TBX-1328 High-Accuracy Isothermal Terminal Block Installation Guide

This guide describes how to install and use the TBX-1328 high-accuracy isothermal terminal block with the SCXI-1120/D, SCXI-1121, SCXI-1125, or SCXI-1126 modules. Table 1 shows the signals you can use with each module.

Table 1. SCXI Module and Signal Compatibility

Module	Millivolts/Volts	Medium Voltage (60 V)	High Voltage (250 V/1,000 V)	Current (4 to 20 mA)	Frequency to Voltage	Thermocouple	RTD/Thermistor	Strain Gauge	Force, Load, Torque
SCXI-1120	Yes	Yes	Yes	Yes	No	Yes	No	No	No
SCXI-1120D	Yes	Yes	Yes	Yes	No	No	No	No	No
SCXI-1121	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
SCXI-1125	Yes	Yes	Yes	Yes	No	Yes	No	No	No
SCXI-1126	Yes	Yes	Yes	Yes	Yes	No	No	No	No

The TBX-1328 high-accuracy isothermal terminal block is a DIN-rail mountable, shielded terminal block with screw terminals to connect to the SCXI-1120/D, SCXI-1121, SCXI-1125, or SCXI-1126 front connector. The TBX-1328 has a high-precision thermistor for precise cold-junction compensation and isothermal copper planes that minimize the temperature gradients across the screw terminals when you take thermocouple measurements. The TBX-1328 mounts on most European standard DIN EN mounting rails.

The terminal block has 24 screw terminals for easy signal connection. Eight screw terminals connect to the SCXI chassis ground through the shield of the SH32-32-A cable. With the SCXI-1120/D, SCXI-1125, or SCXI-1126, the remaining eight pairs of screw terminals connect signals to the eight

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SCXI module input channels. With the SCXI-1121, four pairs of screw terminals connect signals to the four SCXI module input channels and four pairs connect to the SCXI module excitation channels. There are eight resistor sockets, R<0..7>, for use with the 4 to 20 mA current input.

Conventions

The following conventions are used in this guide:

<> — Angle brackets that contain numbers separated by an ellipsis represent a range of values associated with a bit or signal name—for example, DIO<3..0>.

» — 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.

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

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 TBX-1328, you need the following items:

- ❑ TBX-1328 high-accuracy isothermal terminal block
- ❑ *TBX-1328 High-Accuracy Isothermal Terminal Block Installation Guide*
- ❑ *Read Me First: Safety and Radio-Frequency Interference*

- ❑ SCXI chassis and documentation
- ❑ One of the following modules and its documentation:
  - – SCXI-1120/D
  - – SCXI-1121
  - – SCXI-1125
  - – SCXI-1126
- ❑ SH32-32-A shielded cable assembly that includes the TBX cable adapter
- ❑ 3/16 in. wrench
- ❑ Numbers 1 and 2 Phillips screwdrivers
- ❑ 1/8 in. flathead screwdriver
- ❑ Long-nose pliers
- ❑ Wire cutter
- ❑ Wire insulation stripper

Note You can download any NI document from `ni.com/manuals`.

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 field signals to the TBX-1328 for use with the SCXI-1120 or SCXI-1121, follow the labeling on the TBX-1328 indicated along with the appropriate SCXI module type column as shown in Figure 1. For the SCXI-1120D, SCXI-1125, and SCXI-1126 modules, use the SCXI-1120 label.

To connect the signals, complete the following steps, referring to Figures 1 through 3 as necessary:

1. Remove the TBX-1328 terminal block cover by unscrewing the four captive cover screws in the cover corners. These screws stay attached to the cover without falling out.
2. Connect the signal wires to the screw terminals. Refer to the SCXI module user manual for examples of how to connect to field signals and loads. The chassis ground terminals are connected to the SCXI

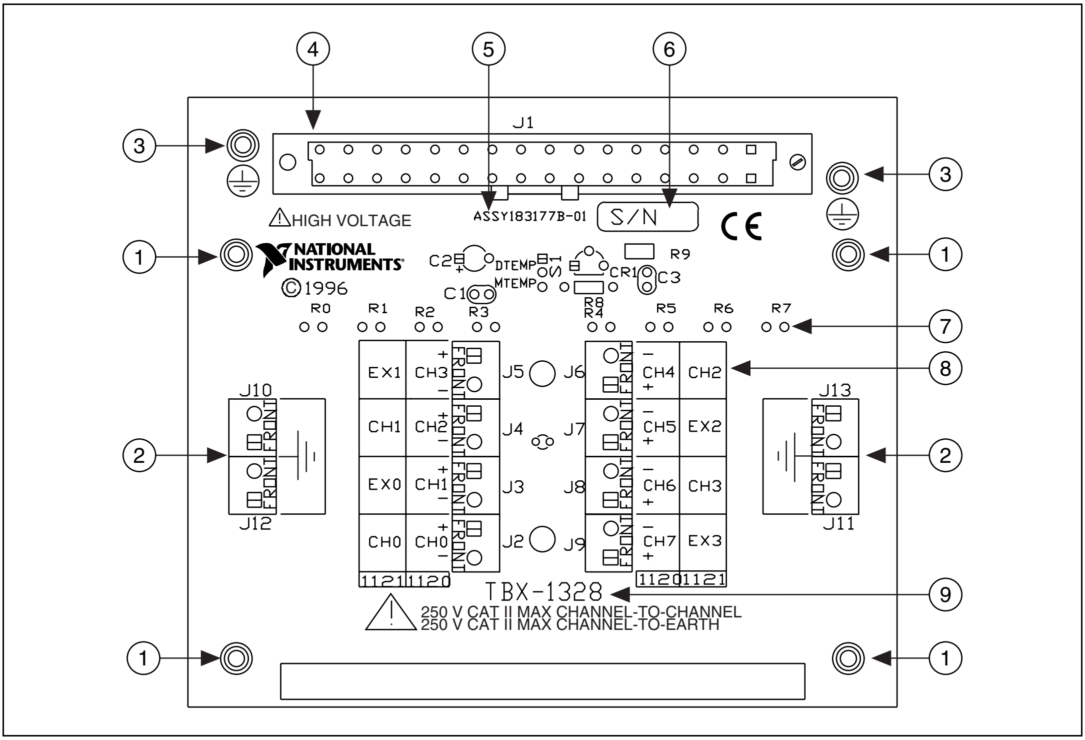
chassis through the cable shield. This connection is not shown in the SCXI module user manual. Allow the signal wires to exit through the TBX-1328 cover opening.

Notes When using the SCXI-1121 module to measure current, you must populate R<0...7>, which corresponds to CH<0...7>. Since the SCXI-1121 can measure a maximum current of 20 mA, the minimum usable resistor value is R = 10 V ÷ 20 mA = 500 Ω.

This terminal block does not provide strain relief for field signal wires. Add strain relief, insulation, and padding for the wires, if necessary.

3. Replace the TBX-1328 terminal block cover and tighten the captive cover screws.

The signal connection is now complete.



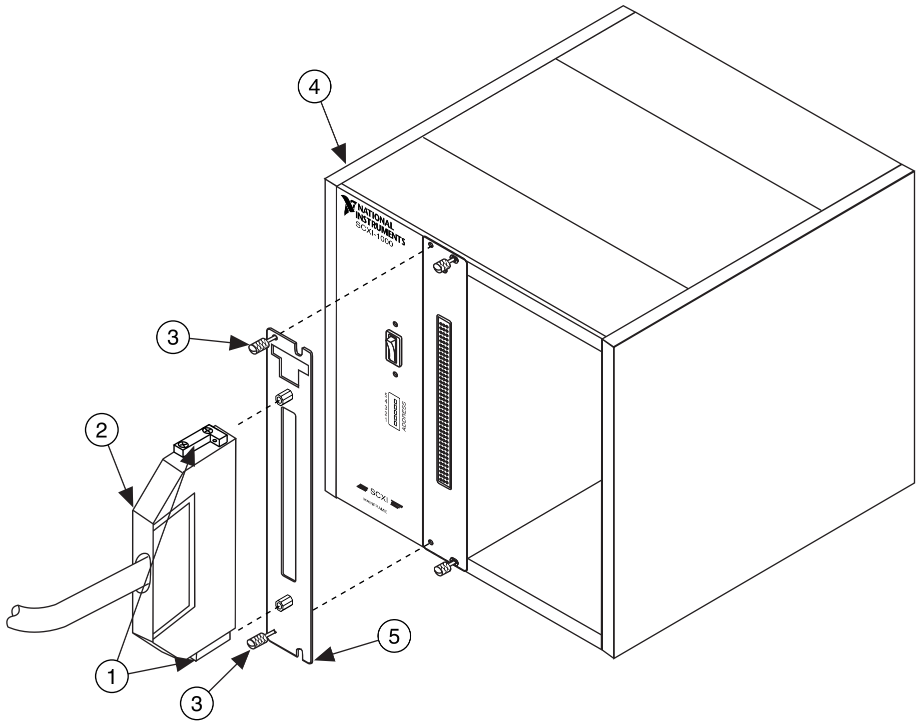
1	Cover Mounting Nut	6	Serial Number
2	Chassis Ground Screw Terminals	7	Current–Receiver Resistor Sockets R<0..7> = Channel<0..7>
3	Backshell Mounting Kit	8	Signal Wire Screw Terminals
4	Cable Connector	9	Product Name
5	Assembly Number		

Figure 1. TBX-1328 Terminal Block Parts Locator Diagram

Installing the Terminal Block and Cable Assembly

After completing the *Connecting the Signals* section, you can install the terminal block. Complete the following steps to mount the SH32-32-A cable assembly and connect the TBX-1328 to the SCXI module while referring to Figures 2 through 4 as needed.

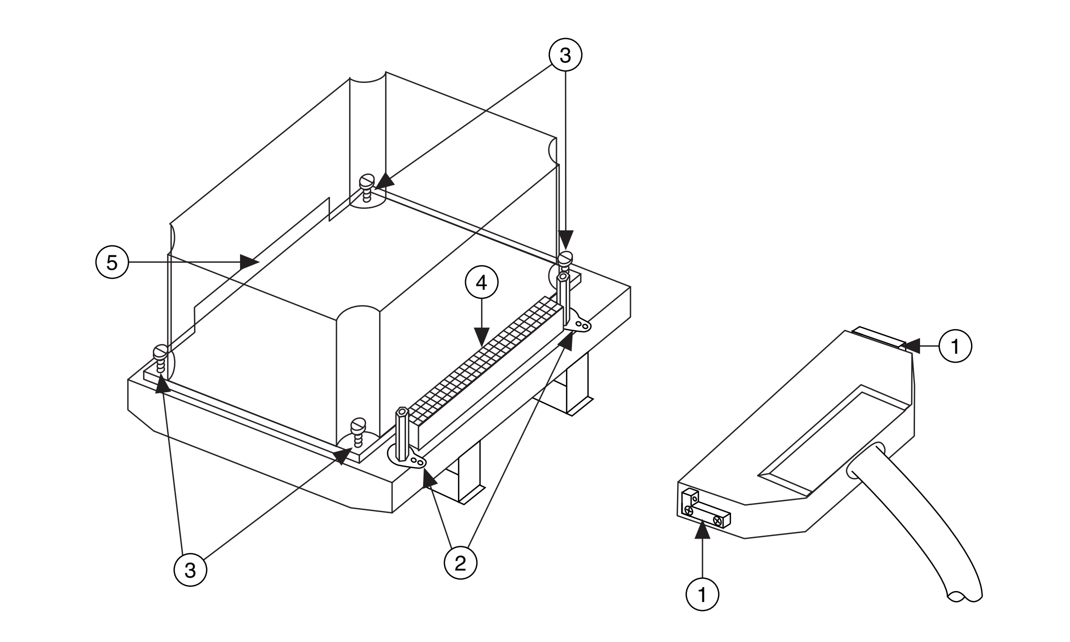
1. Power off the SCXI chassis.
2. Power off the computer that contains the E Series data acquisition (DAQ) device or disconnect the device from the SCXI chassis.
3. Connect the TBX cable adapter to the appropriate SCXI module and secure it by tightening both thumb screws.



1	M 2.5 Mounting Screws	4	SCXI Chassis
2	Cable Assembly	5	TBX Cable Adapter
3	Thumb Screws		

Figure 2. Connecting the SH32-32-A Cable to the SCXI Module

4. Verify that the four backshell mounting ears on the cable assembly are in the position shown in Figure 3. If not, remove the backshell mounting ears and install them in the position shown.



1 Backshell Mounting Screws and Ears	4 Terminal Block Connector
2 Safety Ground Lugs	5 Signal Wire Entry
3 Captive Cover Screws	

Figure 3. Connecting the SH32-32-A Cable to the TBX-1328 Terminal Block

5. Connect one end of the cable assembly to the SCXI module front connector and secure the SH32-32-A cable by tightening both backshell mounting screws.
6. Connect the other end of the cable assembly to the TBX-1328 terminal block connector and secure the SH32-32-A cable by tightening both backshell mounting screws.
7. Reconnect the E Series DAQ device to the SCXI chassis.

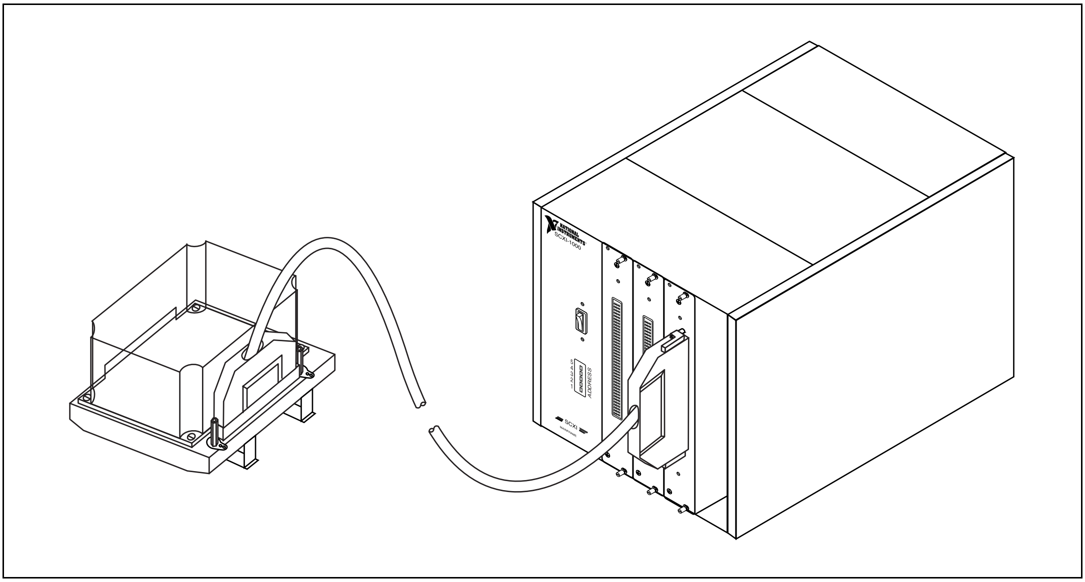


Figure 4. The Completed Installation

Rack Mounting

When you have completed the *Installing the Terminal Block and Cable Assembly* section, you can mount the TBX assembly in the rack. If you are using the National Instruments TBX Rack-Mount Assembly, refer to the *TBX Rack-Mount Installation Guide* for instructions.

If you are not using this rack-mount assembly, complete the following steps to mount the TBX assembly directly onto the DIN rail:

1. Snap the TBX terminal block onto the DIN rail with a firm push.
2. Install the SCXI chassis using the appropriate chassis rack-mount kit.

Note To remove the TBX terminal block from the DIN rail, place a flathead screwdriver into the slot above the terminal block base and pry it from the rail.

Specifications

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

Electrical

Compatible modules

- SCXI-1120/D .... 8 input channels
- SCXI-1121 .... 4 input channels, 4 excitation output channels
- SCXI-1125 .... 8 input channels
- SCXI-1126 .... 8 input channels

Cold-junction temperature-sensor circuitry

- Sensor type .... Thermistor
- Output range .... 1.91 to 0.65 VDC from 0 to 50 °C
- Accuracy[1] .... ±0.5 °C from 15 to 35 °C
  ±0.9 °C from 0 to 15 °C
  and 35 to 50 °C
- Repeatability .... ±0.2 °C from 15 to 35 °C

Coupling .... DC[2]

Current-receiver resistors........................ Resistors not included
Resistor sockets are provided
for each channel

Field-wiring connectors

- Signal screw terminals..................... 16 screw terminals (8 pairs)
- Functional earth ground................... 8 screw terminals
- Terminal spacing .... 0.5 cm (0.2 in.) center-to-center
- Maximum wire gauge...................... 16 AWG
- Strain relief .... none

Dimensions of front entrance .... 1.2 by 7.3 cm
(0.47 by 2.87 in.)

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[1] This specification includes the accuracy of the temperature-sensor circuitry itself and the temperature difference between the thermistor and any screw terminal. The temperature-sensor circuitry accuracy includes manufacturing tolerances in all component values, effects caused by component-value temperature drift, voltage-divider loading, and thermistor self-heating.

[2] In instrumentation terminology, *DC coupling* means that both DC and AC signals are passed.

Mechanical

Dimensions .... 12.7 by 7.62 by 11.16 cm
(5.0 by 3.0 by 4.4 in.)

Weight .... 100 g (3.5 oz)

Compatible DIN rails .... DIN EN 50 022
DIN EN 50 035

Isothermal construction (with cover attached)

Maximum Working Voltage

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

Channel-to-earth.................................... Each channel must remain within 250 V_{rms} or ±250 VDC of ground, Installation Category II

Channel-to-channel .... Each channel must remain within 250 V_{rms} or ±250 VDC of the voltage applied to any other channel, Installation Category II

Environmental

Operating temperature........................... 0 to 50 °C

Storage temperature .... –20 to 70 °C

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

Maximum altitude .... 2,000 m

Pollution Degree (indoor use only) 2

Safety

The TBX-1328 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 m
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 TBX-1328 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/`.

Temperature Measurement Considerations

The TBX-1328 provides high-accuracy temperature measurements for isolation modules such as the SCXI-1120/D, SCXI-1121, and SCXI-1125. The TBX-1328 provides connectivity to thermocouples, thermistors, and RTDs.

The TBX-1328 provides high-accuracy thermocouple measurements using an onboard cold-junction compensation (CJC) sensor. To find out how to read the CJC, refer to the documentation for the module in use.

Temperature measurements with thermistors and RTDs require excitation. The TBX-1328 provides excitation connectivity when used with an SCXI-1121. Refer to the *SCXI-1121 User Manual* for more information on connecting thermistors and RTDs to the excitation channels.

Switch S1 switches the temperature sensor output between MTEMP (multiplexed mode) and DTEMP (parallel mode) modes. In either mode, if there are temperature variations, the measurements can be less accurate. In MTEMP mode, you must scan the temperature independently of the other channels on the SCXI-1120/D, SCXI-1121, and SCXI-1126. 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. When using the SCXI-1125 MTEMP can be scanned from any location in the scan list.

Notes Do *not* place switch S1 in DTEMP mode. DTEMP mode is not supported.

When using SCXI-112*X* modules, the TBX-1328 does not provide open thermocouple detection. To provide open thermocouple detection, you must provide a resistor to +5 V and another resistor to GND, which defeats the isolation boundary and changes the specifications.

Temperature Sensor Output and Accuracy

The TBX-1328 temperature sensor outputs 1.91 to 0.65 V from 0 to 50 °C.

LabVIEW, Measurement Studio, and NI-DAQ can convert a thermistor voltage to the thermistor temperature for the circuit diagram shown in Figure 5.

Note The circuit diagram in Figure 5 is optional information you can use if you want more details about the TBX-1328 temperature sensor.

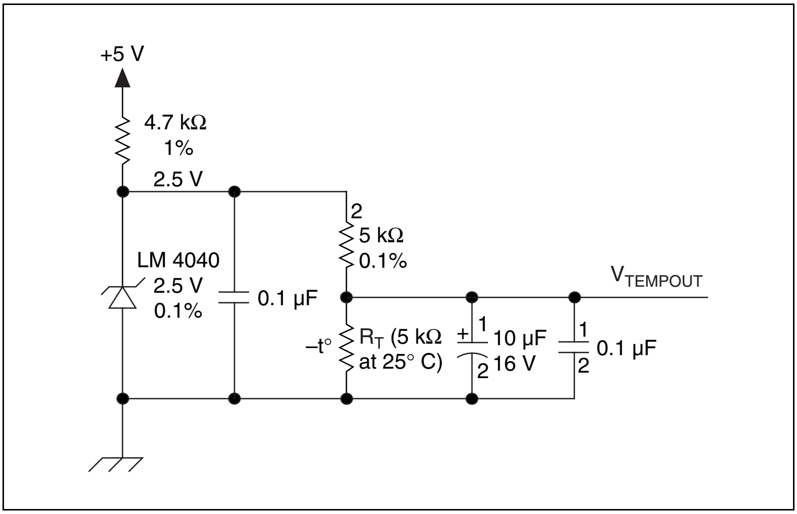

Figure 5. Temperature Sensor Circuit Diagram

In LabVIEW, you can use the Convert Thermistor Reading VI in the **Data Acquisition»Signal Conditioning** palette. If you are using Measurement Studio or NI-DAQ, use the `Thermistor_Convert` function. The VI takes the output voltage of the temperature sensor, the reference voltage, and the precision resistance and returns the thermistor temperature.

Alternatively, you can use the following formulas:

$$T(°C) = T_K - 273.15$$

where T_K is the temperature in degrees kelvin

$$T_K = \frac{1}{[a + b(\ln R_T) + c(\ln R_T)^3]}$$

$a = 1.295361 \times 10^{-3}$
$b = 2.343159 \times 10^{-4}$
$c = 1.018703 \times 10^{-7}$

R_T = resistance of the thermistor in ohms

$$R_T = 5{,}000\left(\frac{V_{TEMPOUT}}{2.5 - V_{TEMPOUT}}\right)$$

$V_{TEMPOUT}$ = output voltage of the temperature sensor

$$T(°F) = \frac{[T(°C)]9}{5} + 32$$

where 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. For example, sample for 1 second and average all the samples. Noisy environments require more samples for greater accuracy.

Reading the Temperature Sensor in LabVIEW

Notes This section does not apply to the SCXI-1126.

When using virtual channels, select **Built-in** as the source of the CJC and NI-DAQ will perform compensation automatically for that thermocouple channel. You do not need to use `mtemp`.

In LabVIEW, the channel string used to read $V_{TEMPOUT}$ depends on which module is connected to the TBX-1328. For more information about channel-string arrays and the SCXI channel-addressing syntax, refer to the *LabVIEW Measurements Manual*, which you can download at `ni.com/manuals`.

- With the SCXI-1120/D, or SCXI-1121, use the address string:

  `ob`*`x`*` ! sc`*`y`*` ! md`*`z`*` ! mtemp`

  You *cannot* put this channel-address string in the same channel-string array as other channels on the module that you are addressing.
- With the SCXI-1125, use the address string:

  `ob`*`x`*` ! sc`*`y`*` ! md`*`z`*` ! cjtemp`

  You can put this channel-address string in the same channel-string array as other channels on the same SCXI-1125 module, but it must be the first channel scanned on the SCXI-1125.

Reading the Temperature Sensor in NI-DAQ

Refer to the *NI-DAQ Function Reference Manual* for the description for reading the temperature sensor using the `SCXI_Single_Chan_Setup`, `SCXI_Change_Chan`, and `SCXI_SCAN_Setup` functions.

Note The method for scanning the temperature sensor on the SCXI-1125 with other channels on the same module using the `SCXI_SCAN_Setup` is the same as that of the SCXI-1102.

Strain Measurement Considerations

When you use the SCXI-1121 with the TBX-1328 to measure strain, a small amount of voltage drop develops across the excitation wires in the SH32-32-A cable. This voltage drop is due to the wire resistance and the current flow in these leads when a strain gauge is connected at the TBX-1328 across the excitation outputs provided on the SCXI-1121.

To reduce errors in the output voltage, first calculate the voltage drop across the SH32-32-A cable. This voltage drop results in a measurement error that depends on the cable length, and on the strain-gauge value and configuration. The SH32-32-A cable has a resistance (R_L) of 0.21 Ω/m. Figure 6 shows a typical full-bridge strain-gauge circuit.

To determine the amount of error introduced by the cable, complete the following steps:

1. Calculate the total resistance (R_{TL}) of the cable, based on the cable length.

Note Remember to include the lead resistance of both V_{ex}+ and V_{ex}–.

2. Determine the bridge resistance of the strain gauge (R_{SG}) connected at the TBX-1328.

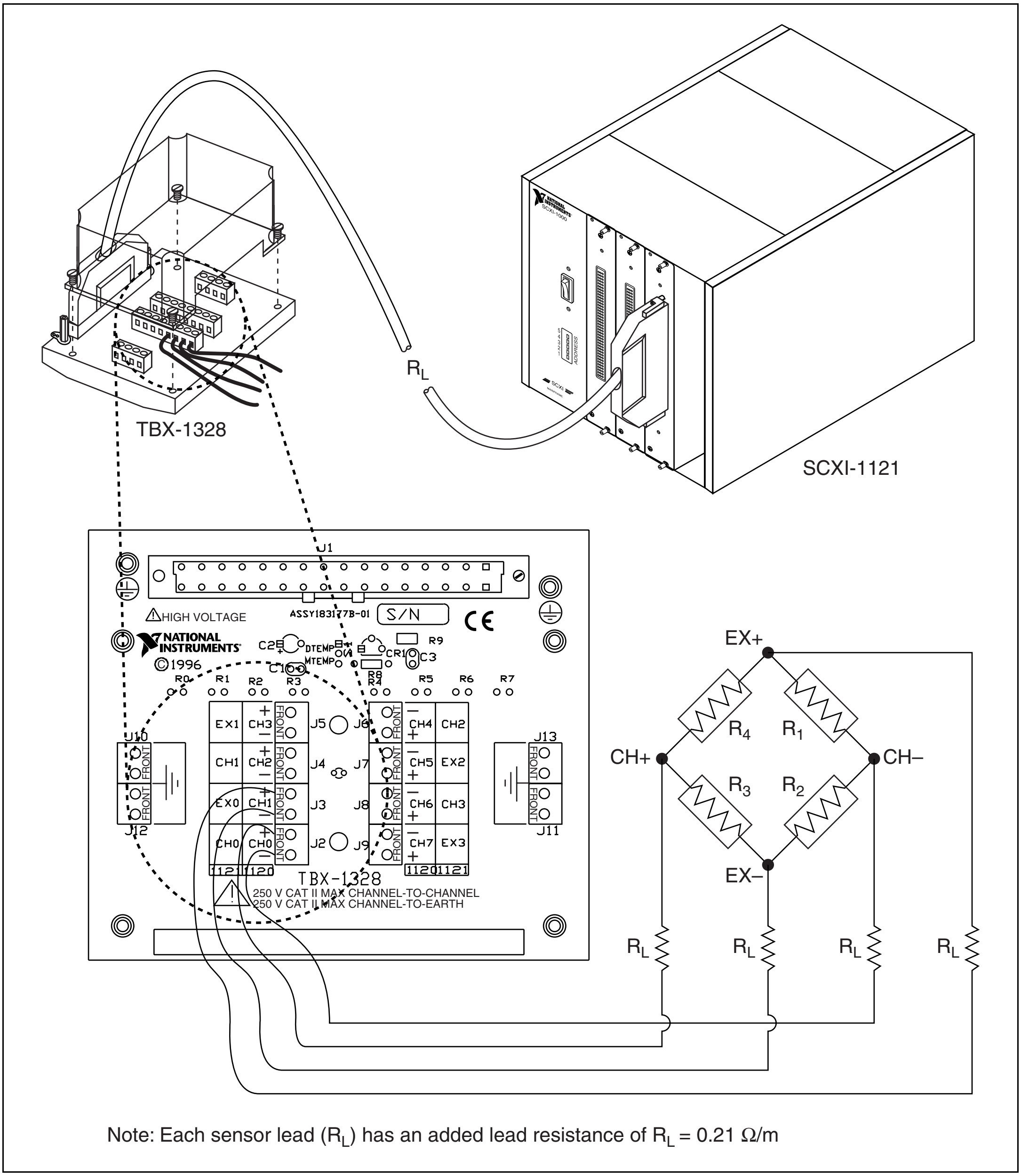

Figure 6. Full-Bridge Strain-Gauge Circuit Diagram

3. Use the following formula to determine the total voltage drop (V_{drop}) in the SH32-32-A cable excitation leads:

$$V_{drop} = \frac{R_{TL}}{R_{TL} + R_{SG}} \times V_{ex}$$

For example, if you have a 1 m SH32-32-A cable, 120 Ω full-bridge strain gauge, and V_{ex} = 3.333 V, then the calculations from steps 1 through 3 are:

1. R_{TL} = 2 × 0.21 Ω/m × 1 m = 0.42 Ω; multiply the cable length by two to take into consideration both the V_{ex}+ and V_{ex}– lead resistances.
2. R_{SG} = 120 Ω is the total equivalent bridge resistance as seen from the V_{ex}+/– terminals of the TBX-1328.
3. V_{drop} = 11.6 mV, which is 0.3% of the 3.333 V excitation.

Now calculate the voltage drop across the field signal wires you are connecting to the TBX-1328. Perform similar calculations for the field wires as you did for the cable. Resistance can vary depending on the cable and field wires. Add this error amount to the voltage drop across the SH32-32-A cable to get a total voltage drop.

You can compensate for this error along with any additional cable lead resistance introduced by the strain-gauge connection wires. One simple way of compensation is to calculate the lead resistance, then input it along with the other strain-gauge parameters into the conversion formula provided in your software applications, such as LabVIEW and Measurement Studio. To minimize resistive compensation, move the load closer to the SCXI module by using shorter cable lengths, or use heavy-gauge wire to connect to the TBX-1328.