TBX-1328 High-Accuracy Isothermal Terminal Block

This guide describes how to install and use the TBX-1328 high-accuracy isothermal terminal block with the SCXI-1120, SCXI-1120D, SCXI-1121, SCXI-1125, and SCXI-1126 modules.

Introduction

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, SCXI-1120D, 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 to minimize the temperature gradients across the screw terminals when you take measurements with thermocouples. The TBX-1328 mounts on most European standard DIN EN mounting rails.

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

What You Need to Get Started

To set up and use your SCXI-1328 terminal block, you need the following items:

- ❑ TBX-1328 high-accuracy isothermal terminal block
- ❑ *TBX-1328 High-Accuracy Isothermal Terminal Block Installation Guide*

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

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.

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.

Safety Information

Caution 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 can 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[1] environment per IEC 60664-1. 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 it 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.

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.

You *must* insulate all of your signal connections to the highest voltage with which the TBX-1328 can come in contact.

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 minimum voltage rating of 300 V and a temperature value of 60 °C for measuring up 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

[1] Category II refers to local-level power distribution, such as that provided by a standard wall outlet.

ground can 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 hazardous voltages (≥30 V_{rms} and 42.4 V_{peak} or 60 VDC) are present, you *must* connect a safety earth-ground wire to the terminal block safety-ground lug, shown in Figure 3. 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 lug, run an earth-ground wire 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 lug hardware when connecting the safety-ground wire; to do so reduces the safety isolation between the high voltage and safety ground.

Clean the module and accessories by brushing off light dust with a soft non-metallic brush. Remove other contaminants with a stiff non-metallic brush. The unit *must* be completely dry and free from contaminants before returning it to service.
The terminal block *must* be used with a UL-listed SCXI chassis.

Voltage Drops and Strain Gauge

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 your output voltage, first you need to calculate the voltage drop across the SH32-32-A cable. This voltage drop results in an error in your measurement and depends on the cable length and on the strain gauge value and configuration. The SH32-32-A cable has a resistance of 0.21 Ω/m.

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

1. Calculate the total resistance (R_{TL}) of the cable based on the cable length.
2. Determine the bridge resistance of your strain gauge (R_{SG}) connected at the TBX-1328.

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 your calculations from steps 1 through 3 would be:

1. R_{TL} = 2 × 0.21 Ω/m × 1 m = 0.42 Ω; notice that you 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 ⇔ 0.3% of 3.333 V excitation.

You then need to calculate the voltage drop across the field signal wires you are connecting to the TBX-1328. Perform similar calculations for your field wires as you did for your cable. Resistance can vary depending on your 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 your other strain-gauge parameters into the conversion formula provided in your data acquisition software packages. In order to minimize resistive compensation, locate the load closer to your SCXI module by using shorter cable lengths, or use heavy-gauge wire to connect to the TBX-1328.

Connecting the Signals

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

To connect your field signals to the TBX-1328 terminal block for use with the SCXI-1120 or SCXI-1121, follow the labeling on the TBX-1328 indicated along 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.

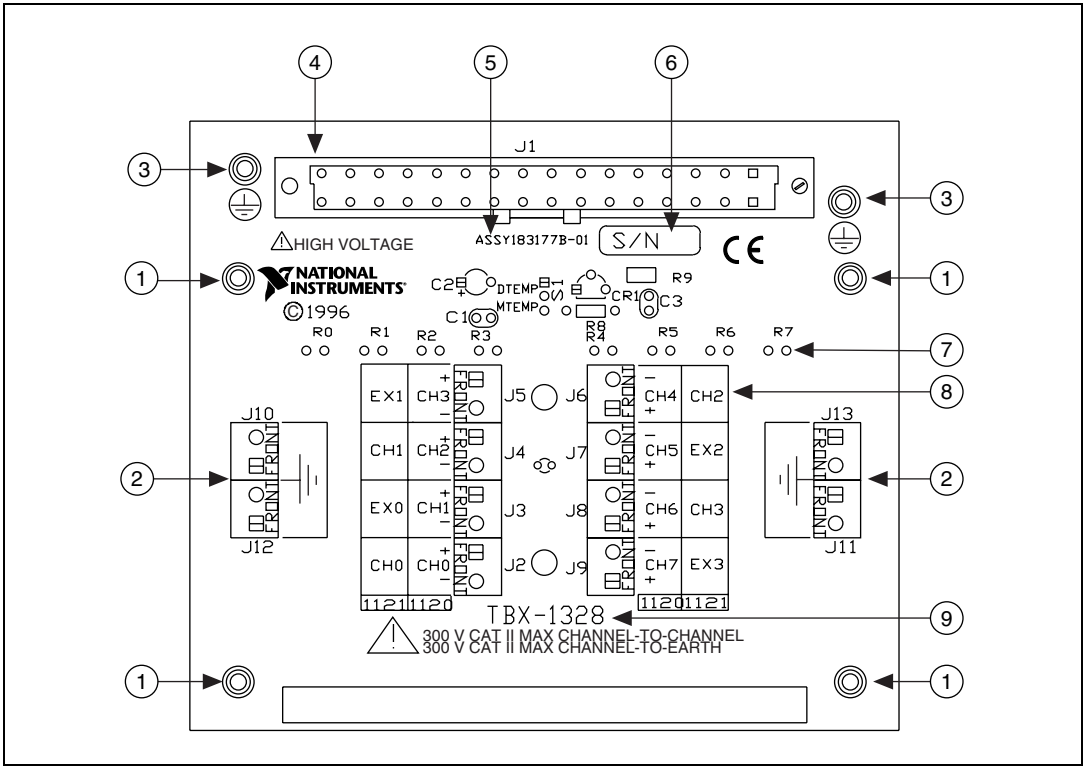
To connect your signals, use the following instructions, referring to Figures 1 and 2 as necessary:

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 is not shown in your SCXI module user manual. Allow your signal wires to exit through the TBX-1328 cover opening.

Note 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.



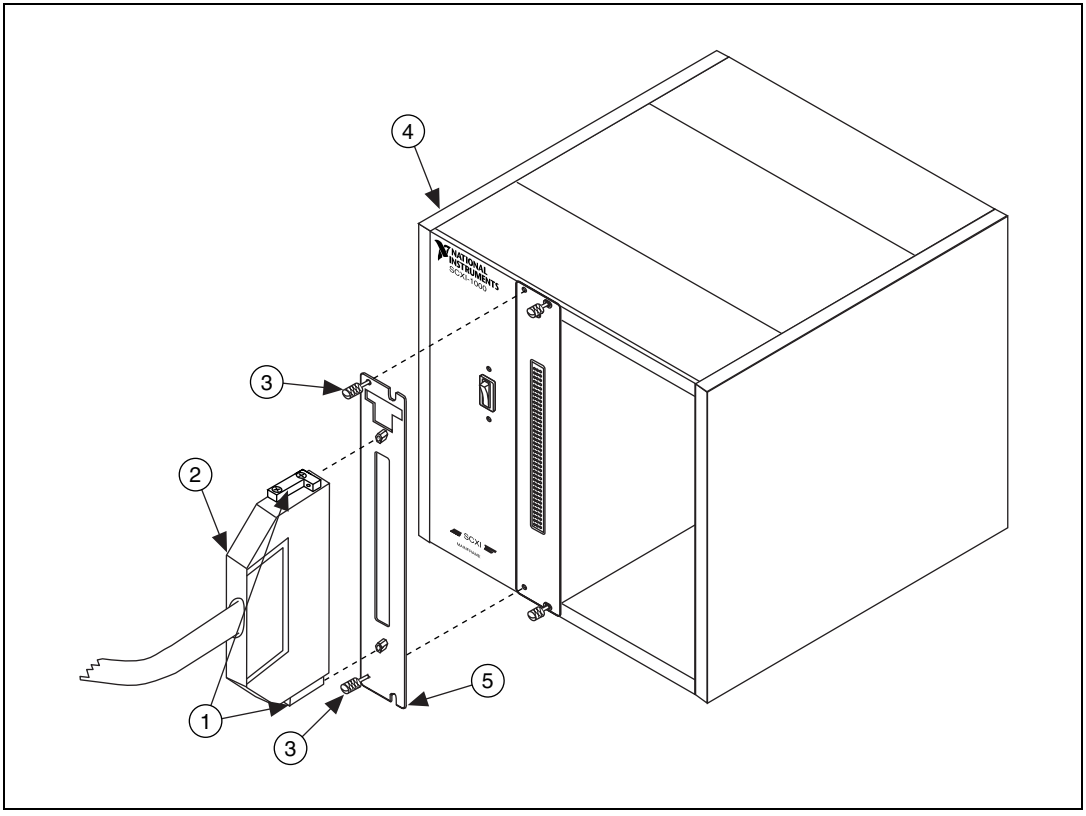
1	Cover Mounting Nut	5	Assembly Number	8	Signal Wire Screw Terminals
2	Chassis Ground Screw Terminals	6	Serial Number	9	Product Name
3	Backshell Mounting Kit	7	Current–Receiver Resistor Sockets R<0..7> = Channel <0..7>		
4	Cable Mating Connector				

Figure 1. TBX-1328 Terminal Block Parts Locator Diagram

Installing the Terminal Block and Cable Assembly

Perform the following steps to mount the SH32-32-A cable assembly and connect the TBX-1328 to your SCXI module while referring to Figures 2 through 4 as needed.

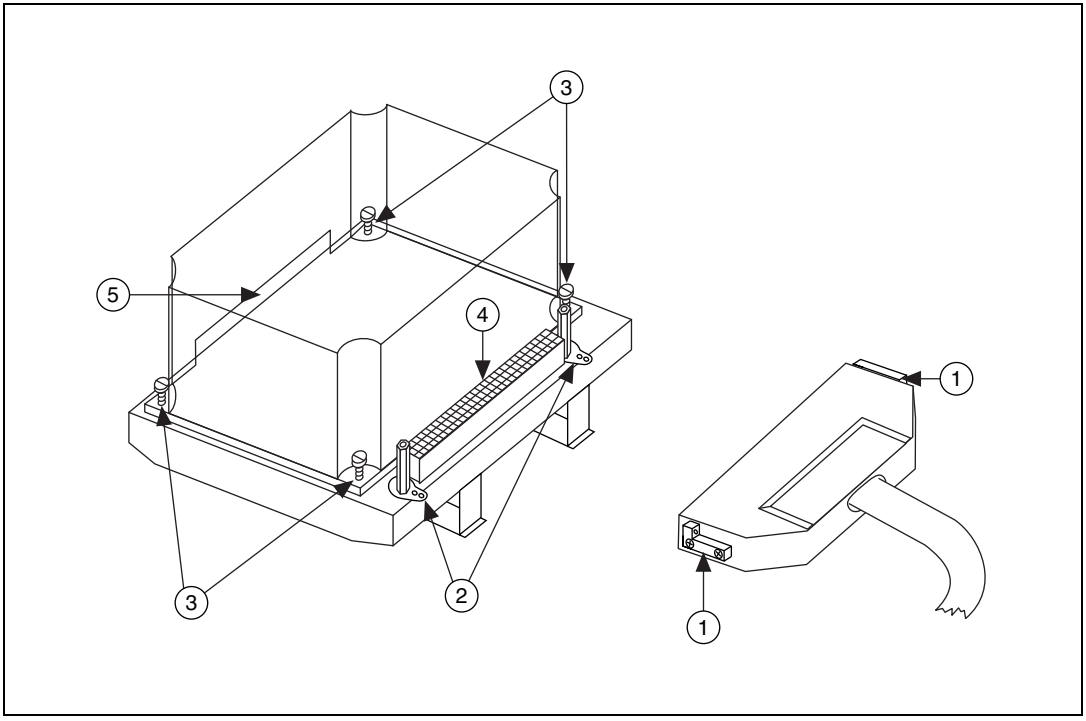
1. Turn off your SCXI chassis.
2. Turn off the computer that contains your data acquisition (DAQ) device or disconnect the device from your SCXI chassis.
3. Connect the TBX cable adapter to the appropriate SCXI module and secure it by tightening both thumb screws.



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

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	2	Safety Ground Lugs	4	Terminal Block Connector
		3	Captive Cover Screws	5	Signal Wire Entry

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

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

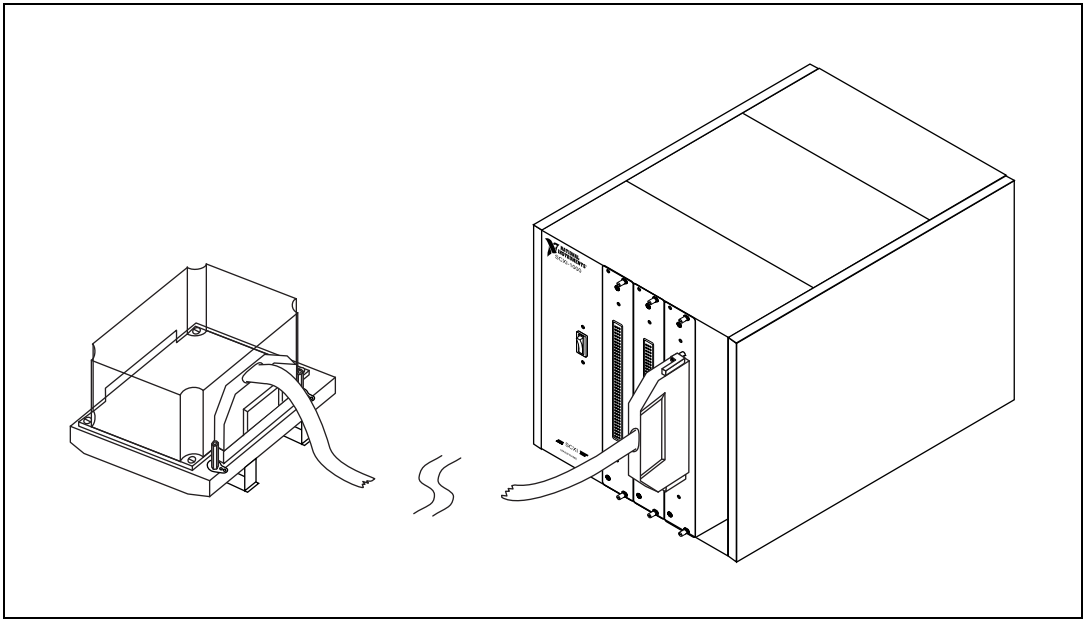


Figure 4. The Completed Installation

Rack Mounting

When you have completed the above installation instructions, you are ready to mount the TBX assembly in your 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, perform the following steps to mount the TBX assembly directly onto your 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 and 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

Maximum working voltage (signal + common – mode)

- Channel to ground ..... Each channel must remain within $300V_{rms}$ or ±300 VDC of ground
- Channel to channel ..... Each channel must remain within 300Vrms or ±300 VDC of the voltage applied to any other channel

[1] This 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.

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.)

Mechanical

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

Weight .....100 gm (3.5 oz.)

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

Isothermal construction (with cover attached)

Environmental

Operating temperature .....0 to 50 °C

Storage temperature .....–20 to 70 °C

Relative humidity .....10 to 90% noncondensing

Altitude (maximum) .....2000 m

Safety

Designed in accordance with IEC 61010-1, UL 3111-1, and CAN/CSA C22.2 No. 1010.1 for electrical measuring and test equipment

Installation Category II

Pollution degree 2

Electromagnetic Compatibility

EMC/EMI	CE, C-Tick and FCC Part 15 (Class A) Compliant
Electrical emissions	EN 55011 Class A at 10 m, FCC Part 15A above 1 GHz
Electrical immunity	Evaluated to EN 61326:1998, Table 1

Note This device should only be operated with shielded cabling for full EMC and EMI compliance. See the Declaration of Conformity for this product for any additional regulatory compliance information.

Temperature Sensor Output and Accuracy

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

National Instruments software can convert a thermistor voltage to the thermistor temperature for the circuit diagram shown in Figure 5. In LabVIEW, you can use the Convert Thermistor Reading VI in the **Data Acquisition»Signal Conditioning** palette. If you are using LabWindows/CVI 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 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

$$T(°\text{F}) = \frac{[T(°\text{C})]9}{5} + 32$$

where *T(*°F*)* and *T(*°C*)* are the temperature readings in degrees Fahrenheit and degrees Celsius, respectively.

Note Use an average of a large number of samples to obtain the most accurate reading. Electrically noisy environments require more samples for greater accuracy.

Reading the Temperature Sensor in LabVIEW

Note This section is not applicable to the SCXI-1126.

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, see the *LabVIEW Measurements Manual*.

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

  ```
  obx ! scy ! mdz ! 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:

  ```
  obx ! scy ! mdz ! cjtemp
  ```

  You can put this channel-address string in the same channel-string array as other channels on the same SCXI-1125 module and can call it multiple times within the same channel-string array.

Temperature Sensor Circuit Diagram

You do *not* need to read this section to operate the TBX-1328. The circuit diagram in Figure 5 is optional information you can use if you want more details about the TBX-1328 temperature sensor.

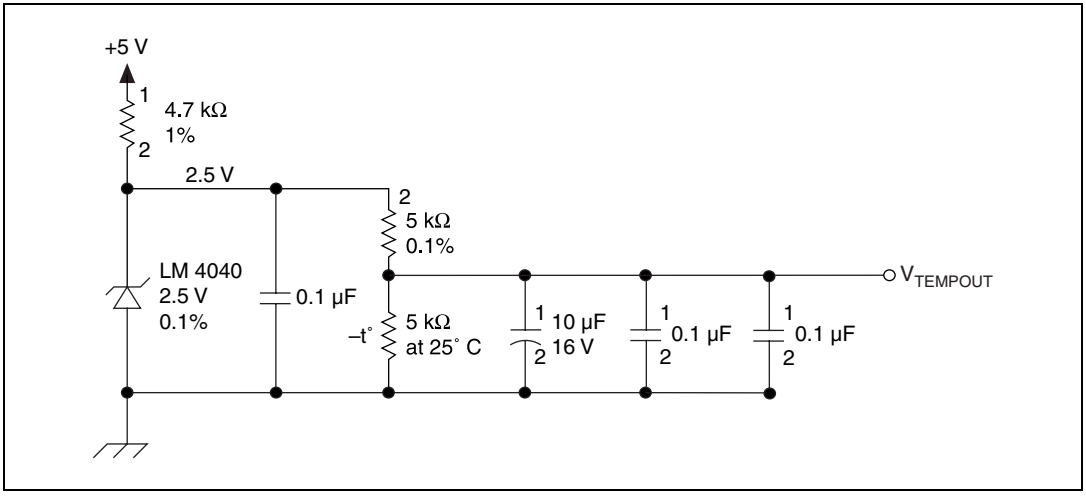


Figure 5. Temperature Sensor Circuit Diagram

Technical Support Resources

NI Web Support

National Instruments Web support is your first stop for help in solving installation, configuration, and application problems and questions. Online problem-solving and diagnostic resources include frequently asked questions, knowledge bases, product-specific troubleshooting wizards, manuals, drivers, software updates, and more. Web support is available through the Technical Support section of `ni.com`

Worldwide Support

National Instruments has offices located around the world to help address your support needs. You can access our branch office Web sites from the Worldwide Offices section of `ni.com`. Branch office Web sites provide up-to-date contact information, support phone numbers, e-mail addresses, and current events.

If you have searched the technical support resources on our Web site and still cannot find the answers you need, contact your local office or National Instruments corporate. For telephone support in the United States,

dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 03 9879 5166, Austria 0662 45 79 90 0, Belgium 02 757 00 20,
Brazil 011 284 5011, Canada (Calgary) 403 274 9391,
Canada (Ottawa) 613 233 5949, Canada (Québec) 514 694 8521,
China (Shanghai) 021 6555 7838, China (ShenZhen) 0755 3904939,
Denmark 45 76 26 00, Finland 09 725 725 11, France 01 48 14 24 24,
Germany 089 741 31 30, Greece 30 1 42 96 427, Hong Kong 2645 3186,
India 91805275406, Israel 03 6120092, Italy 02 413091,
Japan 03 5472 2970, Korea 02 596 7456, Mexico 5 280 7625,
Netherlands 0348 433466, New Zealand 09 914 0488,
Norway 32 27 73 00, Poland 0 22 528 94 06, Portugal 351 1 726 9011,
Singapore 2265886, Spain 91 640 0085, Sweden 08 587 895 00,
Switzerland 056 200 51 51, Taiwan 02 2528 7227,
United Kingdom 01635 523545

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