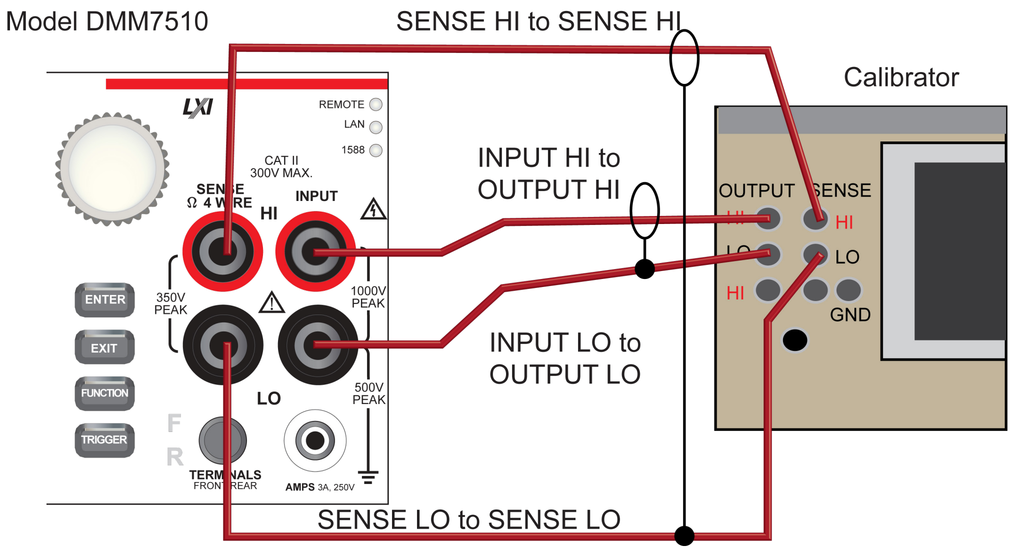
1. Remove the four-wire short from the inputs.
2. Send the following commands.

```
cal.adjust.dc(2)   -- Requires open front terminals.
```

DC voltage adjustment steps 3 and 4: +10 V and -10 V

To prepare to run DC adjustment steps 3, 4, and 5:

1. Connect a cable between the calibrator and the Model DMM7510, as shown in the figure below.



2. Allow the instrument and cable to settle for 5 minutes.

To run DC adjustment step 3:

1. Source **+10 V** and allow the calibrator to properly settle.
2. Ensure that the calibrator output is enabled.
3. Send the following command.

NOTE

Ensure `cal.adjust.dc(3, 10.0)`. The 10 V value may be ±10 % depending on the actual output of the calibrator.

```
cal.adjust.dc(3, 10.0)  -- 10V Require HI and LO Ft terminals.
```

To run DC adjustment step 4:

1. Source **-10 V** and allow the calibrator to properly settle.
2. Ensure that the calibrator output is enabled.
3. Send the following command.

NOTE

Ensure `cal.adjust.dc(4, -10.0)` uses the actual output value of the calibrator.

```
cal.adjust.dc(4, -10.0)    -- '-10V Require HI /LO Ft terminals.
```

DC voltage adjustment step 5: 10 kΩ

To run DC adjustment step 5:

1. Retain the connections made in DC voltage adjustment steps 3 and 4: +10 V and -10 V (on page 3-12).
2. Allow the instruments and cables to settle for 5 minutes.
3. On the calibrator, enable the **OPR** key and the **EX SNS** key.
4. Ensure that the **OPERATE** display and **EX SNS** keys are illuminated.
5. Source **10 kΩ** and allow the calibrator and Model DMM7510 to properly settle.

NOTE

DC adjust step 5 supports an allowed range of source values from 9.0 kΩ to 11.0 kΩ. The Fluke 5720 calibrator supports only approximately 10 kΩ. As a valid alternative, you can use an external stable and low-drift characterizer reference resistor.

NOTE

Ensure `cal.adjust.dc(5, 10.0e3)` uses the calibrator actual source or the external stable and low-drift characterizer reference resistor value.

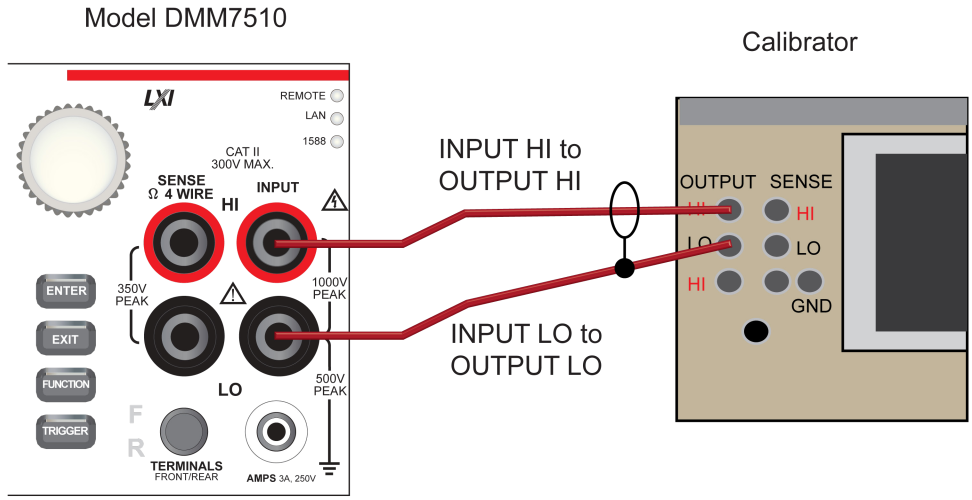
6. Send the following command.

```
cal.adjust.dc(5, 9.999938e3)  -- 10K Require HI and LO and 4W SHI and SLO Ft
    terminals. Enter the actual calibrator source value.
```

AC voltage adjustment steps 1 to 10

To set up the equipment for AC adjustment steps 1 to 10:

1. Connect a cable between the calibrator and the Model DMM7510 as shown in the figure below.



2. Allow the instrument and cables to settle for 30 seconds.
3. On the calibrator, source **10 mV 1.0 kHz**.
4. Enable the **OPR** key.

NOTE

`cal.ac.adjust` steps 1 to 16 require the identified source values. If an alternate value is used, incorrect accuracies will occur and possibly out of tolerance warning messages.

5. Ensure that the **OPERATE** display is illuminated.
6. Allow the calibrator and cable to properly settle.

AC voltage adjustment step 1: 10 mV at 1 kHz

Send the following command:

```
cal.adjust.ac(1)      -- 10mV, 1KHz HI and LO Ft terminals.
```

AC voltage adjustment step 2: 100 mV at 1 kHz

1. On the calibrator, source **100 mV 1.0 kHz**.
2. Allow the calibrator and cable to properly settle.
3. Send the following command:

```
cal.adjust.ac(2)   -- 100mV, 1KHz HI and LO Ft terminals.
```

AC voltage adjustment step 3: 100 mV at 50 kHz

1. On the calibrator, source 100 mV 50 kHz and allow the calibrator and cable to properly settle.
2. Send the following command:

```
cal.adjust.ac(3)      -- 100mV, 50KHz HI and LO Ft terminals.
```

AC voltage adjustment step 4: 1 V at 1.0 kHz

1. On the calibrator, source **1 V 1.0 kHz**.
2. Allow the calibrator and cable to properly settle.
3. Send the following commands.

```
cal.adjust.ac(4)      -- 1V, 1KHz HI and LO Ft terminals
```

AC voltage adjustment step 5: 1 V at 50 kHz

1. On the calibrator, source **1 V 50 kHz**.
2. Allow the calibrator and cable to properly settle.
3. Send the following commands.

```
cal.adjust.ac(5)         -- 1V, 50KHz HI and LO Ft terminals.
```

AC voltage adjustment step 6: 10 V at 1.0 kHz

1. On the calibrator, source **10 V 1 kHz**.
2. Allow the calibrator and cable to properly settle.
3. Send the following commands.

```
cal.adjust.ac(6)         -- 10V, 1KHz HI and LO Ft terminals
```

AC voltage adjustment step 7: 10 V at 50 kHz

1. On the calibrator, source **10 V 50 kHz**.
2. Allow the calibrator and cable to properly settle.
3. Send the following command:

```
cal.adjust.ac(7)      -- 10V, 50KHz HI and LO Ft terminals.
```

AC voltage adjustment step 8: 100 V at 1.0 kHz

⚠ WARNING

The following calibration steps are intended for qualified service personnel only. Do not attempt these procedures unless you are qualified to do so. The following procedures require hazardous voltages, which could cause personal injury or death if contacted. Use appropriate safety precautions when working with hazardous voltages.

1. On the calibrator, source **100 V 1 kHz**.
2. Enable the **OPR** key.
3. Allow the calibrator and cable to properly settle.
4. Send the following command:

```
cal.adjust.ac(8)         -- 100V, 1KHz HI and LO Ft terminals
```

AC voltage adjustment step 9: 100 V at 50 kHz

1. On the calibrator, source **100 V 50 kHz**.
2. Enable the **OPR** key.
3. Allow the calibrator and cable to properly settle.
4. Send the following command:

```
cal.adjust.ac(9)      -- 100V, 50KHz HI and LO Ft terminals.
```

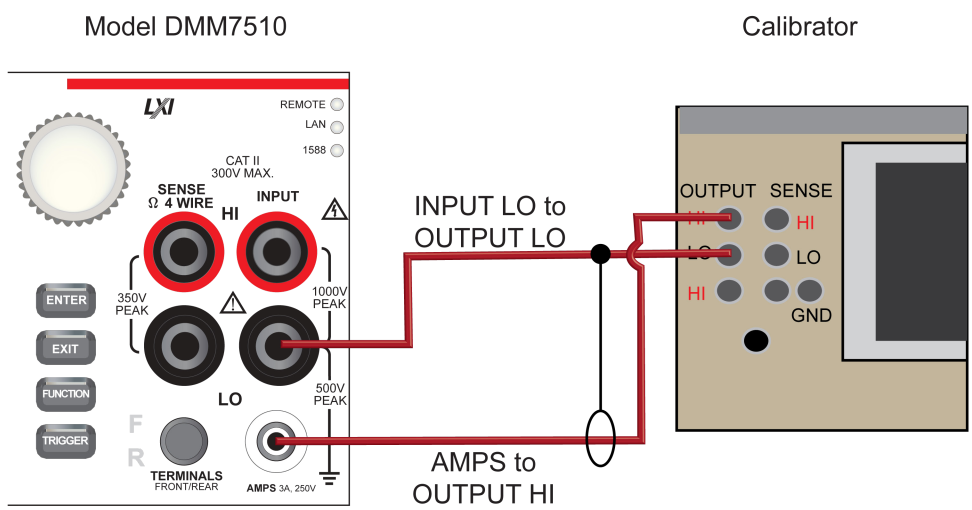
AC voltage adjustment step 10: 700 V at 1.0 kHz

1. On the calibrator, source **700 V 1 kHz**.
2. Enable the **OPR** key.
3. Allow the calibrator and the cable to properly settle.
4. Send the following command:

```
cal.adjust.ac(10)      -- 700V, 1KHz HI and LO Ft terminals.
```

AC current adjustment steps 11 to 16

1. Connect the Model DMM7510 to the calibrator as shown in the following figure.



AC current adjustment step 11: 100 µA at 1 kHz

1. Ensure that the calibrator Current Output is set to **Normal**.
2. On the calibrator, source **100 µA at 1 kHz**.
3. Enable the **OPR** key.
4. Allow the calibrator and cable to properly settle.
5. Send the following command:

```
cal.adjust.ac(11)         -- 100uA, 1KHz 3A and LO Ft terminals.
```

AC current adjustment step 12: 1 mA at 1 kHz

1. On the calibrator, source **1 mA at 1 kHz**.
2. Enable the **OPR** key.
3. Allow the calibrator and cable to properly settle.
4. Send the following command:

```
cal.adjust.ac(12)         -- 1mA, 1KHz 3A and LO Ft terminals.
```

AC current adjustment step 13: 10 mA at 1 kHz

1. On the calibrator, source **10 mA at 1 kHz**.
2. Enable the **OPR** key.
3. Allow the calibrator and cable to properly settle.
4. Send the following command:

```
cal.adjust.ac(13)         -- 10mA, 1KHz 3A and LO Ft terminals.
```

AC current adjustment step 14: 100 mA at 1 kHz

1. On the calibrator, source **100 mA at 1 kHz**.
2. Enable the **OPR** key.
3. Allow the calibrator and cable to properly settle.
4. Send the following command:

```
cal.adjust.ac(14)         -- 100mA, 1KHz 3A and LO Ft terminals.
```

AC current adjustment step 15: 1 A at 1 kHz

1. On the calibrator, source **1 A** at **1 kHz**.
2. Enable the **OPR** key.
3. Allow the calibrator and cable to properly settle.
4. Send the following commands.

```
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()  -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #15, 1A, 1KHz")
cal.adjust.ac(15)         -- 1A, 1KHz 3A and LO Ft terminals.
code,message,severity = eventlog.next()   -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, 1A, 1KHz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

AC current adjustment step 16: 2 A at 1 kHz

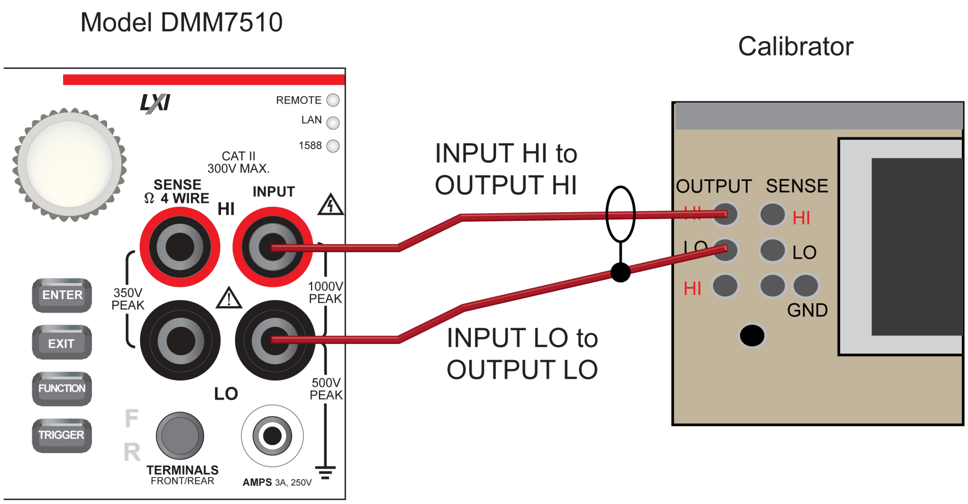
1. On the calibrator, source **2 A** at **1 kHz**.
2. Enable the **OPR** key.
3. Allow the calibrator and cable to properly settle.
4. Send the following command:

```
cal.adjust.ac(16)         -- 2A, 1KHz 3A and LO Ft terminals.
```

AC coupling adjustment step 17

To set up the equipment for AC adjustment step 17:

1. Connect a cable between the calibrator and the Model DMM7510 as shown in the figure below.



2. On the calibrator, source **1.0 V 10 Hz**.
3. Enable the **OPR** key.

NOTE

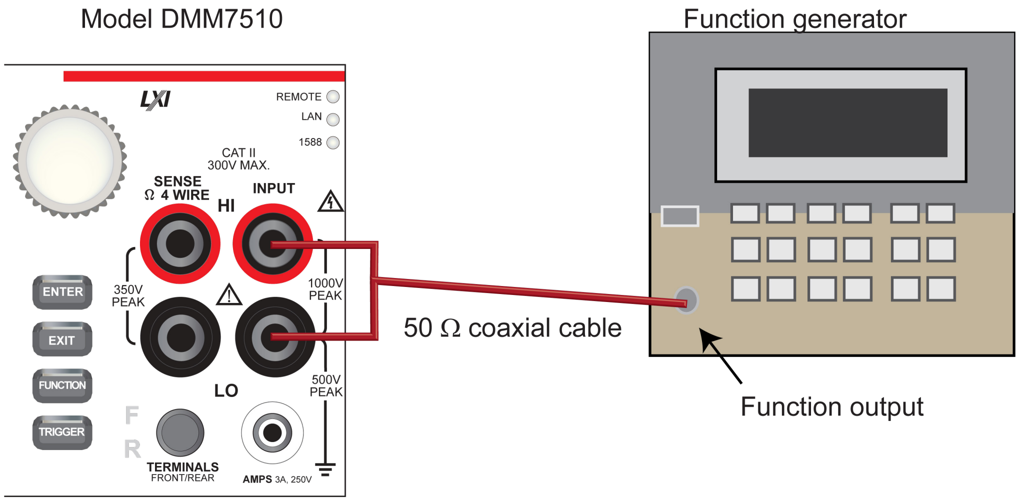
`cal.ac.adjust` step 17 requires the source amplitude value to be entered. The AC adjust step 17 supports an allowed range of source values from 0.9 V_{rms} to 1.1 V_{rms}.

4. Allow the instrument and cables to settle for 30 seconds.
5. Send the following command:

```
cal.adjust.ac(17, 1.0)  -- 1V, 10Hz HI and LO Ft terminals. Enter calibrator source
    value.
```

AC frequency adjustment step 18

1. Connect the Keysight Technologies 33250A function generator to the Model DMM7510 INPUT HI and LO terminals, as shown in the following figure.



2. Set the function generator output impedance to **High**, amplitude of **5 V**$_{RMS}$, waveform to **square wave**.
3. Enable the output.

NOTE

`cal.ac.adjust` step 18 requires the source frequency value to be entered. The AC adjust step 18 supports an allowed range of source frequencies from 900 Hz to 1.1 kHz.

4. Send the following command:

```
cal.adjust.ac(18, 1000)   -- 1V, 1kHz HI and LO Ft terminals. Enter AFG frequency
   value.
```

Set time and calibration adjustment dates

Use the following commands to set the Model DMM7510 time and adjust date.

```
localnode.settime(2015, 01, 09, 10, 04, 38) -- (year, month, date, hour, minutes,
   sec)
cal.adjust.date = os.time({year=2015, month=01,day =09})
print(os.date("%m/%d/%Y", cal.verifydate))
```

Save calibration and set the adjustment dates

NOTE

Calibration is temporary unless you send the `cal.save()` command. Also, calibration data is not saved if calibration is locked, if invalid data exists, or if all steps were not completed.

Use the following commands to save and lock calibration adjustments.

```
cal.save()
cal.lock()
reset()
```

NOTE

Calibrations are complete after they have been saved and locked.

Example TSP calibration code

The following code examples include code for the calibration steps and code that displays prompts on the Model DMM7510 front panel.

You may need to adjust the calibration commands in this code for your equipment setup.

Rear terminal adjustments

```
--Rear DC adjustment step 0: amplifier offset
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()      -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Rear, Step #0, Mux Amp offset")
cal.adjust.rear.dc(0)    -- Supports either 4-Wire short or open terminals.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Rear, Step #0, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--Rear DC adjustment step 1: 4-wire zero
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()   -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Rear, Step #1, 4-Wire short")
cal.adjust.rear.dc(1)  -- Requires  4-Wire short.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Rear, Step #1, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')

--Rear DC adjustment step 2: Open circuit
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()   -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Rear, Step #2, Open Terminals")
cal.adjust.rear.dc(2)  -- Requires open rear terminals.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Rear, Step #2, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--Rear DC adjustment step 3: DCI 10 A full-scale adjustment
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()   -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Rear, Step #3, 2A, DCA 10A range")
cal.adjust.rear.dc(3, 2.0)  -- Requires calibrator to source 2A.
code,message,severity = eventlog.next()    -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Rear, Step #3, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')

--Rear AC adjustment step 1: ACI 10 A Zero adjustment
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()   -- Clear the error event log and Home Screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Rear, Step#1, 0.5A, ACI 10A Zero")
cal.adjust.rear.ac(1)  -- Requires Fluke Model 5700 to source 0.5A ac at 1KHz into
   10A and Lo rear terminals.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Rear, Step#1, ACI, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--Rear AC adjustment step 2: ACI 10 A Full-scale adjustment
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()   -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Rear, Step#2, 7A, ACI 10A FS")
cal.adjust.rear.ac(2, 7.0)  --  Requires calibrator to source 7.0A ac at 1KHz into
   10A and Lo rear terminals.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Rear, Step#1, ACI, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

Front terminal adjustments

```
--DC voltage adjustment step 0: MUX amp offset
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()  -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, Step #0, Mux Amp offset")
cal.adjust.dc(0)  -- Supports either 4-wire short or open terminals.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, Step #0, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--DC voltage adjustment step 1: Input 4-wire short circuit
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()   -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, Step #1, 4W short")
cal.adjust.dc(1)   -- Requires 4-wire short.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, Step #1, 4W short, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')

DC voltage adjustment step 2: Open circuit
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()   -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, Step #2,Open Inputs")
cal.adjust.dc(2)   -- Requires open front terminals.
code,message,severity = eventlog.next() -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, Step #2,Open Inputs, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--DC voltage adjustment step 3: +10 V
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()   -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, Step #3, 10V HI /LO Input")
cal.adjust.dc(3, 10.0)  -- 10V Require HI and LO Ft terminals.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, Step #3,10V HI/LO, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')

--DC voltage adjustment step 4: -10 V
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()      -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, Step #4, -10V HI / LO Input")
cal.adjust.dc(4, -10.0)    -- '-10V Require HI /LO Ft terminals.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, Step #4,-10V HI/LO, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--DC voltage adjustment step 5: 10 kohm
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()      -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, Step #5, 10K-ohm Input")
cal.adjust.dc(5, 9.999938e3)  -- 10K Require HI and LO and 4W SHI and SLO Ft
   terminals. Enter the actual calibrator source value.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, Step #5, 10k-ohm, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')

--AC voltage adjustment step 1: 10 mV at 1 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()      -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #1, 10mV, 1KHz")
cal.adjust.ac(1)      -- 10mV, 1KHz HI and LO Ft terminals.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #1, 10mV, 1KHz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--AC voltage adjustment step 2: 100 mV at 1 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()   -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #2, 100mV, 1KHz")
cal.adjust.ac(2)   -- 100mV, 1KHz HI and LO Ft terminals.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Fr, AC Step #2, 100mV, 1KHz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')

--AC voltage adjustment step 3: 100 mV at 50 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()      -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #3, 100mV, 50KHz")
cal.adjust.ac(3)      -- 100mV, 50KHz HI and LO Ft terminals.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Fr, AC Step #3, 100mV, 50KHz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--AC voltage adjustment step 4: 1 V at 1.0 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()      -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #4, 1V, 1KHz")
cal.adjust.ac(4)      -- 1V, 1KHz HI and LO Ft terminals
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #4, 1V, 1KHz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')

--AC voltage adjustment step 5: 1 V at 50 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()         -- Clear the error event log and Home screen error
   triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #5, 1V, 50KHz")
cal.adjust.ac(5)         -- 1V, 50KHz HI and LO Ft terminals.
code,message,severity = eventlog.next()   -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #5 1V, 50KHz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--AC voltage adjustment step 6: 10 V at 1.0 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()         -- Clear the error event log and Home screen error
   triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #6 10V, 1KHz")
cal.adjust.ac(6)         -- 10V, 1KHz HI and LO Ft terminals
code,message,severity = eventlog.next()   -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #6 10V, 1KHz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')

--AC voltage adjustment step 7: 10 V at 50 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()      -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #7 10V, 50KHz")
cal.adjust.ac(7)      -- 10V, 50KHz HI and LO Ft terminals.
code,message,severity = eventlog.next()   -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #7 10V, 50KHz, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--AC voltage adjustment step 8: 100 V at 1.0 kHz
--WARNING: The following calibration steps are intended for qualified service
   personnel
-- only. Do not attempt these procedures unless you are qualified to do so. The
   following
-- procedures require hazardous voltages, which could cause personal injury or
   death if
-- contacted. Use appropriate safety precautions when working with hazardous
   voltages.
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()   -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #8 100V, 1KHz")
cal.adjust.ac(8)         -- 100V, 1KHz HI and LO Ft terminals
code,message,severity = eventlog.next()   -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #8 100V, 1KHz, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--AC voltage adjustment step 9: 100 V at 50 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()      -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #9 100V, 50KHz")
cal.adjust.ac(9)      -- 100V, 50KHz HI and LO Ft terminals.
code,message,severity = eventlog.next()   -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #9 100V 50KHz, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')

--AC voltage adjustment step 10: 700 V at 1.0 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()      -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #10 700V, 1KHz")
cal.adjust.ac(10)      -- 700V, 1KHz HI and LO Ft terminals.
code,message,severity = eventlog.next()   -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #10 700V, 1KHz, Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--AC current adjustment step 11: 100 uA at 1 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()         -- Clear the error event log and Home screen error
   triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #11, 100uA, 1KHz ")
cal.adjust.ac(11)         -- 100uA, 1KHz 3A and LO Ft terminals.
code,message,severity = eventlog.next()   -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, 100uA, 1KHz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')

--AC current adjustment step 12: 1 mA at 1 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()  -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #12, 1mA, 1KHz")
cal.adjust.ac(12)         -- 1mA, 1KHz 3A and LO Ft terminals.
code,message,severity = eventlog.next()  -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, 1mA, 1KHz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--AC current adjustment step 13: 10 mA at 1 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()  -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #13, 10mA, 1KHz")
cal.adjust.ac(13)         -- 10mA, 1KHz 3A and LO Ft terminals.
code,message,severity = eventlog.next()   -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, 10mA, 1KHz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')

--AC current adjustment step 14: 100 mA at 1 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()  -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #14, 100mA, 1KHz")
cal.adjust.ac(14)         -- 100mA, 1KHz 3A and LO Ft terminals.
code,message,severity = eventlog.next()   -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, 100mA, 1KHz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--AC current adjustment step 16: 2 A at 1 kHz
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()  -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #16, 2A, 1KHz")
cal.adjust.ac(16)         -- 2A, 1KHz 3A and LO Ft terminals.
code,message,severity = eventlog.next()   -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, 2A, 1KHz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')

--AC coupling adjustment step 17
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()  -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #17, 1V, 10Hz")
cal.adjust.ac(17, 1.0)  -- 1V, 10Hz HI and LO Ft terminals. Enter calibrator source
   value.
code,message,severity = eventlog.next()   -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #17, 1V, 10Hz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

```
--AC frequency adjustment step 18
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
eventlog.clear()  -- Clear the error event log and Home screen error triangle.
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #18, 1V, 1000Hz")
cal.adjust.ac(18, 1000)   -- 1V, 1kHz HI and LO Ft terminals. Enter AFG frequency
   value.
code,message,severity = eventlog.next()   -- Set variables to print the error
   messages.
display.changescreen(display.SCREEN_HOME)
delay(2.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Ft, AC Step #18, 1V, 1000Hz , Done")
delay(4.0)
display.clear()
display.changescreen(display.SCREEN_USER_SWIPE)
display.settext(display.TEXT1, "Calibrate Enabled")
display.settext(display.TEXT2, "Start Next Cal Step")
print('Error Code =', code)
print('Error Message =', message)
print('Error Severity =', severity)
print('done')
```

Section 4

TSP command reference

In this section:

TSP commands

Introduction

This section contains detailed information on the Model DMM7510 remote calibration commands.

acal.count

This attribute returns the number of times automatic calibration has been run.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Attribute (R)	Yes	Not applicable	Not applicable	Not applicable

Usage

`value = acal.count`

value	The number of times auto calibration has been run

Details

The number of times that auto calibration has been run since the last factory calibration. The count restarts at 1 after a factory calibration.

Example

`print(acal.count)`	Returns the number of times auto calibration has been run. Example output: 15

Also see

Auto calibration (on page 2-4)
acal.run() (on page 4-6)

acal.lastrun.internaltemp

This attribute returns the internal temperature of the instrument when auto calibration was run.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Attribute (R)	Yes	Not applicable	Not applicable	Not applicable

Usage

```
temperature = acal.lastrun.internaltemp
```

temperature	The internal temperature

Details

The temperature is displayed in Celsius (°C).

The instrument updates the internal temperature value when the instrument refreshes autozero. If autozero is set to off or if autozero is not available for the selected function (such as capacitance, continuity, frequency or period), the internal temperature value is not updated.

Example

`print(acal.lastrun.internaltemp)`	Returns the internal temperature of the instrument when auto calibration was last run. Example output: `63.167084`

Also see

acal.lastrun.tempdiff (on page 4-3)
acal.run() (on page 4-6)
acal.lastrun.tempdiff (on page 4-3)

acal.lastrun.tempdiff

This attribute returns the difference between the internal temperature and the temperature when auto calibration was last run.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Attribute (R)	Yes	Not applicable	Not applicable	Not applicable

Usage

```
temperature = acal.lastrun.tempdiff
```

temperature	The internal temperature

Details

The temperature is displayed in Celsius (°C).

The instrument updates the internal temperature value when the instrument refreshes autozero. If autozero is set to off or if autozero is not available for the selected function (such as capacitance, continuity, frequency or period), the internal temperature value is not updated.

Example

`print(acal.lastrun.tempdiff)`	Returns the difference between the temperature of the instrument when auto calibration was run and the present internal temperature. Example output: `4.5678`

Also see

acal.lastrun.internaltemp (on page 4-2)
acal.run() (on page 4-6)

acal.lastrun.time

This attribute returns the date and time when auto calibration was last run.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Attribute (R)	Yes	Not applicable	Not applicable	Not applicable

Usage

```
dateTime = acal.lastrun.time
```

dateTime	The date and time

Details

The date and time is returned in the format:

`MM/DD/YYYY HH:MM:SS.NNNNNNNNN`

Where:

- `MM/DD/YYYY` is the month, date, and year
- `HH:MM:SS.NNNNNNNNN` is the hour, minute, second, and fractional second

Example

`print(acal.lastrun.time)`	Returns the date and time when the auto calibration was last run. Example output: `05/28/2014 00:37:47.743000000`

Also see

acal.run() (on page 4-6)
Auto calibration (on page 2-4)

acal.nextrun.time

This attribute returns the date and time when the next auto calibration is scheduled to be run.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Attribute (R)	Yes	Not applicable	Not applicable	Not applicable

Usage

```
dateTime = acal.nextrun.time
```

dateTime	The date and time when auto calibration is scheduled to be run

Details

The date and time is returned in the format:

`MM/DD/YYYY HH:MM:SS.NNNNNNNNN`

Where:

- `MM/DD/YYYY` is the month, date, and year
- `HH:MM:SS.NNNNNNNNN` is the hour, minute, second, and fractional second

Example

`print(acal.nextrun.time)`	Returns date and time when auto calibration is next scheduled to be run. Example output: `05/29/2014 17:11:17.000000000`

Also see

Auto calibration (on page 2-4)
acal.run() (on page 4-6)
acal.schedule() (on page 4-7)

acal.revert()

This function returns auto calibration constants to the previous constants.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Function	Yes			

Usage

```
acal.revert()
```

Details

This command reverts the present set of auto calibration constants to the previous set of auto calibration constants.

The last run time and internal temperature are reverted to the previous values. The auto calibration count is not changed.

Example

`acal.revert()`	Auto calibration values are reverted to the previous set of auto calibration constants.

Also see

acal.run() (on page 4-6)

acal.run()

This function immediately runs auto calibration and stores the constants.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Function	Yes			

Usage

```
acal.run()
```

Details

During auto calibration, a progress message is displayed on the front panel. At completion, an event message is generated.

If you have set up auto calibration to run at a scheduled interval, when you send the run command, the instrument adjusts the next scheduled auto calibration to be the next interval. For example, if auto calibration is scheduled to run every 7 days, but you run auto calibration on day 3, the next auto calibration will run 7 days after day 3.

Example

`acal.run()`	Auto calibration starts running. When it is complete, an information message is generated in the event log.

Also see

acal.schedule() (on page 4-7)
Auto calibration (on page 2-4)
localnode.internaltemp

acal.schedule()

This function sets how often auto calibration occurs or prompts you to run it.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Function	Yes	Restore configuration	Nonvolatile memory Configuration script	Run every 8 hours starting at midnight

Usage

```
action, interval, hour = acal.schedule()
acal.schedule(acal.ACTION_NONE)
acal.schedule(action, interval)
acal.schedule(action, interval, hour)
```

action	Determines when and if the instrument automatically runs auto calibration: • To run auto calibration at the scheduled time: `acal.ACTION_RUN` • To notify you that the auto calibration needs to be run at the scheduled time: `acal.ACTION_NOTIFY` • To turn off scheduling: `acal.ACTION_NONE`; no other parameters are needed if none is selected
interval	Determines how often auto calibration should be run or notification should occur: • Every 8 hours: `acal.INTERVAL_8HR` • Every 16 hours: `acal.INTERVAL_16HR` • Every day: `acal.INTERVAL_1DAY` • Every 7 days: `acal.INTERVAL_7DAY` • Every 14 days: `acal.INTERVAL_14DAY` • Every 30 days: `acal.INTERVAL_30DAY` • Every 90 days: `acal.INTERVAL_90DAY`
hour	Specify when the auto calibration should occur; specify in 24-hour time format (`0` to `23`; default is `0`); not available for the 8-hour or 16-hour interval

Details

Autocalibration does not start until all actions that are active on the instrument are complete. When the scheduled time occurs, the autocalibration run command is placed in the command queue and will be executed after any previously sent commands or actions have executed. For example, if a trigger model is running when autocalibration is scheduled to run, autocalibration does not start until the trigger model stops.

If there is a command or action that is waiting a long time for an event, the autocalibration will not run until the event occurs, the action is aborted, or the instrument power is cycled.

If the scheduled time for autocalibration occurs before the warmup period completes, the instrument will not start autocalibration. The instrument waits until the warmup period is complete before starting a scheduled autocalibration. A message is displayed when warmup is complete and autocalibration is going to run.

If the instrument is powered off when an autocalibration was scheduled, autocalibration is run as soon as the warmup period is complete when the instrument is powered on.

You can run autocalibration manually even if a scheduled autocalibration is set.

When autocalibration is scheduled to run at a scheduled interval, but it runs at a time other than the scheduled interval, subsequent scheduled intervals are adjusted according to the actual autocalibration start time.

Example

``acal.schedule(acal.ACTION_RUN, acal.INTERVAL_1DAY, 8)```
Sets auto calibration to run every day at 8 am.

Also see

Auto calibration (on page 2-4)
acal.run() (on page 4-6)

cal.adjust.ac()

This function starts the specified AC adjustment step.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Function	Yes			

Usage

```
cal.adjust.ac(step)
cal.adjust.ac(step, value)
```

step	The AC adjustment step to start
value	The value for this adjustment step (if applicable)

Details

The descriptions of these tests are:

- ACV adjustment (`cal.adjust.ac()`)
  - ACV Step 1, 10 mV 1 kHz, ACV 100 mV range zero
  - ACV Step 2, 100 mV 1 kHz, ACV 100 mV range full-scale and 1 V range zero
  - ACV Step 3, 100 mV 50 kHz, ACV 100 mV frequency flatness adjust
  - ACV Step 4, 1 V 1 kHz, ACV 1 V range full-scale and 10 V range zero
  - ACV Step 5, 1 V 50 kHz, ACV 1 V range frequency flatness adjust
  - ACV Step 6, 10 V 1 kHz, ACV 10 V range full-scale and 100 V range zero
  - ACV Step 7, 10 V 50 kHz, ACV 10 V range frequency flatness adjust
  - ACV Step 8, 100 V 1 kHz, ACV 100 V range full-scale and 700 V range zero
  - ACV Step 9, 100 V 50 kHz, ACV 100 V range frequency flatness adjust
  - ACV Step 10, 700 V 1 kHz, ACV 700 V range full-scale

- ACI Adjustment (`cal.adjust.ac()`)
  - ACI Step 11, 100 µA 1 kHz, ACI 1 mA range zero
  - ACI Step 12, 1 mA 1 kHz, ACI 1 mA range full-scale and 10 mA range zero
  - ACI Step 13, 10 mA 1 kHz, ACI 10 mA range full-scale and 100 mA range zero
  - ACI Step 14, 100 mA 1 kHz, ACI 100 mA range full-scale, 1 A and 3 A range zero
  - ACI Step 15, 1 A 1 kHz, ACI 1 A range full-scale
- ACI Step 16, 2 A 1 kHz, ACI 3 A range full-scale
  - AC-coupling amplitude adjustment
    - ACV Step 17, 1 V 10 Hz, ACV AC coupling amplitude adjustment
  - Frequency adjustment
  - ACV Step 18, 1 V 1 kHz, Squarewave, Frequency adjustment

For detail on how to use `cal.adjust.ac()`, refer to:

- AC voltage adjustment steps 1 to 10 (on page 3-13)
- AC current adjustment steps 11 to 16 (on page 3-16)
- AC coupling adjustment step 17 (on page 3-18)
- AC frequency adjustment step 18 (on page 3-19)

This command generates an error if:

- Calibration is locked
- The step is out of sequence
- The step does not complete successfully
- The value that is passed is invalid for the step, out of range, or not needed

Also see

cal.adjust.dc() (on page 4-12)
cal.lock() (on page 4-16)
cal.unlock() (on page 4-19)

cal.adjust.count

This attribute returns the number of times the instrument has been adjusted.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Attribute (R)	Yes	Not applicable	Nonvolatile memory	Not applicable

Usage

```
adjustments = cal.adjust.count
```

adjustments	The number of adjustments

Details

You can use this command if calibration is locked or unlocked.

Example

`Count = cal.adjust.count` `print(Count)`	Assign the number of times the instrument has been adjusted to a user variable named `Count`. Output the value. Example output: 3 This shows that the instrument has been adjusted 3 times.

Also see

cal.adjust.date (on page 4-11)

cal.adjust.date

This attribute contains the date when the instrument was last adjusted.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Attribute (RW)	Yes	Not applicable	Nonvolatile memory	Not applicable

Usage

```
adjustDate = cal.adjust.date
cal.adjust.date = (os.time{year = year, month = month, day = day})
cal.adjust.date = (os.time({year = year, month = month, day = day, hour = hour, min
    = minute, sec = second}))
```

adjustDate	The date when the last adjustment occurred
year	Year; must be more than 1970
month	Month (1 to 12)
day	Day (1 to 31)
hour	Hour in 24-hour time format (0 to 23)
minute	Minute (0 to 59)
second	Second (0 to 59)

Details

The date and time is returned in the format:

`MMM DD YYYY HH:MM:SS.NNN`

Where:

- `MMM DD YYYY` is the month, date, and year
- `HH:MM:SS.NNN` is the hour, minute, second, and fractional second

You can read this command if calibration is locked or unlocked. To set the date and time, calibration must be unlocked.

Example

`lastCal = cal.adjust.date` `print(lastCal)`	Assign the last adjustment date of the instrument to a user variable named `lastCal`. Output the value. Example output: `Sep 23 2014 10:07:51.447`

Also see

cal.adjust.count (on page 4-10)

cal.adjust.dc()

This function starts the specified DC adjustment step.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Function	Yes			

Usage

```
cal.adjust.dc(step)
cal.adjust.dc(step, value)
```

step	The DC adjustment step to start
value	The value for this adjustment step (if applicable)

Details

The descriptions of these steps are:

- DC Step 0: Internal amplifier offset adjustment
- DC Step 1: 4-wire zero for DCI 1 A to 3 A, DCV, Digitize DCV, 2W Ω, and 4W Ω
- DC Step 2: Open Terminals:
  - DCI, zero 10 µA to 100 mA
  - DCV, 100 V and 1000 V full-scale
  - Resistance, 1 Ω to 1 GΩ full-scale
  - Digitize DCI and DCV full-scale
  - Waveform, analog trigger
  - Frequency, threshold level trigger
- DC Step 3: 10 V, DCV 10 V range
- DC Step 4: -10 V, DCV 10 V range
- DC Step 5: 10 kΩ, Resistance, 4W 10 kΩ range

For detail on how to use `cal.adjust.dc()`, refer to DC voltage adjustment steps 0 to 5 (on page 3-11).

This command generates an error if:

- Calibration is locked
- The step is out of sequence
- The step does not complete successfully
- The value that is passed is invalid for the step, out of range, or not needed

Also see

cal.adjust.ac() (on page 4-8)
cal.lock() (on page 4-16)
cal.unlock() (on page 4-19)

cal.adjust.internaltemp

This attribute returns the internal temperature of the instrument when calibration was last adjusted.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Attribute (R)	Yes	Not applicable	Nonvolatile memory	Not applicable

Usage

```
temperature = cal.adjust.internaltemp
```

temperature	The internal temperature in Celsius (°C)

Example

`print(cal.adjust.internaltemp)`	Returns the internal temperature of the instrument when calibration was last adjusted. Example output: `34.4`

Also see

cal.adjust.tempdiff (on page 4-15)

cal.adjust.rear.ac()

This function starts the specified rear AC adjustment step.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Function	Yes			

Usage

```
cal.adjust.rear.ac(step)
cal.adjust.rear.ac(step, value)
```

step	The rear AC adjustment step to start
value	The value for this adjustment step (if applicable)

Details

The descriptions of these steps are:

- AC Current Step 1, 0.5 A 1 kHz, AC current 10A range zero
- AC Current Step 2, 2 A to 10 A 1 kHz, AC current 10A range full-scale

For detail on how to use `cal.adjust.rear.ac()`, see Rear terminal adjustments (on page 3-6). For code examples, refer to:

- Rear AC adjustment step 1: ACI 10 A Zero adjustment (on page 3-8)
- Rear AC adjustment step 2: ACI 10 A Full-scale adjustment (on page 3-9)

This command generates an error if:

- Calibration is locked
- The step is out of sequence
- The step does not complete successfully
- The value that is passed is invalid for the step, out of range, or not needed

Also see

cal.adjust.rear.dc() (on page 4-14)
cal.lock() (on page 4-16)
cal.unlock() (on page 4-19)

cal.adjust.rear.dc()

This function starts the specified rear DC adjustment step.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Function	Yes			

Usage

```
cal.adjust.rear.dc(step)
cal.adjust.rear.dc(step, value)
```

step	The rear DC adjustment step to start
value	The value for this adjustment step (if applicable)

Details

The descriptions of these steps are:

- DC Step 0: Internal amplifier offset adjustment
- DC Step 1: 4-wire zero, DCA 10A, DCV, Digitize DCV, 2W Ω, and 4W Ω
- DC Step 2: Open Terminals, Capacitance
- DC Step 3: 2 Amp, DCA 10A range

For detail on how to use `cal.adjust.rear.dc()`, see Rear terminal adjustments (on page 3-6). For code examples, refer to:

- Rear DC adjustment step 0: amplifier offset (on page 3-7)
- Rear DC adjustment step 1: 4-wire zero (on page 3-7)
- Rear DC adjustment step 2: Open circuit (on page 3-7)
- Rear DC adjustment step 3: DCI 10 A full-scale adjustment (on page 3-8)

This command generates an error if:

- Calibration is locked
- The step is out of sequence
- The step does not complete successfully
- The value that is passed is invalid for the step, out of range, or not needed

Also see

cal.adjust.rear.ac() (on page 4-13)
cal.lock() (on page 4-16)
cal.unlock() (on page 4-19)

cal.adjust.tempdiff

This attribute returns the difference between the internal temperature and the temperature when adjustment was last done.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Attribute (R)	Yes	Not applicable	Not applicable	Not applicable

Usage

temperature = cal.adjust.tempdiff

temperature	The difference in temperature

Details

The temperature is displayed in Celsius (°C).

The instrument updates the internal temperature value when the instrument refreshes autozero. If autozero is set to off or if autozero is not available for the selected function (such as capacitance, continuity, frequency or period), the internal temperature value is not updated.

Example

`print(cal.adjust.tempdiff)`	Returns the difference between the temperature of the instrument when calibration was adjusted and the present internal temperature. Example output: `4.5678`

Also see

cal.adjust.internaltemp (on page 4-13)

cal.lock()

This function prevents access to instrument calibration.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Function	Yes			

Usage

```
cal.lock()
```

Details

Calibration data is locked during normal operation. To perform calibration, you must unlock calibration.

This command does not save calibration data.

CAUTION

Calibration data is lost if it is you do not save it before sending `cal.lock()`. Use `cal.save()` to save the data.

An error is generated if this command is issued when calibration is already locked.

Example

```
cal.unlock("KI000CAL")
-- Perform operations to generate the calibration data
cal.save()
cal.lock()
```

Unlock the calibration for the instrument using the default password.
Save the calibration data.
Lock the calibration data.

Also see

cal.save() (on page 4-18)
cal.unlock() (on page 4-19)

cal.password

This attribute sets the password that you send when you unlock calibration.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Attribute (W)	Yes	Not applicable	Nonvolatile memory	KI000CAL

Usage

```
cal.password = password
```

password	A string that represents the password to unlock calibration; must be 10 characters or less

Details

This command can only be sent when calibration is unlocked.

The password is not saved until calibration is saved with `cal.save()`.

NOTE

Be sure to record the password; there is no command to retrieve the password once it is set.

Example

`cal.unlock("KI000CAL")` `cal.password = "XYZCorp"` `cal.lock()` `cal.unlock("XYZCorp")`	To change the default calibration password, unlock the calibration with the default password. Sets the password to `XYZCorp`. Lock calibration. Use the password `XYZCorp` for subsequent unlocks.

Also see

cal.save() (on page 4-18)
cal.unlock() (on page 4-19)

cal.save()

This function saves the calibration constants.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Function	Yes			

Usage

```
cal.save()
```

Details

This command stores the internally calculated calibration constants that were derived during the comprehensive calibration procedure. It also sets the adjustment date and increments the adjustment count. Calibration constants are retained indefinitely once saved.

Calibration is temporary unless the changes are saved. Calibration data is not saved if:

- Calibration is locked.
- Invalid data exists (for example, if a calibration step failed or was aborted).
- An incomplete number of calibration steps were done (for example, omission of a negative full-scale step).

Example

```
cal.unlock("KI000CAL")
-- Perform operations to generate the calibration data
cal.save()
cal.lock()
```

Unlock the calibration for the instrument using the default password.
Save the calibration data.
Lock the calibration data.

Also see

cal.adjust.count (on page 4-10)
cal.adjust.date (on page 4-11)
cal.lock() (on page 4-16)
cal.unlock() (on page 4-19)

cal.unlock()

This attribute unlocks calibration operations.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Function	No			

Usage

`cal.unlock(password)`

password	A string containing the password to unlock calibration

Details

Calibration data is locked during normal operation. To perform calibration, you must unlock calibration.

The default password is `KI000CAL`. You can use `cal.password` to change the default.

An error is generated if this command is issued when calibration is already unlocked.

Example

```
cal.unlock("KI000CAL")
-- Perform operations to generate the calibration data
cal.save()
cal.lock()
```

Unlock the calibration for the instrument using the default password.
Save the calibration data.
Lock the calibration data.

Also see

cal.lock() (on page 4-16)
cal.password (on page 4-17)

cal.verify.date

This attribute contains the date of the last calibration verification.

Type	TSP-Link accessible	Affected by	Where saved	Default value
Attribute (RW)	Yes	Not applicable	Nonvolatile memory	Not applicable

Usage

```
verifyDate = cal.verify.date
cal.verify.date = (os.time{year = year, month = month, day = day})
cal.verify.date = (os.time({year = year, month = month, day = day, hour = hour, min
   = minute, sec = second}))
```

verifyDate	The date when the last verification occurred
year	Year; must be more than 1970
month	Month (1 to 12)
day	Day (1 to 31)
hour	Hour in 24-hour time format (0 to 23)
minute	Minute (0 to 59)
second	Second (0 to 59)

Details

The date and time is returned in the format:

`MMM DD YYYY HH:MM:SS.NNN`

Where:

- `MMM DD YYYY` is the month, date, and year
- `HH:MM:SS.NNN` is the hour, minute, second, and fractional second

You can read this command if calibration is locked or unlocked. To set the date and time, calibration must be unlocked.

When using the `os.time()` function, if no parameters are specified, the current date and time of the instrument is used.

The verification date is also available from the front panel:

1. Press the **MENU** key.
2. Select **Calibration**.
3. The verification date is displayed as the **Calibration Date**.

Example 1

```
cal.verify.date = (os.time{year=2014, month=9, day=5})
print(cal.verify.date)
```

Set the verify calibration date to September 5, 2014.
Verify the date. Example output:
`Sep 5 2014 12:00:00.000`

Example 2

```
cal.verify.date = os.time()
```

Set the calibration verification to the present date of the instrument.

Also see

cal.adjust.date (on page 4-11)

Calibration constants

In this appendix:

Calibration constants

The list below provides typical calibration constants. To print the data from your instrument, contact Keithley Instruments (*http://www.keithley.com*) applications.

Constant_Name	**Data**
dac100mv;	1.3107200E+05
dac1v;	1.3107200E+05
dac10v;	1.3107200E+05
dac100v;	1.3107200E+05
c100mvz;	2.7993773E-02
c100mvfs;	2.8050151E-01
c100mvfs_pkpk;	7.9414093E-01
c100mvfs_fast_pkpk;	7.9372764E-01
c1vz;	2.8060042E-02
c1vz_fast;	2.8048071E-02
c1vfs;	2.8115368E-01
c1vfs_fast;	2.8097456E-01
c1vfs_pkpk;	7.9601968E-01
c1vfs_fast_pkpk;	7.9544712E-01
c1vn;	-3.8415337E-05
c1vn_fast;	-3.7236119E-05
c1vn_pkpk;	-6.0162854E-06
c1vn_fast_pkpk;	-4.8710827E-06
c10vz;	2.8060884E-02
c10vfs;	2.8113199E-01
c10vfs_pkpk;	7.9595390E-01
c10vfs_fast_pkpk;	7.9544482E-01
c10vn;	-2.7577862E-05
c100vz;	2.8120784E-02
c100vfs;	2.8173985E-01

Constant_Name	Data
c100vfs_pkpk;	7.9767507E-01
c100vfs_fast_pkpk;	7.9712293E-01
c700vz;	5.6181411E-02
c700vfs;	3.9381000E-01
c700vfs_pkpk;	1.1144911E+00
c700vfs_fast_pkpk;	1.1135194E+00
c700vn;	-3.7857483E-05
c100uafs_pkpk_DC_cb;	4.0990970E-02
c100uafs_pkpk_AC_cb;	7.9383196E-01
c100uafs_fast_pkpk_AC_cb;	7.9339428E-01
c1mafs_pkpk_DC_cb;	4.0947148E-01
c1mafs_pkpk_AC_cb;	7.9549755E-01
c1mafs_fast_pkpk_AC_cb;	7.9499190E-01
c1maz;	2.8044590E-02
c1mafs;	2.8098133E-01
c10maz;	2.7784581E-02
c10mafs;	2.7837800E-01
c100maz;	2.8344974E-02
c100mafs;	2.8395196E-01
c1az;	2.8010009E-02
c1afs;	2.8062545E-01
c3az;	1.4102141E-02
c3afs;	2.8299548E-01
c10az_rear;	6.9557709E-03
c10afs_rear;	9.7818349E-02
usr_1v3hz;	1.0000000E+00
clfrms;	9.9560174E-01
clfrms_pkpk;	7.9272482E-01
clfrms_fast_pkpk;	6.5001123E-01
usr_freq;	1.0000000E+03
cfreq;	1.0000026E+03
usr_10vfs;	1.0000001E+01
usr_m10vfs;	-9.9999941E+00
usr_10kohmfs;	1.0000378E+04
usr_10afs;	2.0000000E+00
acal_temp;	3.5731194E+01
c100mvz;	3.0878425E-07
c100mvz_rear;	1.0272006E-07
c100mvz_acal_cb;	-6.0000000E-06

Constant_Name	Data
c100mvz_acal_x40_gain_cb;	-4.7943891E-04
c100vz_acal_sar	8.3854500E+06
c1vz_acal_x4_gain_cb;	-4.6145535E-05
c10vz;	-7.3364148E-08
c10vz_rear;	-2.8697002E-07
c100vz;	-1.9961670E-07
c100vz_rear;	-2.4218445E-07
c10vfs;	1.4493268E+00
c10vfs_p64;	1.5600000E+01
cm10vfs;	-1.4493159E+00
c100vfs;	1.4400000E-01
c1000vfs_pkpk_open_cb;	2.7211849E-04
c1000vfs_dc_open_cb;	-2.9622170E-07
c100mvz_sar;	8.3877480E+06
c100mvz_sar_rear;	8.3878500E+06
c1vz_sar;	8.3887890E+06
c1vz_sar_rear;	8.3887950E+06
c10vz_sar;	8.3887050E+06
c10vz_sar_rear;	8.3887060E+06
c100vz_sar;	8.3854530E+06
c100vz_sar_rear;	8.3854760E+06
c1000vz_sar;	8.3887190E+06
c1000vz_sar_rear;	8.3887190E+06
c100mvfs_acal_sar;	1.0211540E+06
c100mvfs_acal_cb;	1.6069529E-02
c100mvfs_acal_x40_gain_cb;	-6.4695248E-01
c1vfs_acal_sar;	1.2189320E+06
c1vfs_acal_cb;	1.5814765E-01
c1vfs_acal_x4_gain_cb;	-6.2958472E-01
c5vfs_acal_sar;	5.0331040E+06
c10vfs_6p86_cb;	1.0000093E+00
c10vfs_acal_sar;	1.3242980E+06
cm10vfs_acal_sar;	1.5453327E+07
cFE_B_0_1_acal_sar;	8.3887040E+06
cFE_B_0_4_acal_sar;	8.3884060E+06
cFE_B_0_40_acal_sar;	8.3835210E+06
cFE_B_0_100_acal_cb;	9.1222547E-06
c10ohm2z;	1.6111923E-04
c10ohm2z_rear;	1.6724291E-04

Constant_Name	**Data**
c100ohm2z;	1.6343420E-05
c100ohm2z_rear;	1.6780784E-05
c10kohm2z;	1.5054417E-06
c10kohm2z_rear;	1.3435532E-06
c100kohm2z;	5.4868686E-08
c100kohm2z_rear;	-1.6390474E-07
c10Mohm2z;	-1.3063027E-07
c10Mohm2open;	9.9998346E-01
c1kohm3_rtd_hi_z;	1.6332221E-05
c1kohm3_rtd_hi_z_rear;	1.6781639E-05
c1kohm3_rtd_hi_Ioff_z;	4.1420705E-07
c1kohm3_rtd_hi_Ioff_z_rear;	2.6925354E-07
c1kohm3_rtd_slo_z;	5.6431727E-06
c1kohm3_rtd_slo_z_rear;	5.9843144E-06
c1kohm3_rtd_slo_Ioff_z;	-7.0446950E-08
c1kohm3_rtd_slo_Ioff_z_rear;	-4.6258627E-07
c10kohm3_rtd_hi_z;	1.4564330E-06
c10kohm3_rtd_slo_z;	4.6311379E-07
c100kohm3_rtd_hi_z;	2.5424421E-08
c100kohm3_rtd_slo_z;	-6.1442402E-08
c100kohm3_rtd_slo_Ioff_z;	-1.3030010E-07
c1ohm4dryz;	2.8777512E-07
c1ohm4dryz_rear;	7.8919582E-07
c10ohm4z;	2.8677197E-07
c10ohm4z_rear;	7.8399359E-07
c10ohm4dryz;	2.8944447E-07
c10ohm4dryz_rear;	7.6279316E-07
c100ohm4z;	2.8823267E-07
c100ohm4z_rear;	7.5805452E-07
c100ohm4_Ioff_z;	2.9042361E-07
c100ohm4_Ioff_z_rear;	7.6168618E-07
c100ohm4dryz;	2.8780725E-07
c100ohm4dryz_rear;	7.5854041E-07
c1kohm4dryz;	2.8915559E-07
c1kohm4dryz_rear;	7.6675851E-07
c10kohm4z;	-8.6172054E-08
c10kohm4z_rear;	3.5982976E-07
c10kohm4_Ioff_z;	-3.0000000E-06
c10kohm4_Ioff_z_rear;	-3.0000000E-06

Constant_Name	Data
c10kohm4dryz;	2.9007269E-07
c10kohm4dryz_rear;	7.7646739E-07
c10kohm4_Ioff_dryz;	2.8347362E-07
c10kohm4_Ioff_dryz_rear;	7.5476862E-07
c100kohm4z;	-9.6325724E-08
c100kohm4z_rear;	3.7314337E-07
c100kohm4_Ioff_z;	-1.3985889E-07
c100kohm4_Ioff_z_rear;	3.7075537E-07
c10Mohm4slz;	-9.8016815E-08
c10ohm4_acal_amp_10ma_10ma_fs;	-1.4152391E-01
c100ohm4_acal_fs;	1.4272544E+00
c100ohm4_acal_Ioff_fs;	1.4292973E-02
c10kohm4fs;	1.4310195E-01
c10kohm4_Ioff_fs;	-1.2518740E-07
c10kohm4_acal_fs;	1.4309359E-01
c10kohm4_r_int_fs;	1.4309363E-01
c100kohm4_acal_fs;	1.4292877E-02
c100kohm4_acal_Ioff_fs;	-4.2635635E-07
c_100kohm4_r_int_Ioff_fs;	-4.2452172E-07
c100k_div_fs;	1.4275458E-01
c100k_div_Ioff_fs;	-3.1134592E-07
c9p9M_Rsw_fs;	9.9931308E-01
c10uaz;	-1.0016313E-06
c10uaz_sar;	8.3888800E+06
c100uaz;	-1.0295610E-06
c100uaz_sar;	8.3888800E+06
c100uaz_lo_amp_acal_sar;	8.3889570E+06
c1maz;	-1.0787258E-06
c1maz_sar;	8.3888650E+06
c10maz;	-1.1100190E-06
c10maz_sar;	8.3888410E+06
c100maz;	-1.1586581E-07
c100maz_sar;	8.3876800E+06
c100ma_acal_z;	-2.8944600E-07
c1az;	-7.5448331E-08
c1az_sar;	8.3876830E+06
c1a_acal_z;	-2.7333119E-07
c10az_rear;	-3.6555113E-07
c10az_sar_rear;	8.3879160E+06

Constant_Name	Data
c1uafs;	-1.6889695E-02
c5uafs;	-7.1473604E-02
c10uafs;	-1.4289992E-01
c100uafs;	-1.4323787E-01
c100uafs_acal_sar;	1.4879293E+07
c100uafs_lo_amp_acal_sar;	1.4882901E+07
c1mafs;	-1.4254074E-01
c10mafs;	-1.4123197E-02
c100mafs;	1.4468060E-03
c1afs;	1.4273318E-04
c10afs_rear;	1.4592606E-03
usr_10afs_rear	7.0000000E+00
c3az_sar;	8.3887800E+06
camps_gain_b_0_4_sar;	8.3886860E+06
camps_gain_b_0_1_sar;	8.3886480E+06
camps_gain_b_0_40_sar;	8.3863090E+06
c1kohm4fs;	1.5600000E+01
c1kohm4_Ioff_fs;	7.8100000E-03
c_mux_gain_10;	9.1743224E+00
cdummy_fs_2;	9.1680549E+00
cdummy_fs_3;	0.0000000E+00
cdummy_fs_4;	0.0000000E+00
cdummy_fs_5;	0.0000000E+00
cFE_B_0_DIV100;	2.7910505E-07
cFE_B_0_1;	1.0124907E-05
cFE_B_10_DIV100;	1.5512707E-02
cFE_B_m10_DIV100;	-1.5512364E-02
cFE_B_10_1;	1.5507674E+00
cFE_B_m10_1;	-1.5507792E+00
c_stray_cap_1nf;	3.0647367E-01
c_stray_cap_plus_10nf;	3.7761676E-01
c_vbias_cal_z;	2.9155000E-03
c_vbias_cal_fs;	6.9241000E-01
c_freq_thr_cal_z;	1.0303575E+07
c_freq_thr_cal_fs;	6.4743100E+06
cVlevel_trg_DAC_A_Cal_mfs;	3.0450000E+02
cVlevel_trg_DAC_A_Cal_fs;	3.7935000E+03
cVlevel_trg_DAC_B_Cal_mfs;	3.0350000E+02
cVlevel_trg_DAC_B_Cal_fs;	3.7940000E+03

Keithley Instruments
Corporate Headquarters • 28775 Aurora Road • Cleveland, Ohio 44139 • 440-248-0400 • Fax: 440-248-6168 • 1-800-935-5595 • www.keithley.com

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