SCXI™-1321 Offset-Null and Shunt-Calibration High-Voltage Terminal Block Installation Guide

This guide describes how to install and use the SCXI-1321 offset-null and shunt-calibration terminal block with the SCXI-1121 module. You can only use the SCXI-1321 terminal block with SCXI-1121 revision C or later modules. In addition to the 18 screw terminals, the SCXI-1321 has circuitry for offset-null adjustment of Wheatstone bridges, and a socketed shunt resistor for strain-gauge shunt calibration. This terminal block was primarily designed for Wheatstone bridge transducers such as strain gauges, although it can easily accommodate thermocouples, RTDs, thermistors, millivolt sources, volt sources, and current-loop receivers. Thermocouples have cold-junction compensation (CJC) support.

Conventions

The following conventions are used in this guide:

» — The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.

This icon denotes a note, which alerts you to important information.

This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash. When this symbol is marked on the product, refer to the *Read Me First: Safety and Radio-Frequency Interference* document, shipped with the product, for precautions to take.

bold — Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.

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italic — Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. This font also denotes text that is a placeholder for a word or value that you must supply.

`monospace` — Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames and extensions, and code excerpts.

`monospace italic` — Italic text in this font denotes text that is a placeholder for a word or value that you must supply.

What You Need to Get Started

To set up and use the SCXI-1321, you need the following items:

- ❑ SCXI-1321 offset-null and shunt-calibration terminal block
- ❑ *SCXI-1321 Offset-Null and Shunt-Calibration High-Voltage Terminal Block Installation Guide Installation Guide*
- ❑ *Read Me First: Safety and Radio-Frequency Interference*
- ❑ SCXI chassis and documentation
- ❑ SCXI-1121 module (revision C or later) and documentation
- ❑ Numbers 1 and 2 Phillips screwdrivers
- ❑ 1/8 in. flathead screwdriver
- ❑ Long-nose pliers
- ❑ Wire cutter
- ❑ Wire insulation stripper

Connecting the Signals

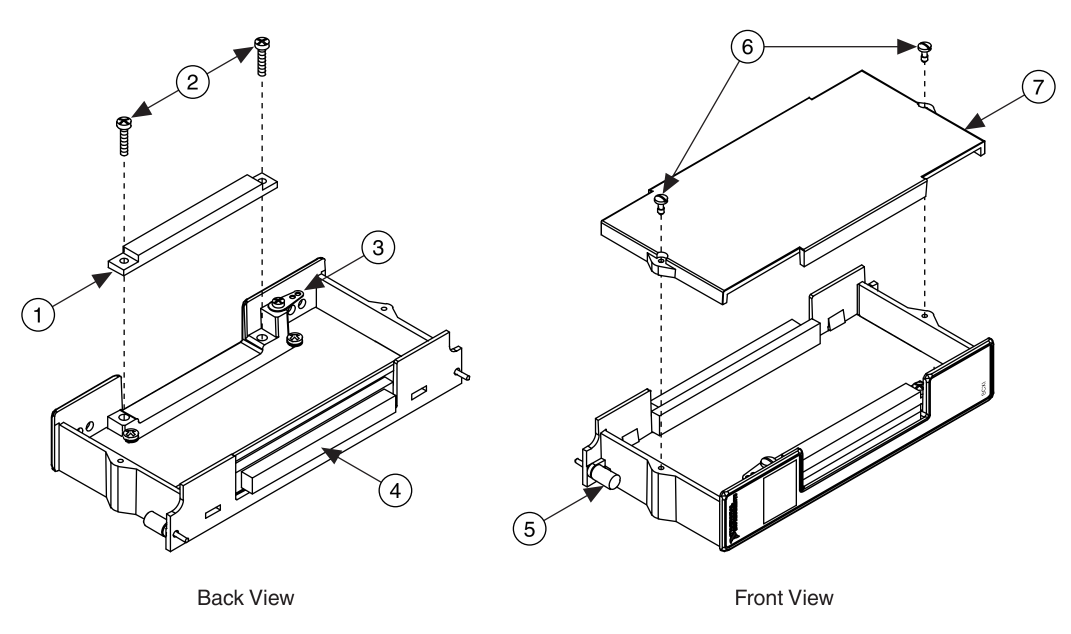
Note Refer to the *Read Me First: Safety and Radio-Frequency Interference* document before removing equipment covers, or connecting or disconnecting any signal wires.

To connect the signal to the terminal block, complete the following steps, referring to Figure 1 as necessary:

1. Unscrew the top-cover screws and remove the cover.
2. Loosen the strain-relief screws and remove the strain-relief bar.
3. Enable or bypass each of the nulling circuits, depending on the signal you are measuring.

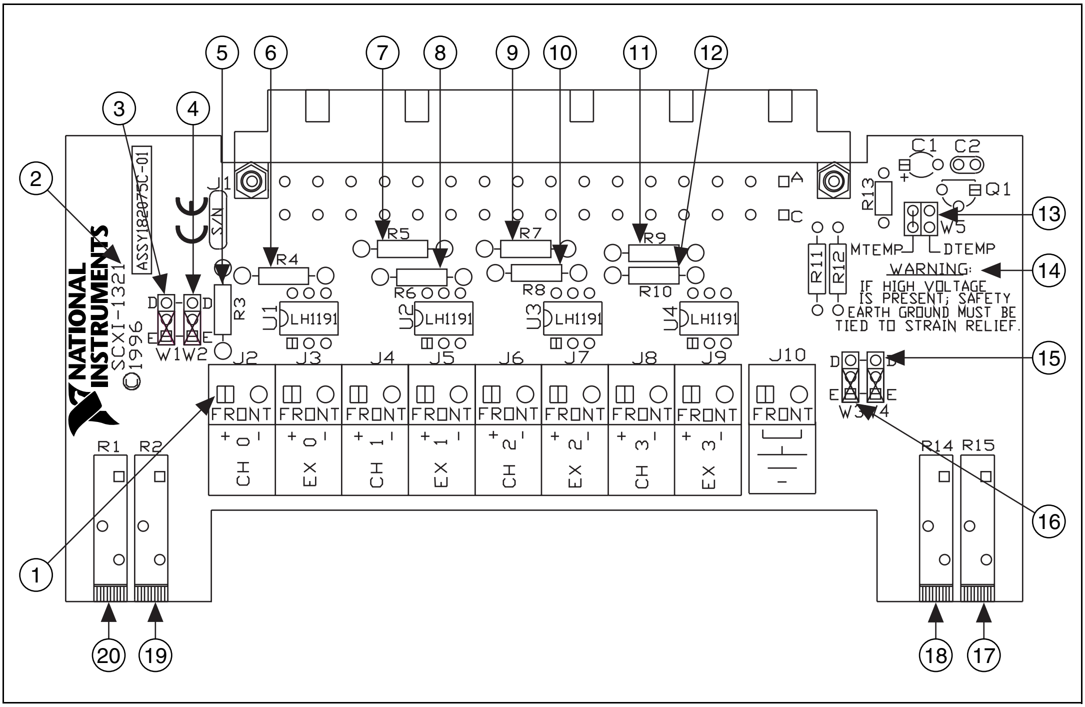
Note Disable the offset-nulling circuitry when you are not using a Wheatstone bridge or when the excitation channel of the SCXI-1121 is in current mode.

4. Run the signal wires through the strain-relief opening. You can add insulation or padding if necessary.
5. Prepare the signal wire by stripping the insulation no more than 7 mm (0.28 in.).
6. Connect the wires to the screw terminals by inserting the stripped end of the wire fully into the terminal. No bare wire should extend past the screw terminal. Exposed wire increases the risk of a short circuit and a hardware failure.
7. Tighten the screws to a torque of 0.57 to 0.79 newton-m (5 to 7 lb-in.).
8. Connect safety earth ground to the safety-ground lug. Refer to the *Read Me First: Safety and Radio-Frequency Interference* document for connection information.
9. Reinstall the strain-relief bar, and tighten the strain-relief screws.
10. Reinstall the top cover, and tighten the top-cover screws.
11. Connect the terminal block to the module front connector as explained in the *Installing the Terminal Block* section.



1	Strain-Relief Bar	3	Safety-Ground Lug	5	Thumbscrew	7	Top Cover
2	Strain-Relief Screws	4	Mating Connector	6	Top-Cover Screws		

Figure 1. SCXI-1321 Parts Locator Diagram



1 Screw Terminals	8 R6 (CH1 Shunt Resistor)	15 W4 CH3 Null Enabled)
2 Product Information	9 R7 (CH2 Null Resistor)	16 W3 (CH2 Null Enabled)
3 W1 (CH0 Null Enabled)	10 R8 (CH2 Shunt Resistor)	17 R15 (CH3 Null Potentiometer)
4 W2 (CH1 Null Enabled)	11 R9 (CH3 Null Resistor)	18 R14 (CH2 Null Potentiometer)
5 R3 (CH0 Null Resistor)	12 R10 (CH3 Shunt Resistor)	19 R2 (CH1 Null Potentiometer)
6 R4 (CH0 Shunt Resistor)	13 W5 (CJC Mode)	20 R1 (CH0 Null Potentiometer)
7 R5 (CH1 Null Resistor)	14 Warning Label	

Note: R3 through R10 are socketed.

Figure 2. SCXI-1321 Circuit Parts Locator Diagram

Installing the Terminal Block

To connect the terminal block to the SCXI module front connector, complete the following steps:

1. Connect the module front connector to its connector on the terminal block.
2. Make sure that the module top and bottom thumbscrews do *not* obstruct the rear panel of the terminal block.
3. Tighten the top and bottom screws on the back of the terminal block to hold it securely in place.
4. Refer to the *Performed or Supported Signal Conditioning* section for information on specific signal conditioning.

Note To minimize the temperature gradient inside the terminal block, move the SCXI chassis away from any extreme temperature differential.

Specifications

All specifications are typical at 25 °C unless otherwise specified.

Electrical

Cold-junction sensor

- Accuracy[1] ....0.9 °C
- Output..10 mV/°C from 0 to 55 °C

Resistors

- R_{SHUNT} ....301 kΩ ±1%
- R_{NULL} ....39 kΩ ±5%
- R_{TRIM} ....10 kΩ

Nulling potentiometer

- Range..0 to 10 kΩ
- Step size...infinite (user adjustable)

Mechanical

Resistor sockets

- Connecting lead size........................0.023 to 0.026 in.
- Connecting lead length....................0.110 to 0.175 in.
- Lead spacing...................................0.500 in.

Maximum Working Voltage

Maximum working voltage refers to the signal voltage plus the common-mode voltage.

Channel-to-earth ....300 V, Installation Category II

Channel-to-channel................................300 V, Installation Category II

[1] The temperature sensor accuracy includes tolerances in all component values caused by temperature and loading, and self-heating.

Environmental

Operating temperature .... 0 to 50 °C

Storage temperature .... –20 to 70 °C

Humidity .... 10 to 90% RH, noncondensing

Maximum altitude .... 2,000 meters

Pollution Degree (indoor use only) 2

Safety

The SCXI-1321 is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 3111-1, UL61010B-1
- CAN/CSA C22.2 No. 1010.1

Note For UL and other safety certifications refer to the product label or to `ni.com`.

Electromagnetic Compatibility

Emissions .... EN 55011 Class A at 10 meters; FCC Part 15A above 1 GHz

Immunity .... EN 61326:1997 + A2:2001, Table 1

EMC/EMI .... CE, C-Tick and FCC Part 15 (Class A) Compliant

Note For EMC compliance, operate this device with shielded cabling.

CE Compliance

The SCXI-1321 meets the essential requirements of applicable European Directives, as amended for CE Marking, as follows:

Low-Voltage Directive (safety) 73/23/EEC

Electromagnetic Compatibility Directive (EMC)89/336/EEC

Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, click **Declarations of Conformity Information** at `ni.com/hardref.nsf/`.

Performed or Supported Signal Conditioning

This section provides information on types of signal conditioning performed by the SCXI-1321 or is supported by it.

Offset Nulling

Offset nulling is a hardware nulling procedure used with Wheatstone-bridge transducers that have an initial offset error. Correcting this error improves measurement accuracy. The nulling circuitry operates with quarter-bridge, half-bridge, and full-bridge strain-gauge configurations. Each channel has its own nulling circuitry and its own trimming potentiometer as listed in Table 1.

Table 1. Trimmer Potentiometers and Corresponding Channels

Channel Number	Trimmer Potentiometer
0	R1
1	R2
2	R14
3	R15

To null the static offset voltage of the bridge, complete the following steps:

1. Connect the bridge configuration to the selected channel.
2. Select and read the channel output.
3. While monitoring the output, rotate the trimmer wiper with a flathead screwdriver until you reach 0 V.

You have nulled the bridge and are ready for a measurement.

The nulling range that is provided with the terminal block is ±2.5 mV, assuming that you have a 120 Ω strain gauge quarter-bridge configuration and 3.3 V excitation voltage. You can change this range by replacing the nulling resistor with a resistor of another value. Each channel has an independent socketed nulling resistor. Therefore, you can mix the ranges to accommodate each channel requirement. Table 2 lists the nulling resistors and their corresponding channels.

Table 2. Nulling Resistors and Corresponding Channels

Channel Number	Nulling Resistor
0	R3
1	R5
2	R7
3	R9

The factory default value of all the nulling resistors on the terminal block is 39 kΩ.

Note These resistors are socketed for easy replacement. These sockets best fit a 1/4 W resistor lead size.

To determine the nulling range, use the following formula while referring to Figures 3 through 5:

$$V_{nulling\ range} = \pm\left|\frac{V_{exc}}{2} - \frac{V_{exc}R_d(R_{null} + R_g)}{R_{null}R_g + R_d(R_{null} + R_g)}\right|$$

where

V_{exc} is the excitation voltage (3.3 V or 10 V)

R_d is either a completion resistor or a second strain-gauge nominal resistance

R_{null} is the nulling resistor value
(range of trim potentiometer + nulling resistor)

R_g is the nominal strain-gauge resistance value

For example,

$V_{nulling\ range} = \pm 2.56$ mV

$V_{exc} = 3.3$ V

$R_d = 120\ \Omega$

$R_{null} = 39\ k\Omega$

$R_g = 120\ \Omega$

Assuming a strain-gauge range with a gauge factor of GF = 2 and a quarter-bridge configuration, this range corresponds to ±1,498 με, as given by the strain formula for a quarter-bridge strain-gauge configuration:

$$\varepsilon = \frac{-4V_r}{GF(1 + 2V_r)}$$

where

$$V_r = \frac{\textit{strained voltage} - \textit{static unstrained voltage}}{V_{exc}}$$

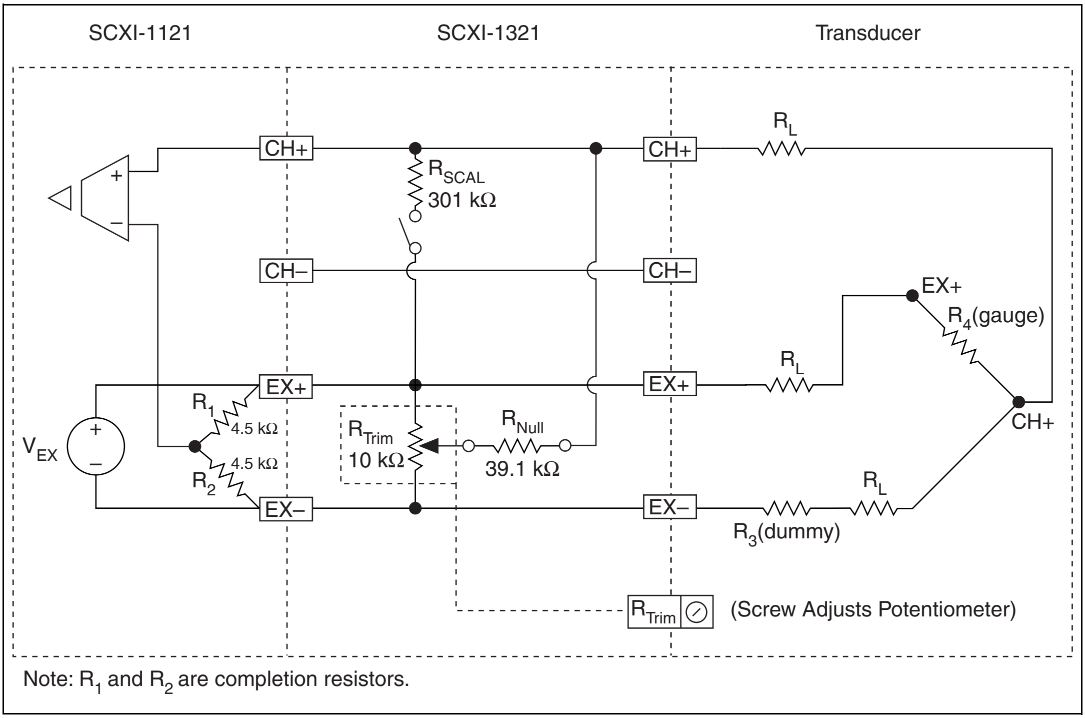


Figure 3. Quarter-Bridge Nulling Circuit

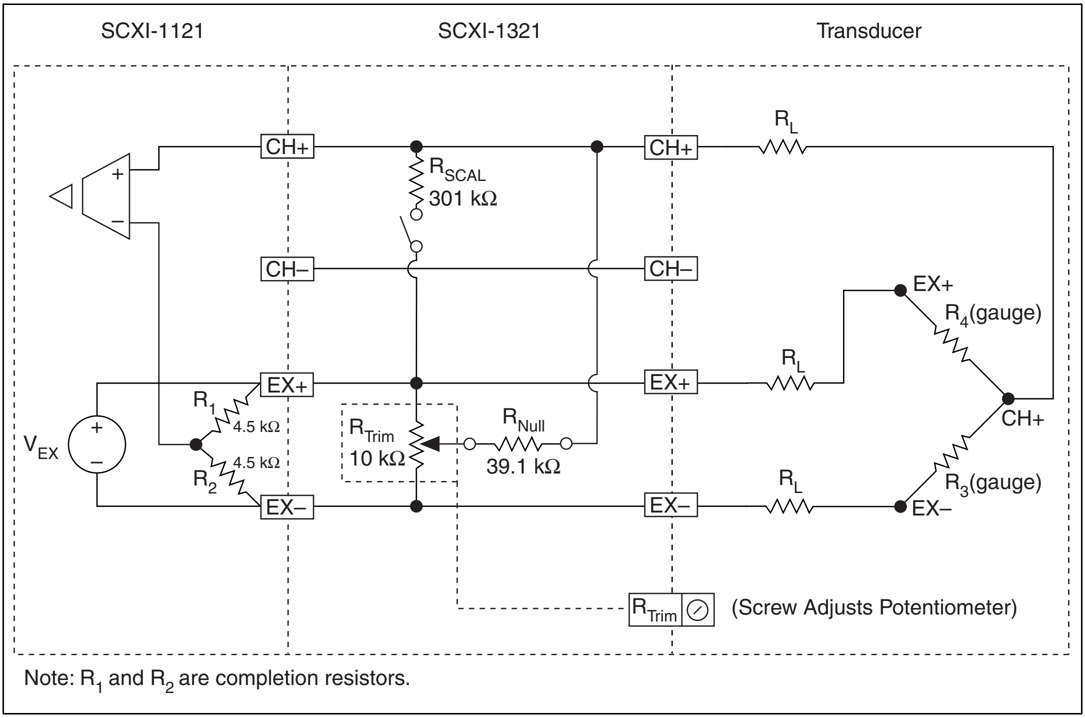


Figure 4. Half-Bridge Nulling Circuit

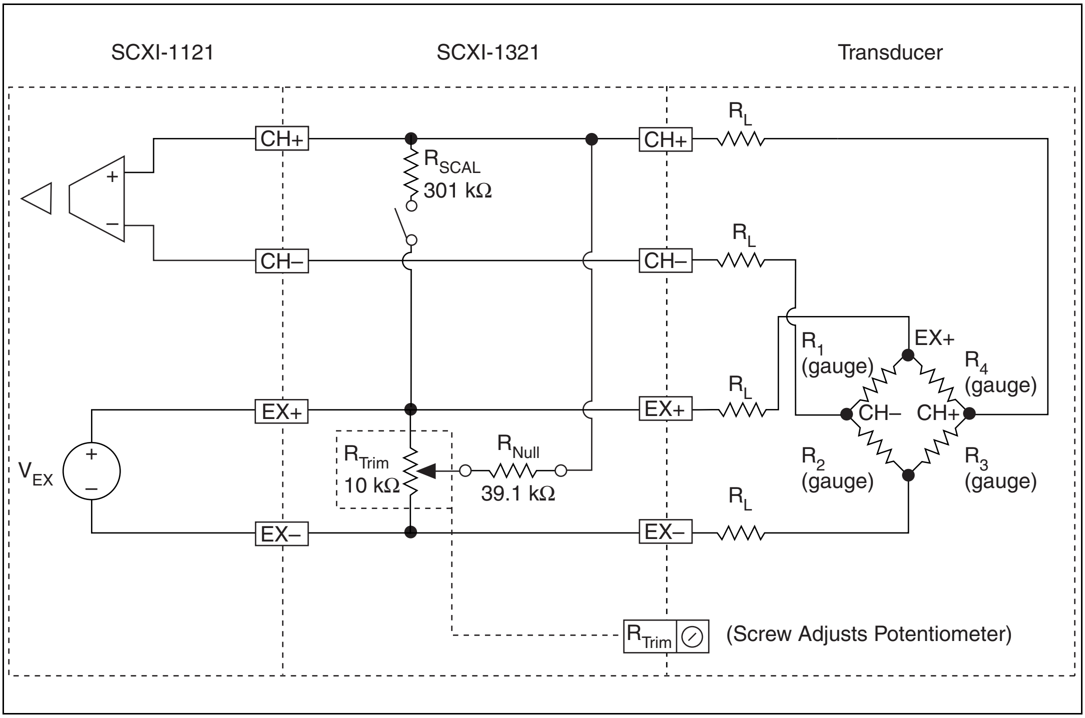


Figure 5. Full-Bridge Nulling Circuit

Shunt Calibration

Shunt calibration provides a method of adjusting for gain error to improve accuracy. The shunt-calibration circuitry configuration places a shunting resistor in parallel with the resistive element connected between EX+ and CH+ (element R4) of the Wheatstone bridge gauge, as shown in Figure 5. Shunt calibration circuits of each channel are independent from each other, although they are controlled together in software; therefore, when SCAL is engaged on a channel, all the shunt switches of the channels are closed. When SCAL is disengaged, all the switches are open. At startup or reset, all switches are open by default. You can control SCAL with the NI-DAQ function `SCXI_Calibrate_Setup`. Set the `Cal_Op` parameter to `2` for engaged or `0` for disengaged.

You can use LabVIEW to take measurements from channels with the shunt resistors connected by using the SCXI channel string
`obx ! scy ! mdz ! shuntw`.

where

x is the onboard channel number (0 for single chassis systems)

y is the chassis ID (1 by default)

z is the module slot of the SCXI-1121

w is the channel of the module that you want to engage the shunt and take measurements

For example, if you want to measure the voltage at channel 0 with the shunt resistor enabled, use the SCXI channel string `ob0 ! sc1 ! md1 ! shunt0`.

You also can specify a list of channels by using `ob0 ! sc1 ! md1 ! shunt0:w`, for example. Refer to the *LabVIEW Measurements Manual* for information on using SCXI channel strings.

The shunting resistors R_{SCAL} are socketed so that you can replace them with a resistor of another value to achieve the required nulling range for your application. The sockets and corresponding channels are shown in Table 3. The factory installed R_{SCAL} provided on the terminal block have a 301 kΩ ±1% value.

Table 3. Socket to Channel Relationship

Channel	Shunt Resistor Socket
0	R4
1	R6
2	R8
3	R10

Assuming a quarter-bridge strain-gauge configuration with a gauge factor of GF = 2, the equivalent strain change introduced by the R_{SCAL} shunting resistor is –199 με.

Refer to the *Traditional NI-DAQ User Manual* for more information on strain-gauge bridge configurations and formulas.

Use the following formula to determine the change due to this shunting resistor:

$$V_{change} = \frac{V_{ex}R_d(R_{SCAL} + R_g)}{R_gR_{SCAL} + R_d(R_{SCAL} + R_g)} - \frac{V_{ex}}{2}$$

Next, using the appropriate strain-gauge strain formula, and assuming that you have no static voltage, determine the equivalent strain the R_{SCAL} should provide. For example, R_{SCAL} = 301 kΩ and a quarter-bridge 120 Ω strain gauge with a gauge factor of GF = 2, V_{exc} = 3.3 V, and R = 120 Ω produces the following:

$$V_{change} = 0.3321 \text{ mV}$$

Replacing the strained voltage by V_{change} in the quarter-bridge strain equation produces an equivalent 199 με of change. Refer to the *NI-DAQ User Manual* for more information on voltage to strain conversion equations.

Cold-Junction Compensation

CJC is used only with thermocouples and provides improved accuracy of temperature measurements. The CJC temperature sensor, mounted in the SCXI-1321, outputs 10 mV/°C and has an accuracy of ±0.9 °C over the 0 to 55 °C temperature range. To determine the temperature, use the following formulas:

$$T\,(°C) = 100 \times V_{TEMPOUT}$$

$$T\,(°F) = \frac{T\,(°C) \times 9}{5} + 32$$

where $V_{TEMPOUT}$ is the temperature sensor output voltage, and *T (°F)* and *T (°C)* are the temperature readings in degrees Fahrenheit and degrees Celsius, respectively.

Note Use the average of a large number of samples to obtain the most accurate reading. Noisy environments require averaging for greater accuracy. You cannot use virtual channels to take the readings.

You can enable the CJC sensor in one of two ways depending on the input mode configuration of the SCXI-1121. Jumper W5 switches the temperature sensor output between MTEMP (multiplexed mode) and DTEMP (parallel mode) modes. In MTEMP mode, you must scan the cold-junction temperature independently of the other AI channels on the SCXI-1121 using the LabVIEW Getting Started Analog Input VI, available in `examples\daq\run_me.llb`, with the channel string `ob0 ! sc1 ! md1 ! mtemp`. This reads the temperature sensor on the terminal block connected to the module in slot 1 of SCXI chassis 1.

You then can average several measurements of the cold-junction temperature and use this average to compensate for the cold junction of the thermocouple. Using this averaging method compensates for temperature variations during the measurement period and makes the CJC temperature more accurate.

You can read a temperature at the beginning of the test and use that value with the data that follows. Using this method assumes that there are no temperature variations during the measurement period. If there are temperature variations, the measurements can be less accurate. You also can read the cold-junction temperature once per scan of the thermocouple channels.

Use the DTEMP mode if you are operating the SCXI-1121 in parallel mode. DTEMP uses CH4 analog input, therefore CH3 is not available.

RTD and Thermistor Excitation

By properly setting the excitation, you can configure the SCXI-1321 on a per channel basis for RTD and thermistor measurements. With the SCXI-1121 excitation set in the current mode, you must disable the nulling circuit of the channel of interest. You can do this in two steps:

1. Place the enable/disable jumper in position D (disable) as shown in Table 4.
2. Remove the nulling resistor from its sockets.

Table 4. Jumper Settings of the Nulling Circuits

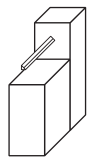
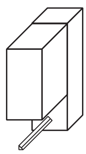
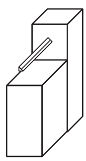
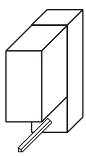
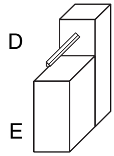
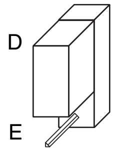
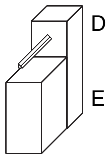
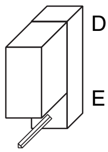
Jumper	Position	Description
W1		Nulling circuit of Channel 0 is enabled (factory default setting)
		Nulling circuit of Channel 0 is disabled
W2		Nulling circuit of Channel 1 is enabled (factory default setting)
		Nulling circuit of Channel 1 is disabled

Table 4. Jumper Settings of the Nulling Circuits (Continued)

Jumper	Position	Description
W3		Nulling circuit of Channel 2 is enabled (factory default setting)
		Nulling circuit of Channel 2 is disabled
W4		Nulling circuit of Channel 3 is enabled (factory default setting)
		Nulling circuit of Channel 3 is disabled

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