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

This guide describes how to install and use the SCXI-1321 offset-null and shunt-calibration terminal block with your SCXI-1121 module.

Introduction

You can only use the SCXI-1321 terminal block with SCXI-1121 revision C and later revisions. The SCXI-1321 terminal block has a shielded board with supports for connection to the SCXI-1121 input connector. In addition to the 18 screw terminals, the SCXI-1321 has circuitry for offset-null adjustment of Wheatstone bridges, and a shunt resistor for strain-gauge shunt calibration. This terminal block was primarily designed for bridge-type transducers such as strain gauges. The SCXI-1321 can also easily accommodate thermocouples, RTDs, thermistors, millivolt sources, volt sources, and current-loop receivers.

What You Need to Get Started

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

- ❑ SCXI-1321 offset-null and shunt-calibration terminal block
- ❑ *SCXI-1321 Offset-Null and Shunt-Calibration Terminal Block Installation Guide*
- ❑ SCXI chassis
- ❑ SCXI-1121 module
- ❑ No. 1 and No. 2 Phillips-head screwdrivers
- ❑ $^{1}/_{8}$ in. flathead screwdrivers

- ❑ Long-nose pliers
- ❑ Wire cutter
- ❑ Wire insulation stripper

Safety Information

Cautions ***DO NOT OPERATE THE DEVICE IN AN EXPLOSIVE ATMOSPHERE OR WHERE THERE MAY BE FLAMMABLE GASES OR FUMES.***

KEEP AWAY FROM LIVE CIRCUITS. Do not remove equipment covers or shields unless you are trained to do so. If signal wires are connected to the device, hazardous voltages may exist even when the equipment is turned off. To avoid a shock hazard, do not perform procedures involving cover or shield removal unless you are qualified to do so and disconnect all field power prior to removing covers or shields.

Equipment described in this document must be used in an Installation Category II environment per IEC 664. This category requires local level supply mains-connected installation.

DO NOT OPERATE DAMAGED EQUIPMENT. The safety protection features built into this device can become impaired if the device becomes damaged in any way. If the device is damaged, turn the device off and do not use until service-trained personnel can check its safety. If necessary, return the device to National Instruments for service and repair to ensure that its safety is not compromised.

Do not operate this equipment in a manner that contradicts the information specified in this document. Misuse of this equipment could result in a shock hazard.

Terminals are for use only with equipment that has no accessible live parts.

DO NOT SUBSTITUTE PARTS OR MODIFY EQUIPMENT. Because of the danger of introducing additional hazards, do not install unauthorized parts or modify the device. Return the device to National Instruments for service and repair to ensure that its safety features are not compromised.

When using the device with high common-mode voltages, you MUST insulate your signal wires for the highest input voltage. National Instruments is NOT liable for any damages or injuries resulting from inadequate signal wire insulation. Use only 26-14 AWG wire with a voltage rating of 300 V and 60° C for measuring 250 to 300 V.

When connecting or disconnecting signal lines to the SCXI terminal block screw terminals, make sure the lines are powered off. Potential differences between the lines and the SCXI ground create a shock hazard while you connect the lines.

Connections, including power signals to ground and vice versa, that exceed any of the maximum signal ratings on the SCXI device can create a shock or fire hazard or can damage any or all of the boards connected to the SCXI chassis, the host computer, and the SCXI device. National Instruments is NOT LIABLE FOR ANY DAMAGES OR INJURIES resulting from incorrect signal connections.

If high voltages (≥30 Vrms and 42.4 V peak or 60 VDC) are present, YOU MUST CONNECT A SAFETY EARTH GROUND WIRE TO THE TERMINAL BLOCK SAFETY GROUND SOLDER LUG, shown in Figure 1. This complies with safety agency requirements and protects against electric shock when the terminal block is not connected to the chassis. To connect the safety earth ground to the safety ground solder lug, run an earth ground wire in the cable from the signal source to the terminal block. National Instruments is NOT liable for any damages or injuries resulting from inadequate safety earth ground connections.

Do not loosen or re-orient the safety ground solder lug hardware when connecting the safety ground wire; to do so reduces the safety isolation between the high voltage and safety ground.

Temperature Sensor Output and Accuracy

The temperature sensor 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:

$$T\ (°C) = 100 \times V_{TEMPOUT}$$

$$T\ (°F) = T\ (°C) \times 9/5 + 32$$

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.***

Using the Nulling Circuitry and the Shunt Calibration

SCXI-1321 Nulling Circuitry

The nulling circuitry operates with full-bridge, half-bridge, quarter-bridge, and 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, use the following procedure:

1. Hook up your 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 your bridge and are ready for a measurement.

The nulling range that is provided with your terminal block is ±2.5 mV, assuming that you have a 120 Ω strain gauge quarter-bridge configuration and 3.333 V excitation voltage. You can change this range by replacing the nulling resistor with a resistor your choice of another value. Each channel has an independent nulling resistor. You can therefore mix your 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 value of all the nulling resistors on your terminal block is 39 kΩ. Notice that these resistors are socketed for easy replacement. These sockets best fit a $^1/_4$ W resistor lead size.

To determine your nulling range, use the following formula (refer to Figure 1 for visual help):

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

where

R_g is the nominal strain gauge resistance value.

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

R_{null} is the nulling resistor value.

V_{exc} is the excitation voltage (3.333 V or 10 V).

For example, assuming:

$V_{exc} = 3.333$ V

$R_g = 120\ \Omega$

$R_d = 120\ \Omega$

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

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

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

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

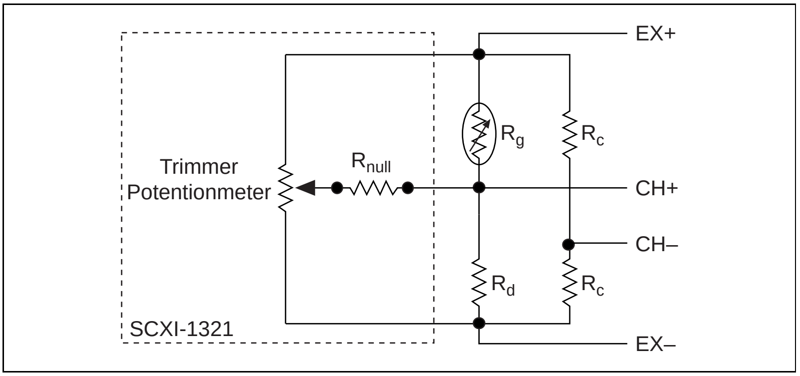


Figure 1. Nulling Circuit

Note ***R_c stands for the completion resistors.***

Using the SCXI-1321 with RTDs and Thermistors

When using this terminal block with RTDs or thermistor-type transducers and 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 3.
2. Remove the nulling resistor from its sockets.

Table 3. Jumper Settings of the Nulling Circuits

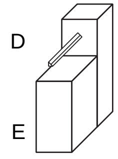
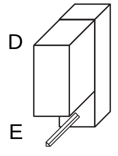
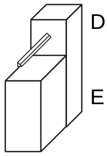
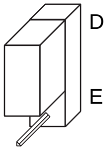
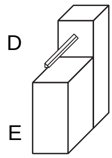
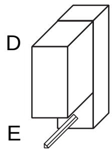
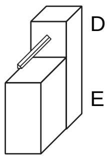
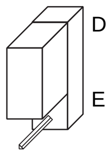
Jumper	Position	Description
W1		Nulling circuit of Channel 0 is enabled; factory setting
		Nulling circuit of Channel 0 is disabled

Table 3. Jumper Settings of the Nulling Circuits (Continued)

Jumper	Position	Description
W2		Nulling circuit of Channel 1 is enabled; factory setting
		Nulling circuit of Channel 1 is disabled
W3		Nulling circuit of Channel 2 is enabled; factory setting
		Nulling circuit of Channel 2 is disabled
W4		Nulling circuit of Channel 3 is enabled; factory setting
		Nulling circuit of Channel 3 is disabled

SCXI-1121 Shunt Calibration

Shunt calibration circuits are independent from each other but are controlled together. In other words, when SCAL is set to 1 on the SCXI-1121, all the shunt switches close; when SCAL is cleared to 0, all the switches open. At startup or reset, all switches are open. This shunt calibration circuitry configuration places a shunting resistor in parallel with the strain gauge, as shown in Figure 2.

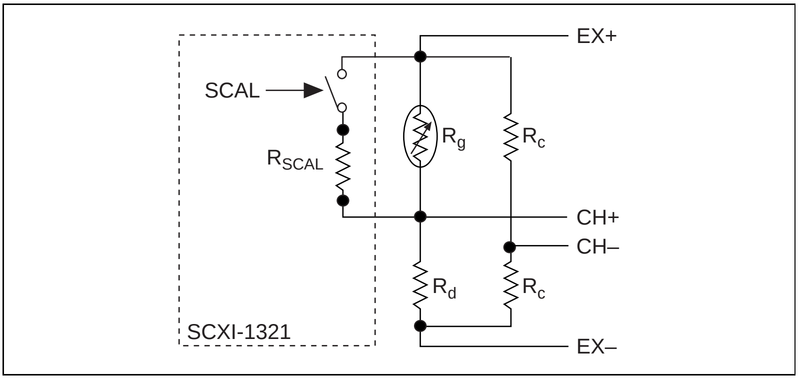


Figure 2. Shunt Circuit

The shunting resistors R_{SCAL} are socketed so that you can replace them with a resistor of another value to achieve the required changes. The R_{SCAL} provided on your terminal block have a 301 kΩ ±1% value.

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.

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

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

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 and V_{exc} = 3.333 V and R = 120Ω 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.

Using Shunt Calibration with National Instruments Software

If you are using LabVIEW for Windows 2.5.2 or LabVIEW 3.0, use the channel string `shunt`*x* to enable shunt calibration. If you are using NI-DAQ or LabVIEW 2.2.1 or earlier versions, use the `SCXI_Calibrate_Setup` function or VI. If you are using register-level code to program the SCXI-1121 and the SCXI-1321, you must write to the SCAL register yourself.

Signal Connection

Note ***Refer to the*** *Safety Information* ***section before removing equipment covers or connecting or disconnecting any signal wires.***

When connecting your signals to the SCXI-1321, follow the labeling on the SCXI-1321 for the appropriate module, as indicated in Figure 2.

To connect the signal to the terminal block, perform the following steps, referring to Figures 1 and 2 as necessary:

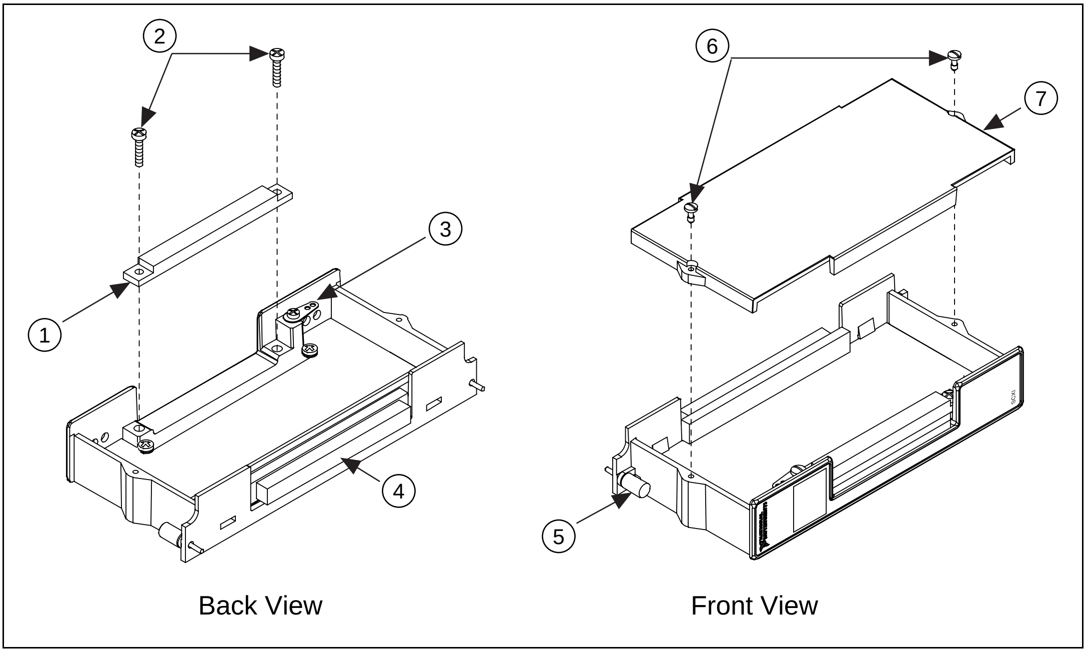
1. Unscrew the top cover screws and remove the cover.
2. Loosen the strain-relief screws and remove the strain-relief bar.
3. Enable or bypass each of the nulling circuits, depending on the signal you are measuring.

Note ***For correct operation of the SCXI-1121 excitation channels, disable the nulling circuit on the excitation channels when you are using the SCXI-1321 with the SCXI-1121.***

4. Run the signal wires through the strain-relief opening. You can add insulation or padding if necessary.
5. Prepare your signal wire by stripping the insulation no more than 7 mm.
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 shorting and causing a failure.
7. Tighten the screws to a torque of 5–7 in.-lb.
8. Connect safety earth ground to the safety ground solder lug. Refer to the *Safety Information* section 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 *Installation* section later in this guide.

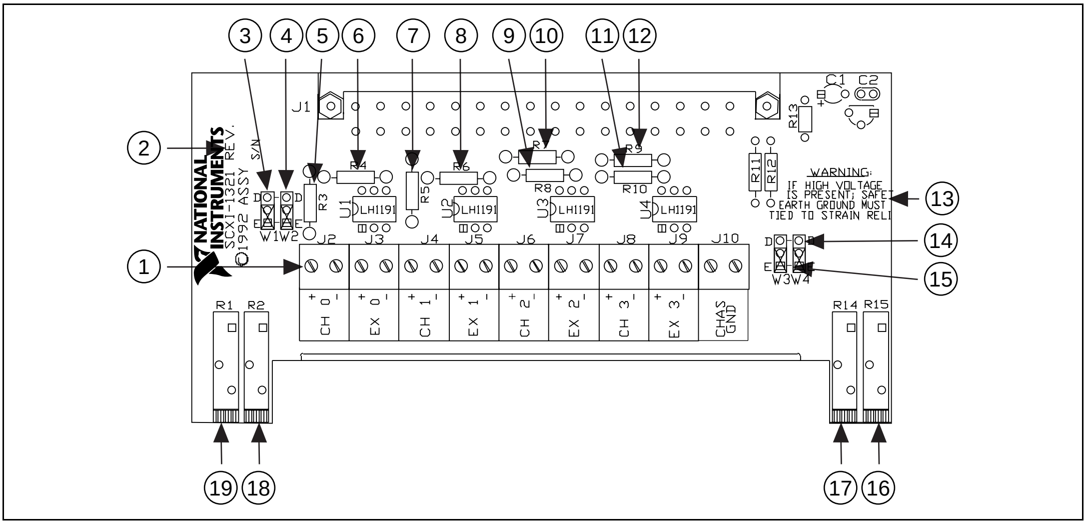
Figure 3 shows the SCXI-1321 terminal block parts locator diagram.



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

Figure 3. SCXI-1321 Parts Locator Diagram

Figure 4 shows the SCXI-1321 signal connections.



1	Screw Terminals	6	R4	12	R10	17	R14
2	Product Name, Assembly Number, Revision Letter, and Serial Number	7	R5	13	Warning Label	18	R2
3	W1	8	R6	14	W3	19	R1
4	W2	9	R7	15	W4		
5	R3	10	R8	16	R15		
		11	R9				

Figure 4. SCXI-1321 Signal Connections

Installation

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

1. Connect the module front connector to its mating 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.

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

Cleaning the Terminal Block

Clean the terminal block by brushing off light dust with a soft, nonmetallic brush. Remove other contaminants with deionized water and a stiff nonmetallic brush. The unit must be completely dry and free from contaminants before returning to service.

Specifications

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

Cold-junction sensor

Accuracy[1] ....0.9° C

Output..10 mV/°C from 0° to 55° C

Maximum voltage between any terminals or to earth.................................250 Vrms

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

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