

Model 7708 Multiplexer Module

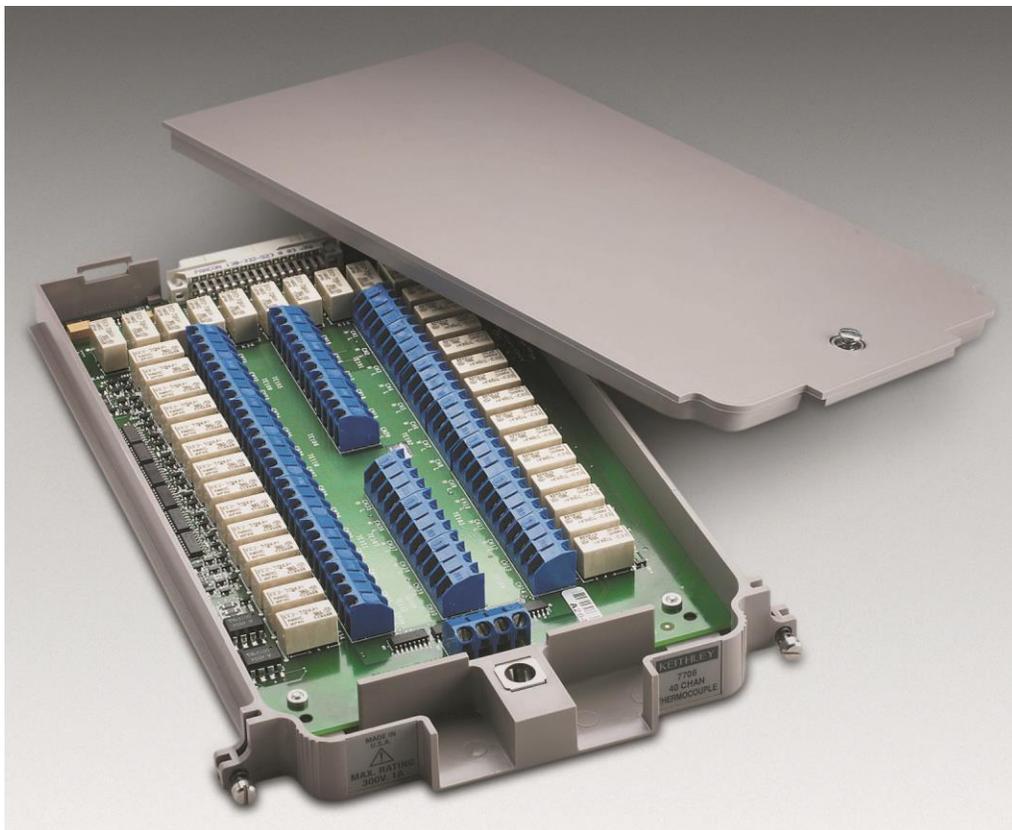
Instructions for use with DAQ6510

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Introduction

The Model 7708 40-Channel Differential Multiplexer Plug-In Module with Automatic CJC offers 40 channels of 2-pole or 20 channels of 4-pole multiplexer switching that can be configured as two independent banks of multiplexers. Automatic CJC is provided so that no other accessories are required to make thermocouple measurements. The 7708 is ideal for RTD, thermistor, and thermocouple temperature applications. It is also well suited for mixed-signal measurement applications that require multi-point monitoring, such as environmental stress screening.

Figure 1: Model 7708 40-Channel Differential Multiplexer Module



Item shipped may vary from model pictured here.



The 7708 includes the following features:

- DC and AC voltage measurement
- Two-wire or four-wire resistance measurements (automatically pairs switches for four-wire measurements— $n + 20$)
- Temperature applications (RTD, thermistor, thermocouple)
- Built-in cold junction reference
- Screw terminal connections

The 7708 can be used with the DAQ6510 data acquisition instrument.

NOTE

If you are using this switching module with the 2700, 2701, or 2750, please see the Model 7708 40-Channel Differential Multiplexer with Automatic CJC User's Guide, Keithley Instruments document number PA-744.

Connections

WARNING

Connection and wiring procedures in this document are intended for use by qualified personnel only. Do not perform these procedures unless qualified to do so. Failure to recognize and observe normal safety precautions could result in personal injury or death.

WARNING

Do not exceed the maximum specifications for the 7708 module. Refer to the specifications provided in the data sheet. Failure to recognize and observe normal safety precautions could result in personal injury or death.

Wiring procedure

Use the following procedure to make connections to the 7708 module. Make all connections using the correct wire size (up to 20 AWG).

⚠ WARNING

All wiring must be rated for the maximum voltage in the system. For example, if 1000 V is applied to the front terminals of the instrument, the switching module wiring must be rated for 1000 V. Failure to recognize and observe normal safety precautions could result in personal injury or death.

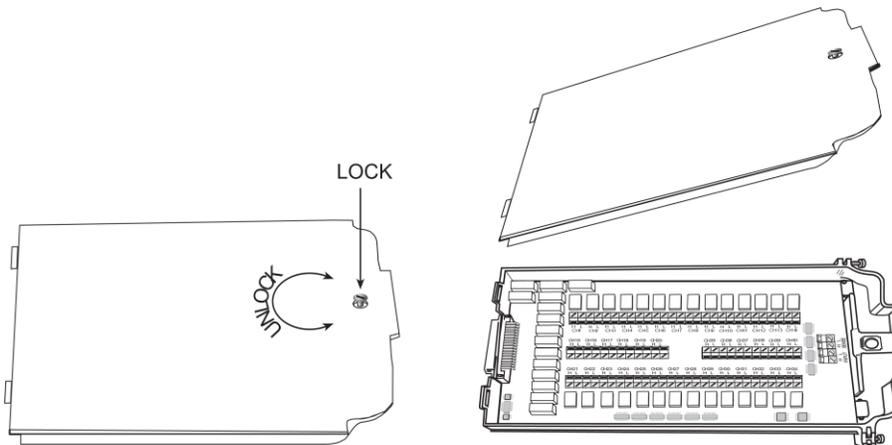
Equipment needed:

- Flat-blade screwdriver
- Cable ties

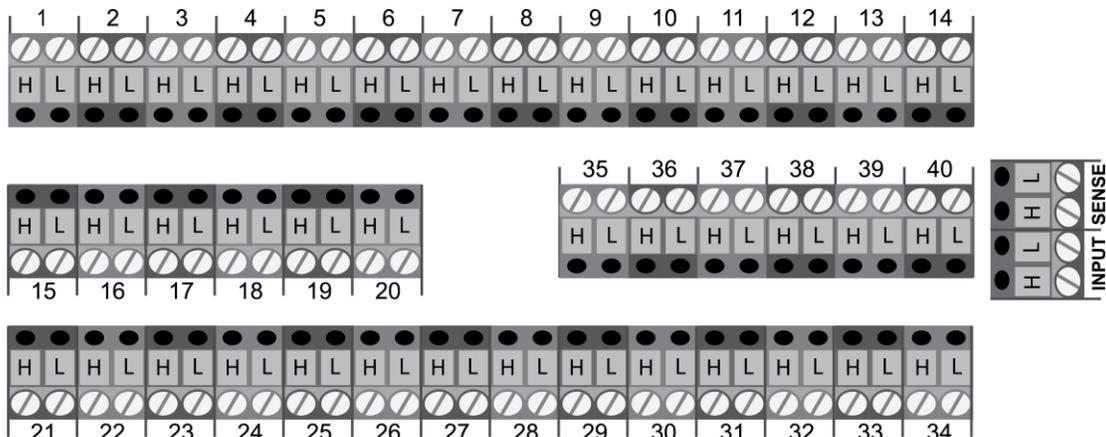
To wire the 7708 module:

1. Make sure all power is discharged from the 7708 module.
2. Using a screwdriver, turn the access screw to unlock and open the cover.

Figure 2: Screw terminal access

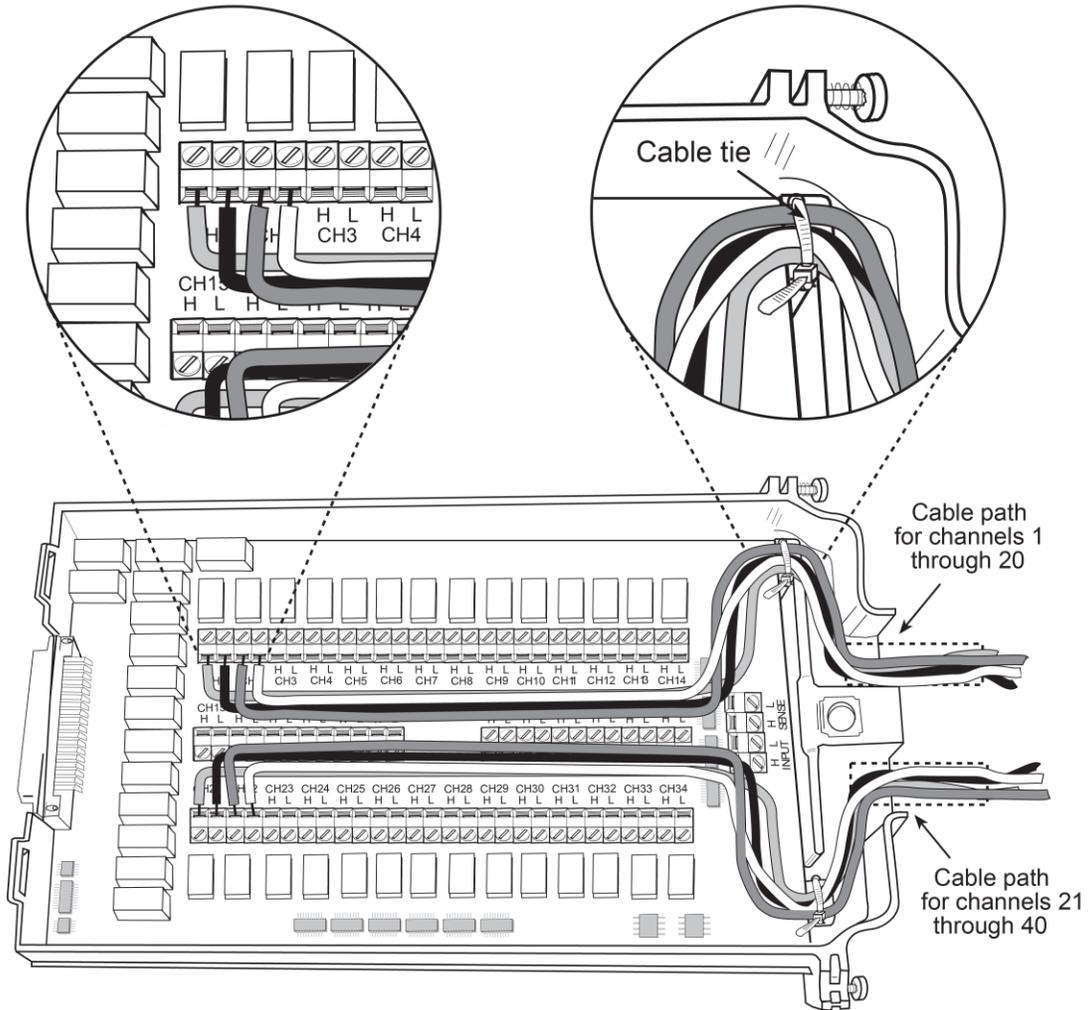


3. Using a small flat-blade screwdriver, loosen terminal screws and install wires as needed. Channel designations for the screw terminals are shown in the following figure.



- Route wire along the cable path and secure with cable ties as shown. The following figure shows connections to channels 1 and 2.

Figure 3: Wire dressing



- Record the connections in the [Connection log](#) (on page 8).
- Close the cover.
- Using a screwdriver, press in the access screw and turn to lock the cover.

Schematic diagram

The simplified schematic diagram of the 7708 is shown in the following figure. The channels are grouped into two banks of 20 channels (40 channels total). Backplane isolation is provided for each bank. Each bank also includes separate cold junction reference points.

The first bank contains channels 1 to 20 and the second bank contains channels 21 to 40. Each channel is wired with separate inputs for HI/LO, providing fully isolated inputs.

Although the 7708 relays are the latching type (relays hold their state even after power has been removed), all relay states are set to open a few seconds after either a power cycle or a reset command is issued.

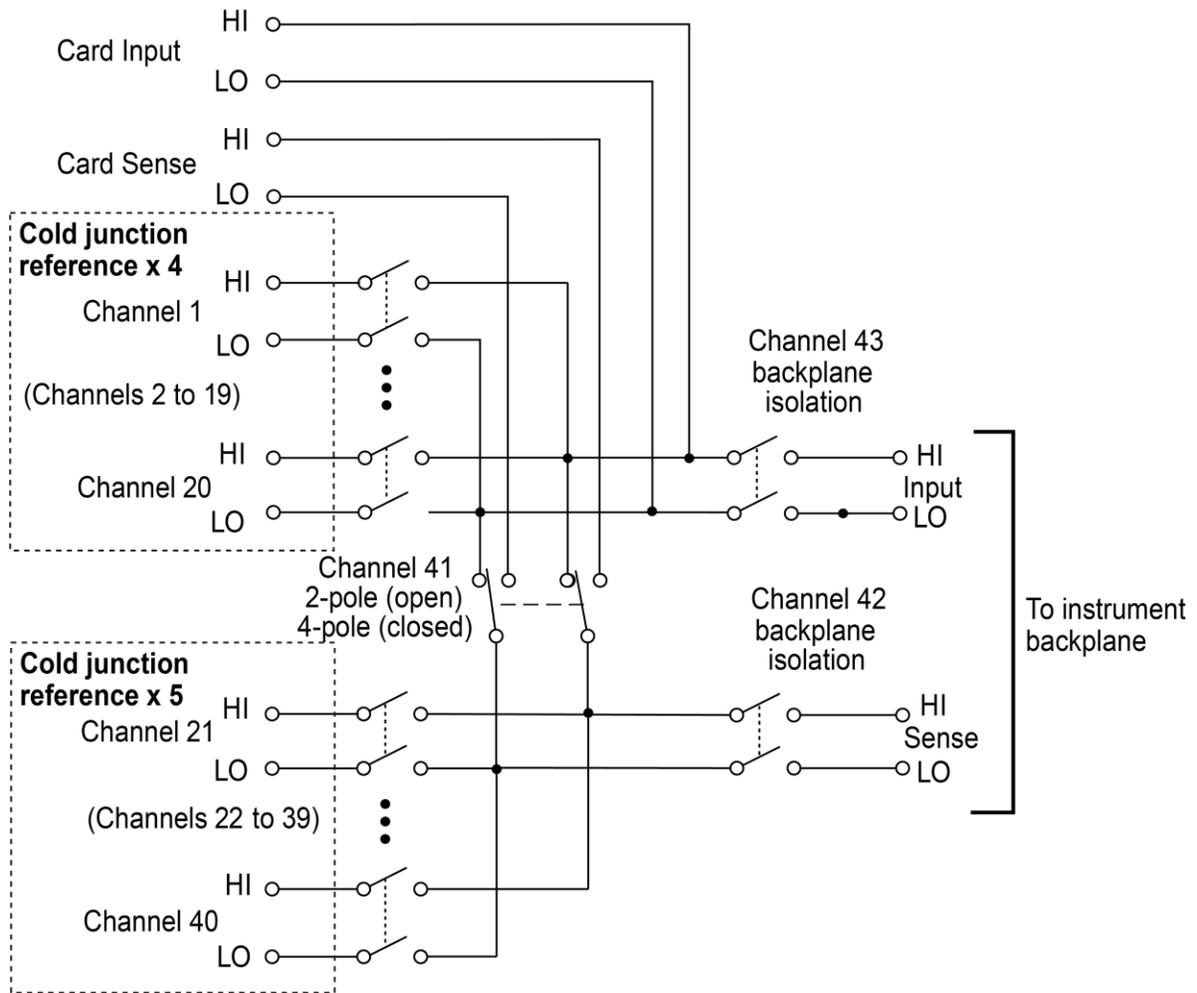
Connections to DMM functions are provided through the module backplane connector of the instrument.

When automatically configured for 4-wire measurements (including 4-wire resistance and RTD temperature), the channels are paired as shown in the following table. Connect 4-wire sense leads using channels 21 to 40.

CH1 and CH21	CH8 and CH28	CH15 and CH35
CH2 and CH22	CH9 and CH29	CH16 and CH36
CH3 and CH23	CH10 and CH30	CH17 and CH37
CH4 and CH24	CH11 and CH31	CH18 and CH38
CH5 and CH25	CH12 and CH32	CH19 and CH39
CH6 and CH26	CH13 and CH33	CH20 and CH40
CH7 and CH27	CH14 and CH34	

The 7708 switching module has 40 channels that can calculate ratio and channel average. The ratio calculation can be done for the DCV function, and the channel average calculation can be done for the DCV and TEMP (thermocouples only) functions. Paired channels are used for ratio and channel average. Channels are paired in the same manner as they are for 4-wire measurements.

Figure 4: Model 7708 simplified schematic



Channel 41 (2W/4W Configuration), Channel 42 (Sense Isolation), and Channel 43 (Input Isolation) are normally automatically configured by the DAQ6510.

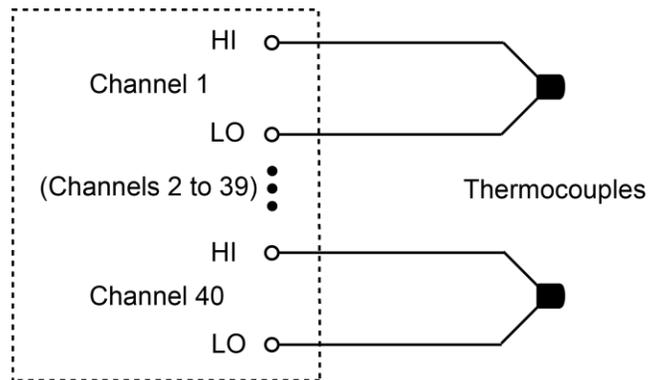
Typical connections

The following examples show typical wiring connections for the following types of measurements:

- Thermocouple
- Two-wire resistance and thermistor
- Four-wire resistance and RTD
- DC or AC voltage

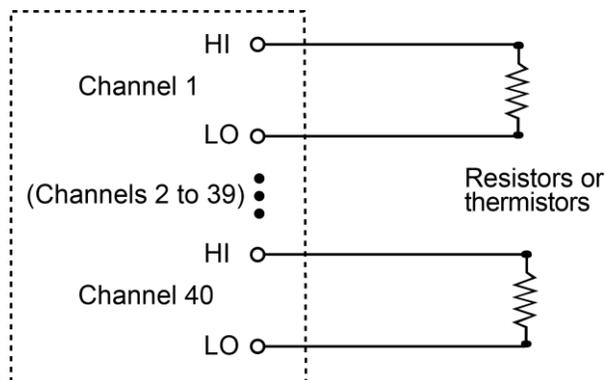
Thermocouple connections

Figure 5: Thermocouple connections



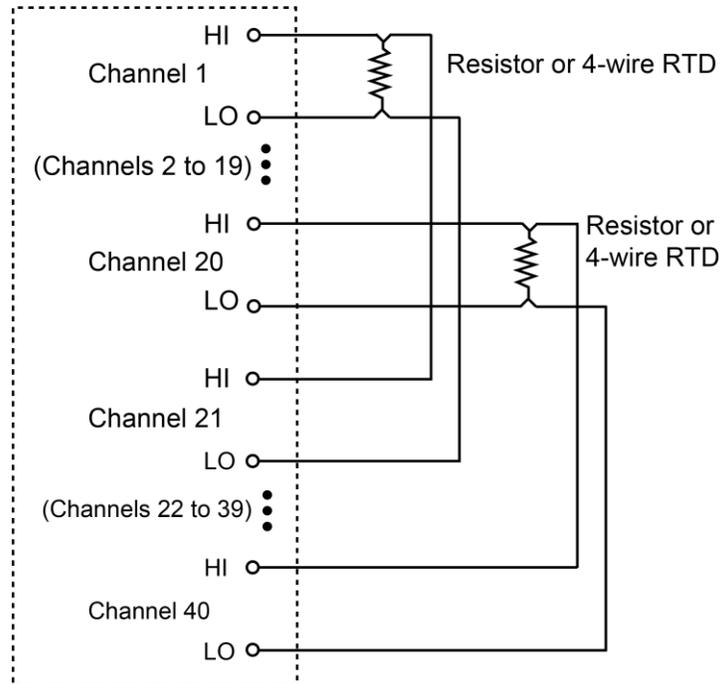
Two-wire resistance and thermistor connections

Figure 6: Two-wire resistance and thermistor connections



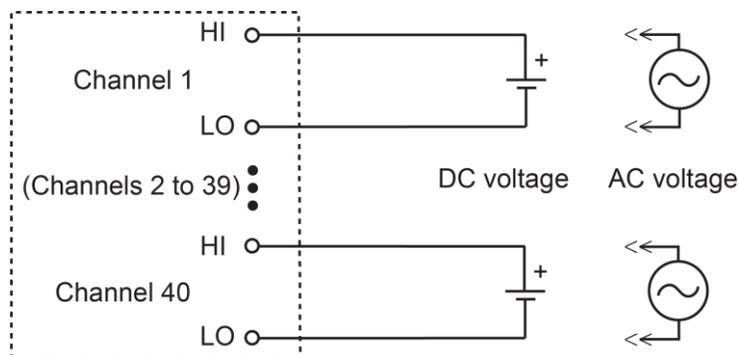
Four-wire resistance and RTD connections

Figure 7: 4-wire resistance and RTD connections



DC or AC voltage connections

Figure 8: Voltage connections - DC or AC



Connection log

You can use the next table to record your connection information.

Channel		Color	Description	Description	Color	Channel
INPUT	H					
	L					
SENSE	H					
	L					
CH1	H				H	CH21
	L				L	
CH2	H				H	CH22
	L				L	
CH3	H				H	CH23
	L				L	
CH4	H				H	CH24
	L				L	
CH5	H				H	CH25
	L				L	
CH6	H				H	CH26
	L				L	
CH7	H				H	CH27
	L				L	
CH8	H				H	CH28
	L				L	
CH9	H				H	CH29
	L				L	
CH10	H				H	CH30
	L				L	
CH11	H				H	CH31
	L				L	
CH12	H				H	CH32
	L				L	
CH13	H				H	CH33
	L				L	
CH14	H				H	CH34
	L				L	
CH15	H				H	CH35
	L				L	
CH16	H				H	CH36
	L				L	
CH17	H				H	CH37
	L				L	
CH18	H				H	CH38
	L				L	
CH19	H				H	CH39
	L				L	
CH20	H				H	CH40
	L				L	

Installation

WARNING

Before operating an instrument with an accessory switching module, verify that the switching module is properly installed and the mounting screws are tightly fastened. If the mounting screws are not properly connected, an electrical shock hazard may be present.

To use the switching operations, a switching module must be installed in the DAQ6510.

If you are installing two switching modules, it is easier to install one switching module into Slot 2 first, then install the second switching module into Slot 1.

NOTE

If you have a Keithley Instruments Model 2700, 2701, or 2750 instrument, you can use your existing switching module in the DAQ6510. Follow the instructions in your original equipment documentation to remove the module from the instrument, then use the following instructions to install it in the DAQ6510. You do not need to remove wiring to the module.

NOTE

For inexperienced users, it is recommended that you do not connect a device under test (DUT) and external circuitry to the switching module. This allows you to exercise close and open operations without the dangers associated with live test circuits. You can also set up pseudocards to experiment with switching. Refer to Pseudocards in the *Model DAQ6510 Reference Manual* for information on setting up pseudocards.

WARNING

To prevent electric shock that could result in injury or death, never handle a switching module that has power applied to it. Before installing or removing a switching module, make sure the DAQ6510 is turned off and disconnected from line power. If the switching module is connected to a DUT, make sure power is removed from all external circuitry.

WARNING

If a card slot is unused, you must install slot covers to prevent personal contact with high voltage circuits. Failure to install slot covers could result in personal exposure to hazardous voltages, which could cause personal injury or death if contacted.

CAUTION

Before installing or removing a switching module, make sure the DAQ6510 power is turned off and disconnected from line power. Failure to comply may result in incorrect operation and loss of data in the memory.

Required equipment:

- Medium flat-blade screwdriver
- Medium Phillips screwdriver

To install switching module into the DAQ6510:

1. Turn off the DAQ6510.
2. Disconnect the power cord from the power source.
3. Disconnect the power cord and any other cables that are connected to the rear panel.
4. Position the DAQ6510 so you are facing the rear panel.
5. Use the screwdriver to remove the slot cover screws and the cover plate. Retain the plate and screws for future use.
6. With the top cover of the switching module facing up, slide the switching module into the slot.
7. Press the switching module in firmly to make sure the switching module connector is connected to the DAQ6510 connector.
8. Use the screwdriver to tighten the two mounting screws to secure the switching module to the mainframe. Do not overtighten.
9. Reconnect the power cord and any other cables.

Remove a switching module

NOTE

Before you remove a switching module, or begin any testing, make sure that all of the relays are open. Since some relays may be latched closed, you must open all of the relays before removing the switching module to make connections. Additionally, if you drop your switching module, it is possible for some relays to latch closed.

To open all channels select **Menu > Control > Open**. If there are no channels closed, the Open button is not selectable. If any channel is closed, then the Open button is active and selecting it will open all channels.

WARNING

To prevent electric shock that could result in injury or death, never handle a switching module that has power applied to it. Before installing or removing a switching module, make sure the DAQ6510 is turned off and disconnected from line power. If the switching module is connected to a DUT, make sure power is removed from all external circuitry.

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CAUTION

Before installing or removing a switching module, make sure the DAQ6510 power is turned off and disconnected from line power. Failure to comply may result in incorrect operation and loss of data in the memory.

Required equipment:

- Medium flat-blade screwdriver
- Medium Phillips screwdriver

To remove switching module from the DAQ6510:

1. Turn off the DAQ6510.
2. Disconnect the power cord from the power source.
3. Disconnect the power cord and any other cables that are connected to the rear panel.
4. Position the DAQ6510 so you are facing the rear panel.
5. Use the screwdriver to loosen the mounting screws that secure the switching module to the mainframe.
6. Carefully remove the switching module.
7. Install a slot plate or switching module in the empty slot.
8. Reconnect the power cord and any other cables.

Operation

This switching module does not support current measurements. If the instrument has the TERMINALS switch set to REAR and you are working with the slot that contains this switching module, the AC , DC , and digitize current functions are not available. You can measure current using the front panel or using another slot that contains a switching module that supports the AC , DC , and digitize current measurements.

If you use remote commands to attempt to measure current when configuring a channel, an error is returned.

Performance verification

The performance of the module is tested by verifying the accuracy of measurements made through the module. If verification limits are met through the front-panel terminals of the DAQ6510, they should also be met through the module.

WARNING

Do not attempt to perform this procedure unless qualified to do so. Failure to recognize and observe normal safety precautions could result in personal injury or death.

NOTE

Measurement accuracy through the module should only be verified after instrument accuracy has been verified through the front-panel terminals of the DAQ6510. Refer to the DAQ6510 Calibration and Adjustment manual (documentation number DAQ6510-905-01) for verification information.

This verification procedure requires that the DAQ6510 be within its calibration interval.

Module verification test procedures include:

- DC volts
- AC volts
- Resistance
- Temperature
- Frequency
- Ratio and average

Make sure that you perform the verification tests using the following conditions:

- Under the proper environmental conditions
- After the specified warm-up period
- With connections made to the correct input terminals
- Using the correct line voltage
- With the TERMINALS switch in the REAR position
- With the proper calibration equipment and the reading limits provided with the verification procedures. See [Calculating resistance reading limits](#) (on page 14) for more information.

Environmental conditions

Conduct your performance verification procedures in a test environment that has:

- An ambient temperature of 18 °C to 28 °C.
- A relative humidity of less than 80% unless otherwise noted.

Warm-up period

Allow the DAQ6510 to warm up for at least one hour before verifying the module.

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 an instrument that is 10 °C outside the specified temperature range.

Allow the test equipment to warm up for the minimum time specified by the manufacturer.

Example reading limit calculation

The following is an example of how reading limits have been calculated. Assume you are testing the 10 VDC range using a 10 V input value. Using the DAQ6510 one-year accuracy specification for 10 VDC of \pm (25 ppm of reading + 5 ppm of range), the calculated limits are:

$$\text{Reading limits} = 10 \text{ V} \pm [(10 \text{ V} \times 25 \text{ ppm}) + (10 \text{ V} \times 5 \text{ ppm})]$$

$$\text{Reading limits} = 10 \text{ V} \pm (0.00025 + 0.00005)$$

$$\text{Reading limits} = 10 \text{ V} \pm 0.00030 \text{ V}$$

$$\text{Reading limits} = 9.99970 \text{ V to } 10.00030 \text{ V}$$

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 previous example, except that you should use the actual calibration resistance values instead of the nominal values 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 DAQ6510 one-year 10 kΩ range accuracy of ± (75 ppm of reading + 6 ppm of range), the calculated reading limits are:

$$\text{Reading limits} = 10.03 \text{ k}\Omega \pm [(10.03 \text{ k}\Omega \times 75 \text{ ppm}) + (10 \text{ k}\Omega \times 6 \text{ ppm})]$$

$$\text{Reading limits} = 10.02929 \text{ k}\Omega \text{ to } 10.03081 \text{ k}\Omega$$

Recommended test equipment

The table below summarizes recommended verification equipment. You can use alternate equipment if that equipment has specifications that meet or exceed those listed below. Be aware that calibrator uncertainty adds to the uncertainty of each measurement.

Fluke 5700A Calibrator:		
DC voltage	AC voltage (1 kHz, 50 kHz)	Resistance
100 mV: ±14 ppm	100 mV: ±200 ppm	100 Ω: ±17 ppm
1.0 V: ±7 ppm	1.0 V: ±82 ppm	1 kΩ: ±12 ppm
10 V: ±5 ppm	10 V: ±82 ppm	10 kΩ: ±11 ppm
100 V: ±7 ppm	100 V: ±90 ppm	100 kΩ: ±13 ppm
1000 V: ±9 ppm	700 V: ±85 ppm	1 MΩ: ±18 ppm 10 MΩ: ±37 ppm 100 MΩ: ±120 ppm
Fluke 5725A Amplifier AC Voltage, 50 kHz: 700 V, ±375 ppm The Fluke 5725A amplifier is necessary only if you need to verify the 750 VAC range at 50 kHz. Verification at 220 V and 50 kHz using the 5700A calibrator is adequate for most applications.		
Keithley 3930A or 3940 Frequency Synthesizer 1 V _{RMS} , 10 V _{RMS} , 1 kHz, ±5 ppm, steady state and burst modulation		
General Radio 1433-T Precision Decade Resistance Box 10 Ω to 400 Ω, ±0.02%		
Miscellaneous equipment Double banana plug to double banana plug shielded cables (two) BNC to double banana plug shielded cable		

Performance verification procedures

NOTE

The following procedures describe how to check one channel (CH1) or one channel pair (CH1 and CH11) of the module. To check other channels or channel pairs, modify the procedures by connecting the verification equipment to the appropriate channel or channel pair.

When performing the verification procedures:

- Make sure that the equipment is properly warmed up and connected to the correct input terminals.
- Make sure that the TERMINALS switch is set to REAR.
- Do not use autoranging for any verification tests. Autorange hysteresis may cause the DAQ6510 to be on an incorrect range. For each test signal, you must manually set the correct range for the DAQ6510.
- Make sure the calibrator output is enabled before you verify each measurement.
- Always let the source signal settle before taking a reading.

The verification limits stated in this section have been calculated using only the DAQ6510 one-year accuracy specifications, and they do not include test equipment uncertainty. If a particular measurement falls slightly outside the allowable range, recalculate new limits based on both DAQ6510 specifications and pertinent calibration equipment specifications.

WARNING

Do not attempt to perform this procedure unless qualified to do so. Failure to recognize and observe normal safety precautions could result in personal injury or death.

WARNING

The maximum common-mode voltage (the voltage between any module terminal and chassis ground) is 300 VDC or 300 V_{RMS}. Exceeding this value may cause a breakdown in insulation, creating a shock hazard.

Verifying DC voltage

To check DC voltage accuracy, apply accurate voltages from the DC voltage calibrator to the input terminals of the module and verify that the displayed readings fall within specified limits.

CAUTION

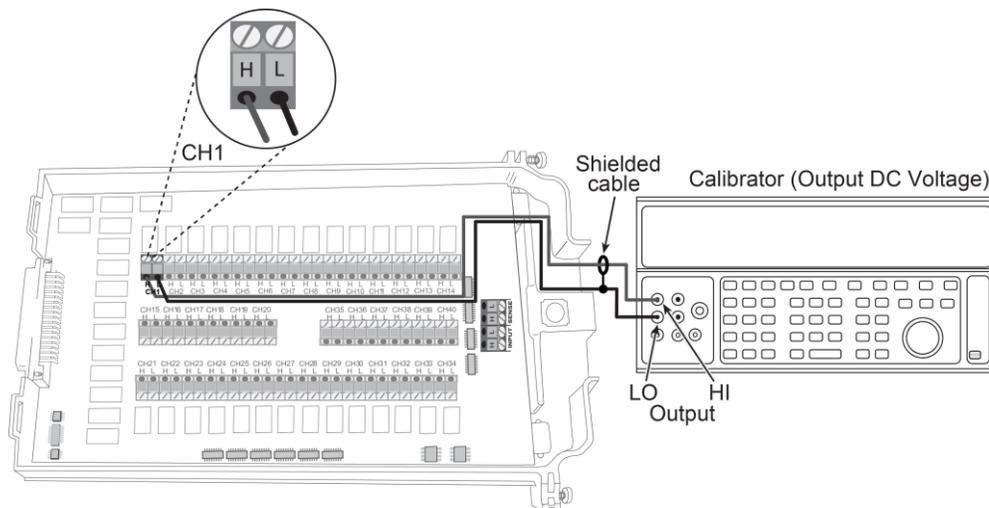
Do not exceed 300 VDC between plug-in module INPUT H and L terminals or between any adjacent channels. Failure to observe this precaution can cause instrument damage.

To verify DC voltage accuracy:

1. Connect the CH1 H and L INPUT terminals to the DC voltage calibrator as shown in the next figure.

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.



2. Install the module in Slot 1 of the DAQ6510.
3. Turn on the power.
4. Allow the instrument to warm up for one hour.
5. Make sure that the front-panel TERMINALS switch is set to **REAR**.
6. On the front panel of the instrument, select the **FUNCTION** key and then select **DC Voltage**.
7. On the Home screen, swipe to the **CHANNEL** swipe screen.
8. Close channel **101**.
9. Set the range to **100 mV**.
10. Set the calibrator output to **0.00000 mV DC**.
11. Allow the reading to settle.
12. Swipe to the **Settings** screen.
13. Enable **Rel**.
14. For the calibrator, source positive, negative, and full-scale voltages, see the ranges listed in the table below. For each voltage setting, make sure that the reading is within stated limits.
15. Return to the **CHANNEL** swipe screen and open Channel 1.

Range	Applied DC voltage	Reading limits (1 year, 18 °C to 28 °C)
100 mV	100.0000 mV	99.9935 to 100.0065 mV
1 V	1.000000 V	0.999969 to 1.000031 V
10 V	10.00000 V	9.99970 to 10.00030 V
100 V	100.0000 V	99.9955 to 100.0045 V
1000 V	300.000 V	299.983 V to 300.017 V

Verifying AC voltage

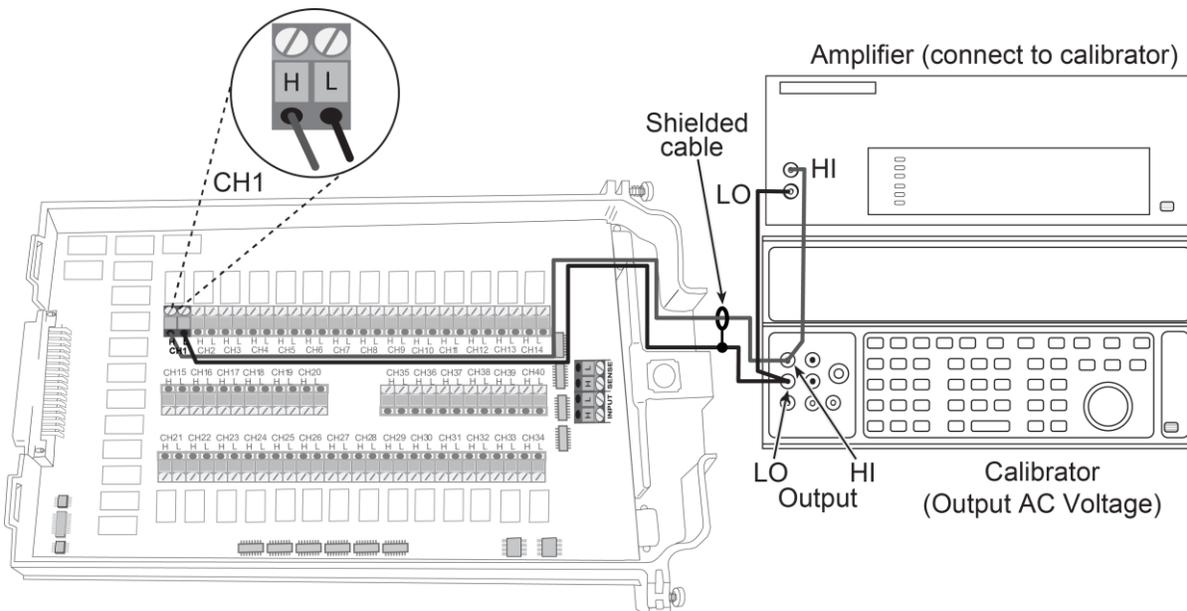
To check AC voltage accuracy, apply accurate AC voltages at specific frequencies from the AC voltage calibrator to the module inputs. Verify that the displayed readings fall within specified ranges.

CAUTION

Do not exceed 300 V_{RMS} between the INPUT H and L terminals or between adjacent channels, or 8×10^7 V·Hz input. Failure to observe this precaution may result in instrument damage.

To verify AC voltage accuracy:

1. Connect the CH1 H and L INPUT terminals of the module to the AC voltage calibrator, as shown in the next figure.



2. Install the module in Slot 1 of the DAQ6510.
3. Turn on the power.
4. Allow the instrument to warm up for one hour.
5. Make sure that the front-panel TERMINALS switch is set to **REAR**.
6. On the front panel of the instrument, select the **FUNCTION** key and then select **AC Voltage**.
7. On the Home screen, swipe to the **CHANNEL** swipe screen.
8. Close channel **101**.
9. Set the range to **100 mV**.
10. Swipe to the **Settings** screen.
11. Disable **Rel**.
12. Source 1 kHz and 50 kHz AC voltages for each of the ranges summarized in the table below. Make sure that the respective DAQ6510 readings are within stated limits.
13. Return to the **CHANNEL** swipe screen and open Channel 1.

ACV range	Applied AC voltage	1 kHz reading limits (1 year, 18 °C to 28 °C)	50 kHz reading limits (1 year, 18 °C to 28 °C)
100 mV	100.0000 mV	99.910 to 100.090 mV	99.830 to 100.170 mV
1 V	1.000000 V	0.99910 to 1.00090 V	0.99830 to 1.00170 V
10 V	10.00000 V	9.9910 to 10.0090 V	9.98300 to 10.0170 V
100 V	100.0000 V	99.910 to 100.090 V	99.830 to 100.170 V
750 V	300.000 V*	299.60 to 300.40 V	299.27 to 300.73 V

* If the 5725A amplifier is not available, change the 300 V @ 50 kHz step to 220 V @ 50 kHz. Reading limits for 220 V @ 50 kHz = 219.36 V to 220.64 V.

Verifying resistance

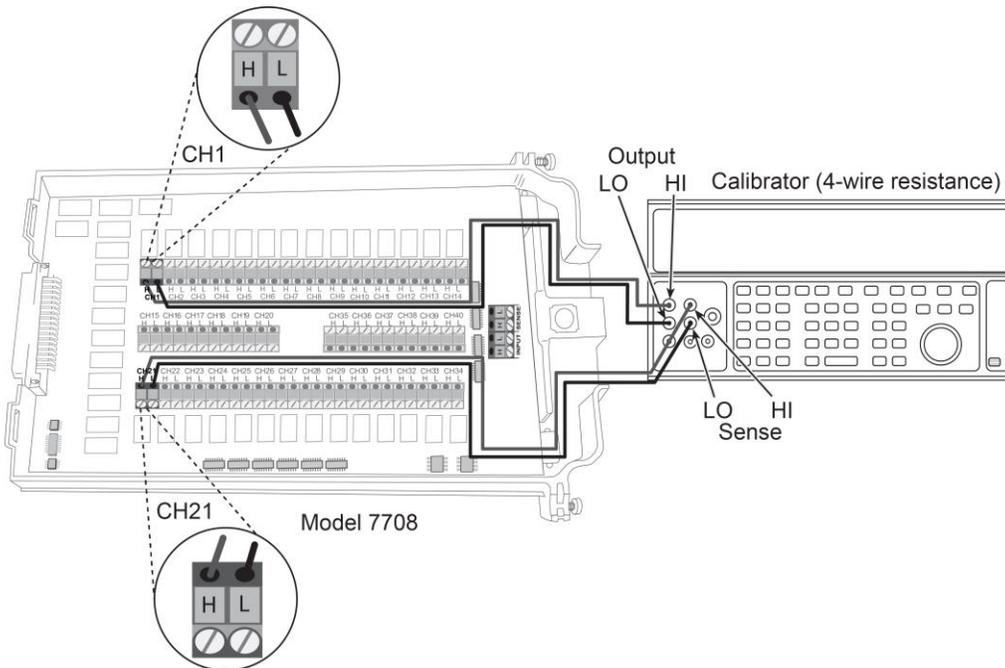
Check resistance by connecting accurate resistance values to the module and verifying that its resistance readings are within the specified limits.

CAUTION

Do not apply more than 300 VDC between the module **INPUT** or **SENSE H** and **L** terminal or between any adjacent channels. Failure to observe this precaution can cause instrument damage.

To verify resistance accuracy:

- Using shielded Teflon or equivalent cables in a 4-wire configuration, connect the 7700 CH1 H and L INPUT terminals and CH11 H and L SENSE terminals to the calibrator as shown in the next figure.

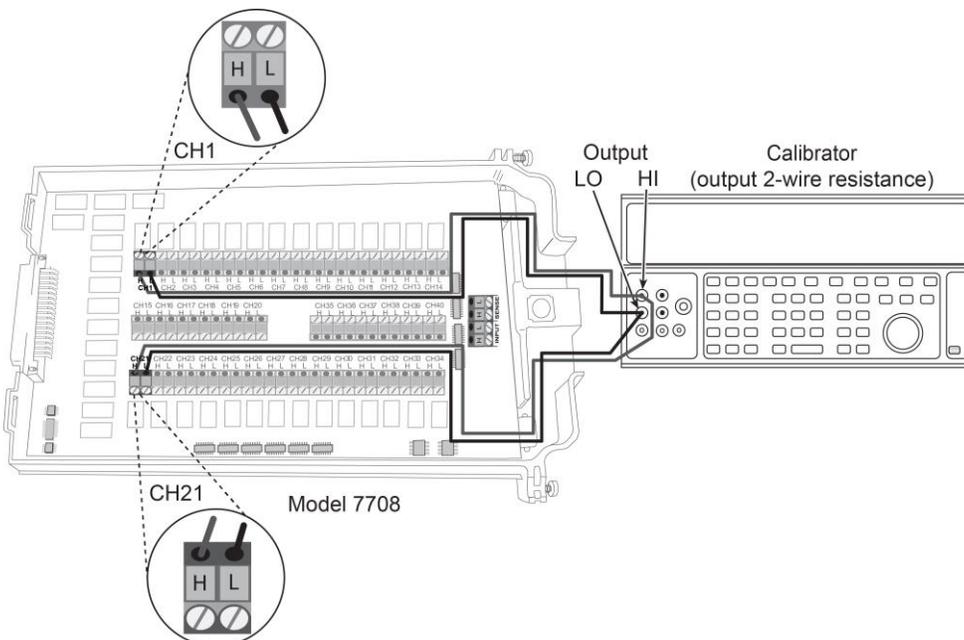


- Install the module in Slot 1 of the DAQ6510.
- Turn on the power.
- Allow the instrument to warm up for one hour.
- Make sure that the front-panel **TERMINALS** switch is set to **REAR**.
- Set the calibrator for 4-wire resistance with external sense on.
- On the front panel of the instrument, select the **FUNCTION** key and then select **4W Resistance**.
- On the Home screen, swipe to the **CHANNEL** swipe screen.
- Set the range to 100 Ω range.
- Swipe to the **Settings** screen.
- Enable the **Filter**.
- For the 100 Ω range, select the **MENU** key, select **Channel Settings**, and set Offset Compensation to **On**.
- Recalculate reading limits based on actual calibrator resistance values.
- Source the nominal full-scale resistance values for the 100 Ω to 10 M Ω ranges listed in the table below. Verify that the readings are within calculated limits.

Ω Range	Nominal resistance	Nominal reading limits (1 year, 18°C to 28°C)	Recalculated limits**
1 Ω^*	1 Ω	0.999715 m Ω to 1.000285 Ω	_____ to _____ Ω
10 Ω	10 Ω	9.99895 m Ω to 10.00105 Ω	_____ to _____ Ω
100 Ω^*	100 Ω	99.9895 Ω to 100.0105 Ω	_____ to _____ Ω
1 k Ω	1 k Ω	0.999929 Ω to 1.000081 k Ω	_____ to _____ k Ω
10 k Ω	10 k Ω	9.99929 Ω to 10.00081 k Ω	_____ to _____ k Ω
100 k Ω	100 k Ω	99.9905 Ω to 100.0095 k Ω	_____ to _____ k Ω
1 M Ω	1 M Ω	0.999894 Ω to 1.000106 M Ω	_____ to _____ M Ω
10 M Ω	10 M Ω	9.99590 Ω to 10.00410 M Ω	_____ to _____ M Ω
100 M Ω	100 M Ω	99.7970 Ω to 100.2030 M Ω	_____ to _____ M Ω

* Enable offset compensation for the 100 Ω range.
 ** Calculate limits based on actual calibration resistance values and DAQ6510 one-year resistance accuracy specifications. See [Calculating resistance reading limits](#) (on page 14) for more information.

1. Connect the CH1 and CH11 terminals of the module to the calibrator as shown in the next figure.
2. Disable external sense on the calibrator.
3. Set the range of the DAQ6510 to 100 M Ω range.
4. Source a nominal 100 M Ω resistance value. Verify that the reading is within calculated limits for the 100 M Ω range.
5. Return to the **CHANNEL** swipe screen and open Channel 1.



Verifying temperature

Thermocouple, thermistor, and RTD temperature readings are derived from DC volts and resistance measurements, respectively. For that reason, it is not necessary to independently verify the accuracy of temperature measurements. If the DC volts and resistance functions meet or exceed specifications, temperature function accuracy is automatically verified.

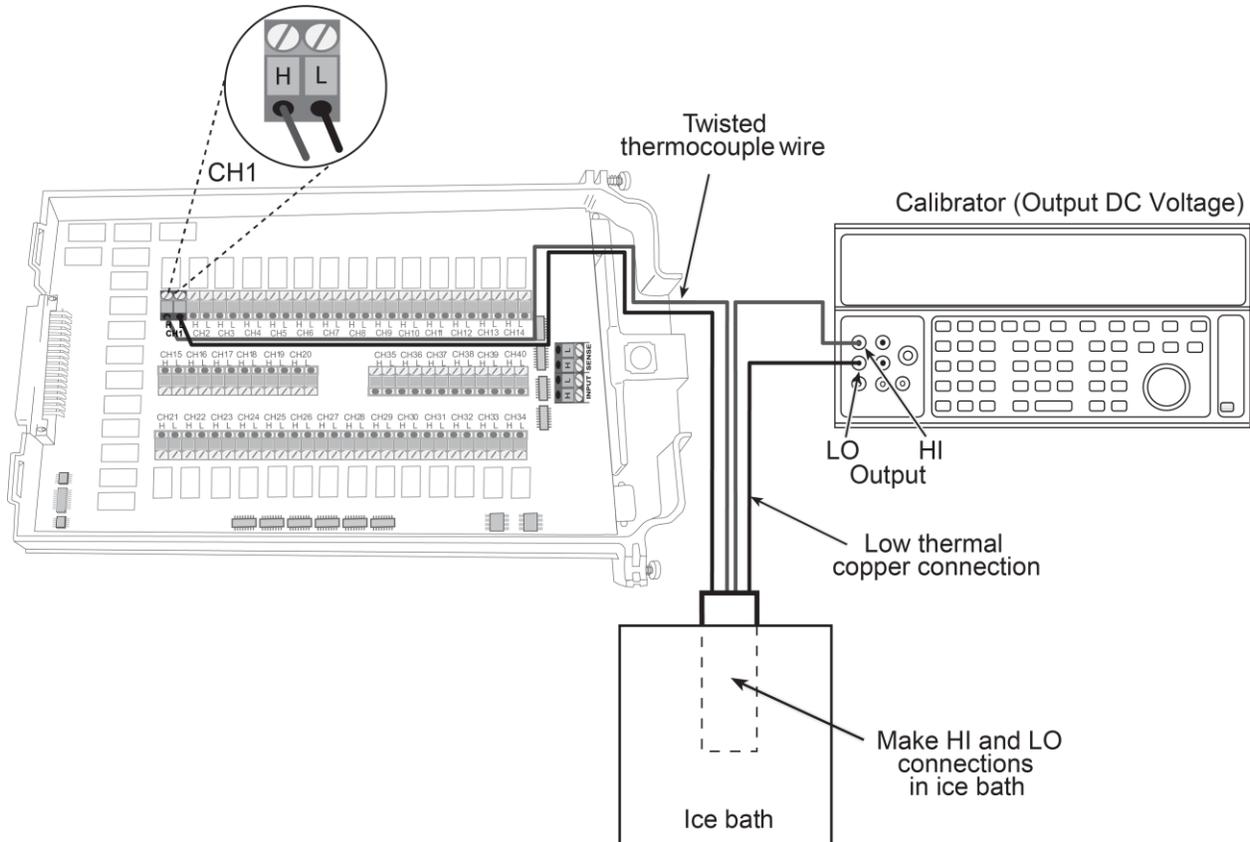
You can verify temperature accuracy using the following procedures.

Thermocouple temperature

This setup and reading limits table below does not include errors from ice point, thermocouple wire, and connections. HI and LO connections from the calibrator and 7700 must be electrically isolated from each other.

To verify the thermocouple temperature:

1. Connect the DC voltage calibrator output terminals and ice point reference to the CH1 H and L INPUT terminals of the module using low-thermal shielded connections, as shown in the next figure.



2. Install the module in Slot 1 of the DAQ6510.
3. Turn on the power.
4. Allow the instrument to warm up for one hour.
5. Make sure that the front-panel TERMINALS switch is set to **REAR**.
6. On the front panel of the instrument, select the **FUNCTION** key and then select **Temperature**.
7. On the Home screen, swipe to the **CHANNEL** swipe screen.
8. Close channel **101**.
9. Set the channel to temperature.
10. Configure the channel for °C units, thermocouple, and internal reference junction as follows:
 - a. Press the **MENU** key.
 - b. Select **Channel Settings**.
 - c. Set the Transducer to **TC**.
 - d. Set the Thermocouple to **K** or **J**.
 - e. Set the Unit to **Celsius**.
 - f. Set the Reference Junction to **Internal**.
11. Source each of the voltages in the table below based on the type of thermocouple used. Verify that the temperature readings are within limits.
12. Return to the **CHANNEL** swipe screen and open **Channel 1**.

Based on the type of thermocouple used, verify your data against the specifications in the following table.

Thermocouple type	Applied DC voltage*	Reading limits (1 year, 18 °C to 28 °C)
J	-7.659 mV	-192.33 °C to -187.67 °C
	0 mV	-1.0 °C to +1.0 °C
	42.280 mV	749.0 °C to 751.0 °C
K	-5.730 mV	-192.33 °C to -187.67 °C
	0 mV	-1.0 °C to +1.0 °C
	54.138 mV	1349.0 °C to 1351.0 °C

*Voltages shown are based on the ITS-90 standard.

RTD temperature

To verify the RTD temperature:

1. Connect the precision decade resistance box to the CH1 and CH11 H and L terminals of the module using four-wire connections. Refer to the first figure in Verifying resistance for connections.
2. Install the module in Slot 1 of the DAQ6510.
3. Turn on the power.
4. Allow the instrument to warm up for one hour.
5. Make sure that the front-panel TERMINALS switch is set to **REAR**.
6. On the front panel of the instrument, select the **FUNCTION** key and then select **Temperature**.
7. On the Home screen, swipe to the **CHANNEL** swipe screen.
8. Close channel **101**.
9. Set the channel to **Temperature**.
10. Configure the channel for °C units and RTD temperature sensor as follows:
 - a. Press the **MENU** key.
 - b. Select **Channel Settings**.
 - c. Set Transducer to **4-Wire RTD**.
 - d. Set 4-Wire RTD to **PT385**.
11. Source each of the voltages in the table below to verify that the temperature readings are within limits. Make sure to select the appropriate thermocouple type for each group of readings.
12. Set the decade resistance box to each of the values shown in the table below. Verify that the temperature readings are within the required limits.
13. Return to the **CHANNEL** swipe screen, and open **Channel 1**.

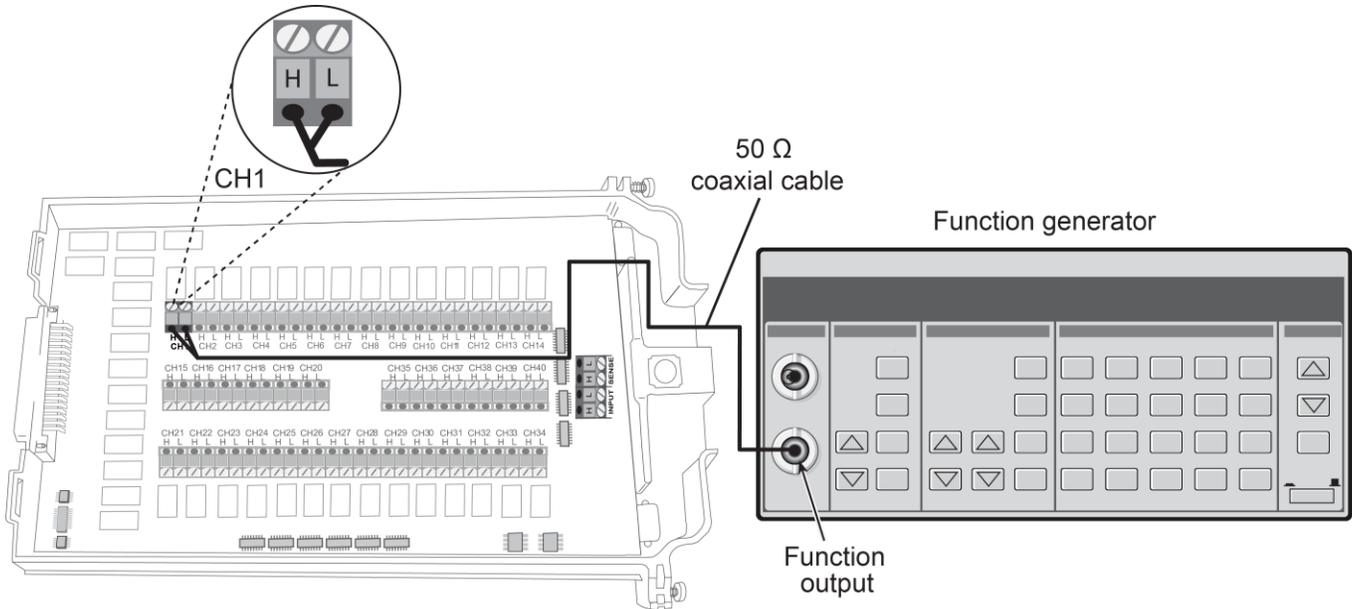
Applied resistance*	Reading limits (1 year, 18 °C to 28 °C)
22.80 Ω	-190.06 °C to -189.94 °C
100.00 Ω	-0.06 °C to +0.06 °C
313.59 Ω	599.94 °C to 600.06 °C

*Based on $\alpha = 0.00385$

Verifying frequency

To verify the module frequency:

1. Connect the function generator to the CH1 H and L INPUT terminals of the module. Refer to the next figure for more information.



2. Install the module in Slot 1 of the DAQ6510.
3. Turn on the power.
4. Allow the instrument to warm up for one hour.
5. Make sure that the front-panel TERMINALS switch is set to **REAR**.
6. Set the function generator to output a 1 kHz 1 V_{RMS} sine wave.
7. On the front panel of the instrument, select the **FUNCTION** key and then select **Frequency**.
8. On the Home screen, swipe to the **CHANNEL** swipe screen.
9. Close channel **101**.
10. Verify that the DAQ6510 frequency reading is between 0.9999 kHz and 1.0001 kHz.

Verifying ratio and average

Follow the procedure below to verify ratio and average.

CAUTION

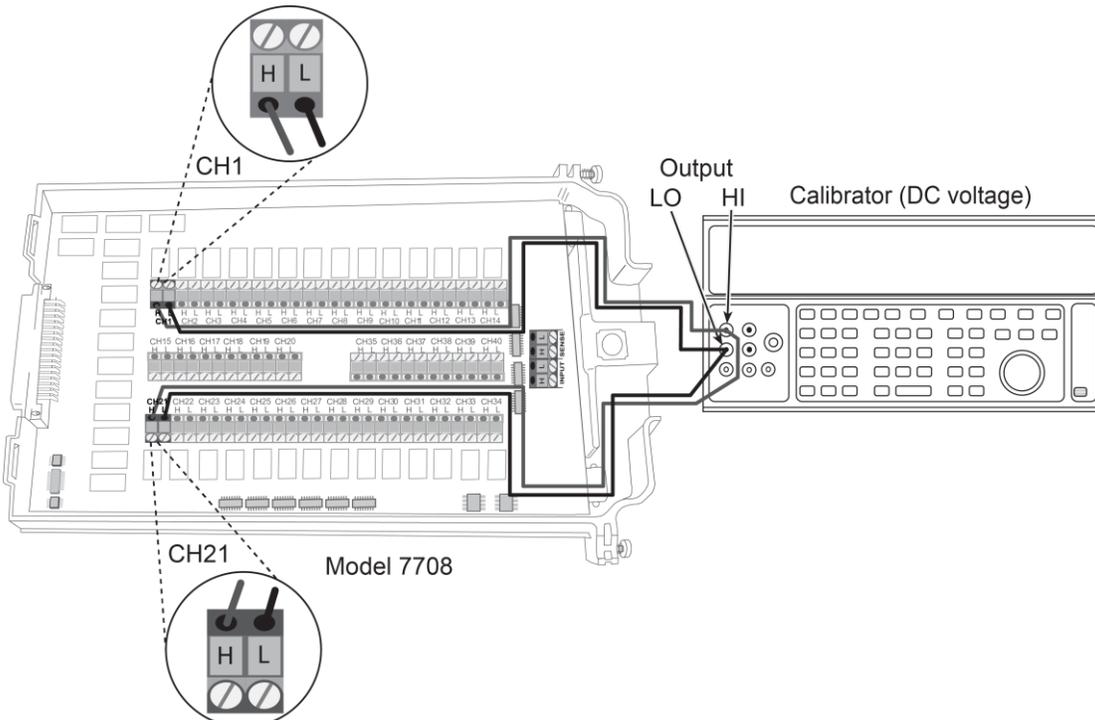
Do not exceed 300 VDC between plug-in module INPUT H and L terminals or between any adjacent channels. Failure to observe this precaution can cause instrument damage.

NOTE

Use shielded cables to minimize noise.

To verify ratio and average:

1. Connect the CH1 H and L INPUT terminals to the DC voltage calibrator as shown in the next figure.



2. Install the module in Slot 1 of the DAQ6510.
3. Turn on the power.
4. Allow the instrument to warm up for one hour.
5. Make sure that the front-panel TERMINALS switch is set to **REAR**.
6. On the front panel of the instrument, select **FUNCTION** and then select **DCV Ratio**.
7. On the Home screen, swipe to the **CHANNEL** swipe screen.
8. Close channel **101**.
9. Set the range to **1 V**.
10. Set the calibrator output to **1.00000 VDC**.
11. Allow the reading to settle.
12. Verify that the ratio reading is between 0.9999926 and 1.000074.
13. Return to the **CHANNEL** swipe screen and open **Channel 1**.

Range	Applied DC voltage	Reading limits (1 year, 18 °C to 28 °C)
100 mV	100.0000 mV	99.9935 to 100.0065 mV
1 V	1.000000 V	0.999969 to 1.000031 V
10 V	10.00000 V	9.99970 to 10.00030 V
100 V	100.0000 V	99.9955 to 100.0045 V
1000 V	300.000 V	299.983 V to 300.017 V

Calibration

The following procedure calibrates the temperature sensors on the modules.

WARNING

Do not attempt to perform this procedure unless qualified to do so. Failure to recognize and observe normal safety precautions could result in personal injury or death.

Recommended test equipment

To calibrate the module, you need the following equipment.

- Digital thermometer: 18 °C to 28 °C ± 0.1 °C
- Keithley 7797 Calibration/Extender Board

Extender board connections

The extender board is installed in the DAQ6510. The module is connected to the extender board externally to prevent heating of the module during calibration.

To make extender board connections:

1. Remove power from the DAQ6510.
2. Install the extender board into Slot 1 of the instrument.
3. Plug the module into the P1000 connector on the rear of the 7797 Calibration/Extender Board.

Calibration procedure

NOTE

Before calibrating the temperature on the module, make sure that power has been removed from the module for at least two hours to allow module circuitry to cool down. After turning on the power during the calibration procedure, complete the procedure as quickly as possible to minimize module heating that could affect calibration accuracy. Initially allow the DAQ6510 to warm up for at least one hour with the 7797 calibration card installed. If you are calibrating multiple modules sequentially, then power off the DAQ6510, quickly unplug the previously calibrated module, and plug in the next one.

You must use remote commands to run calibration. Refer to the DAQ6510 reference manual (document number DAQ6510-901-01) for information on setting up remote communications.

To set up calibration:

1. Turn on the DAQ6510 power.
2. To make sure that the instrument is using the SCPI command set, send:

```
*LANG SCPI
```

3. Turn power off, and turn power back on.
4. On the front panel, verify that TERMINALS is set to **REAR**.

To calibrate temperature:

1. Accurately measure and record the cold temperature of the module surface at the center of the module with the digital thermometer.
2. Unlock calibration by sending:

```
:CALibration:PROTECTED:CODE "KI006510"
```

3. Calibrate temperature on the module with the following command, where <temp> is the cold calibration temperature measured in step 1:

```
:CALibration:PROTECTED:CARD1:STEP0 <temp>
```

4. Send the following commands to save and lock out calibration:

```
:CALibration:PROTECTED:CARD1:SAVE
```

```
:CALibration:PROTECTED:CARD1:LOCK
```

Errors that can occur during calibration

If calibration errors occur, they are reported in the event log. You can review the event log from the front panel of the instrument, by using the SCPI `:SYSTEM:EVENTlog:NEXT?` command, or by using the TSP `eventlog.next()` command.

The error that can occur on this module is "5527, Temperature Cold Cal error." If this error occurs, contact Keithley Instruments. Refer to [Factory service](#) (on page 27).

Factory service

To return the switching module to Keithley Instruments for repair:

- Call the Repair Department at 1-800-833-9200 or send an email to RMAREQUEST@tektronix.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.

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 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 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. Maximum signal levels are defined in the specifications and operating information and shown on the instrument panels, test fixture panels, and switching cards.

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 hazard. 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 warning, 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 hazards 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.

The **CAUTION** heading with the  symbol in the user documentation explains hazards that could result in moderate or minor injury or damage the instrument. Always read the associated information very carefully before performing the indicated procedure. Damage to the instrument 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. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. The detachable mains power cord provided with the instrument may only be replaced with a similarly rated power cord. 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 to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call a Keithley office for information.

Unless otherwise noted in product-specific literature, Keithley instruments are designed to operate indoors only, in the following environment: Altitude at or below 2,000 m (6,562 ft); temperature 0 °C to 50 °C (32 °F to 122 °F); and pollution degree 1 or 2.

To clean an instrument, use a cloth dampened with deionized water 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 June 2017.