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Installation Guide

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 and SCXI-1121 modules.

Introduction

The TBX-1328 high-accuracy isothermal terminal block is a DIN rail-mountable terminal block that consists of a shielded board with screw terminals to connect to the SCXI-1120 or SCXI-1121 front connector. The TBX-1328 has a high-precision thermistor and isothermal copper planes to minimize the temperature gradients across the screw terminals when you measure 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 via the shield of the SH32-32-A cable. With the SCXI-1120, 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

- ❑ TBX-1328 high-accuracy isothermal terminal block kit
  - TBX-1328 high-accuracy isothermal terminal block
  - *TBX-1328 High-Accuracy Isothermal Terminal Block Installation Guide*
  - $^1/_8$ in. flathead screwdriver
- ❑ SCXI chassis
- ❑ SCXI-1120 or SCXI-1121 module and documentation
- ❑ SH32-32-A shielded cable assembly
- ❑ Long-nose pliers
- ❑ $^3/_{16}$ in. wrench
- ❑ No. 1 Phillips-head screwdriver

321179A-01 *March 1996*

Installation

Perform the following steps to mount the SH32-32-A cable assembly and connect the TBX-1328 to your SCXI module. Refer to the figures as needed.

Warning: ***SHOCK HAZARD: Refer to the*** *Signal Connection* ***section BEFORE connecting signals. If signal wires are connected to the terminal block, dangerous voltages may exist even when the equipment is turned off.***

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. Slide the SCXI module out of the SCXI chassis.
4. Unscrew the SCXI module grounding screw with a No. 1 Phillips-head screwdriver and remove the module cover (see Figure 1).

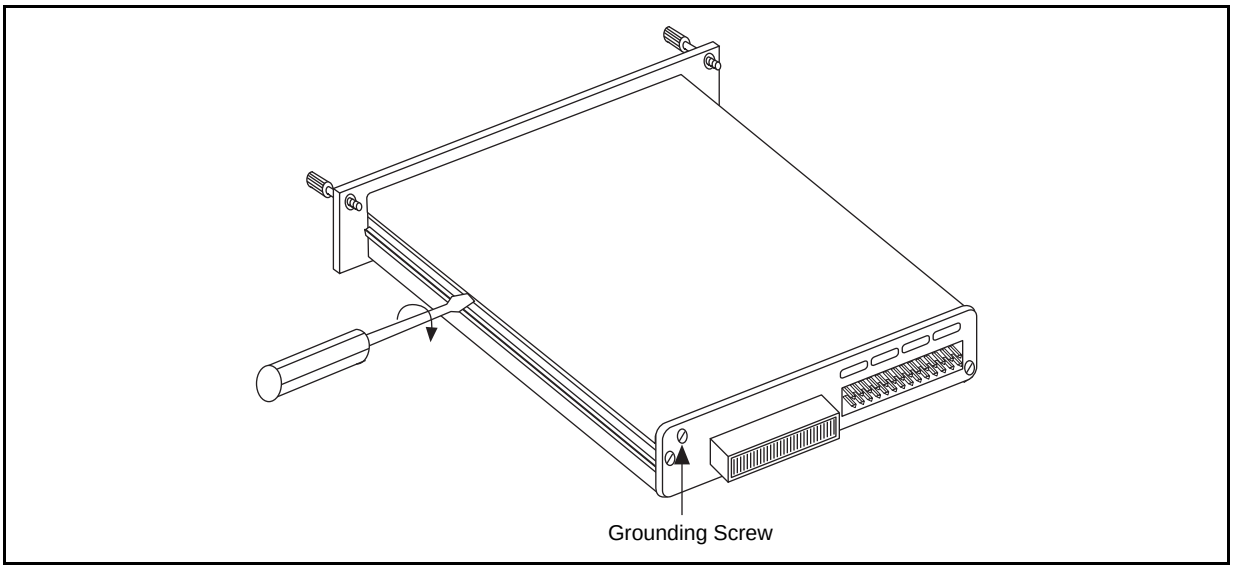
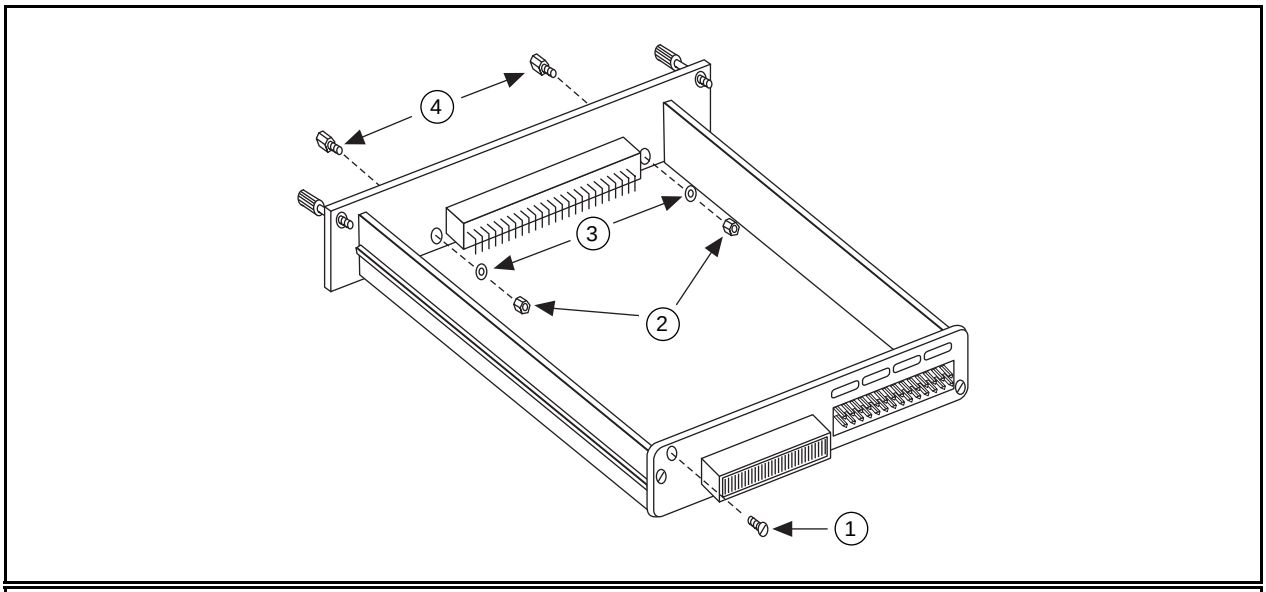


Figure 1. Removing the SCXI Module Cover

5. Place one jack screw in the SCXI module as shown in Figure 2.
6. While holding the jack screw in place, insert the lock washer and then the nut. Use long-nose pliers to do this.
7. Tighten the nut by holding it firmly and rotating the jack screw with a $^{3}/_{16}$ in. wrench.
8. Repeat steps 5 through 7 for the second jack screw.
9. Replace the SCXI module cover and tighten the grounding screw.



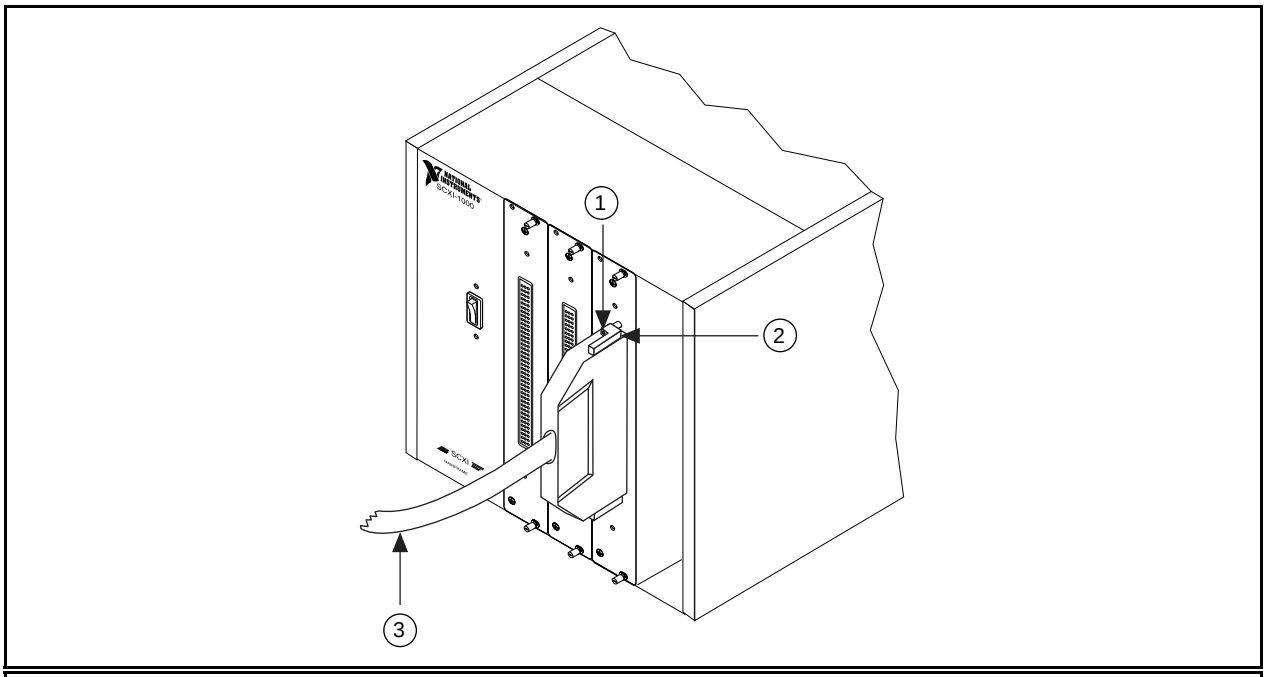
1	Grounding Screw	3	Lock Washers
2	Nuts	4	Jack Screws

Figure 2. Preparing the SCXI Module for the Cable Assembly

10. Slide the SCXI module back into place in the SCXI chassis.

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

12. 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.



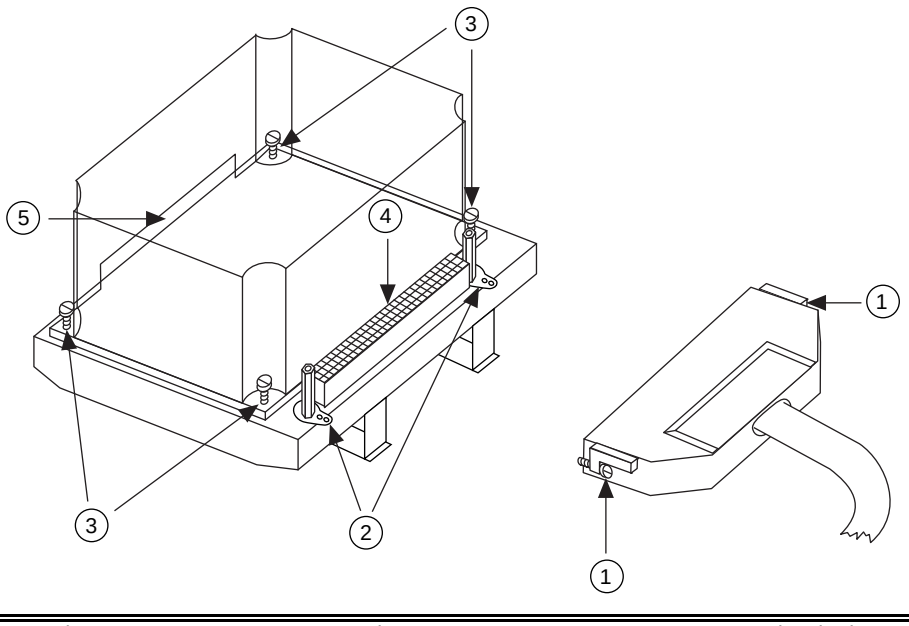
1	Mounting Screw	3	SH32-32-A Cable
2	Mounting Ear		

Figure 3. Connecting the SH32-32-A Cable to the SCXI Module

13. 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. See Figure 4.

Note: ***To minimize the temperature gradient inside the terminal block and maintain its isothermal nature for accurate cold-junction compensation, place the TBX-1328 terminal block away from extreme temperature differentials.***

See Figure 5 for the completed installation.



1	Mounting Screws and Ears	3	Captive Cover Screws	5	Signal Wire Entry
2	Shield Grounding Solder Lugs	4	Terminal Block Connector		

Note: ***The SH32-32-A cable is not shown in the exact position for proper connection to the terminal block connector. See Figure 5 for the completed connection.***

Figure 4. Connecting the SH32-32-A Cable to the TBX-1328 Terminal Block

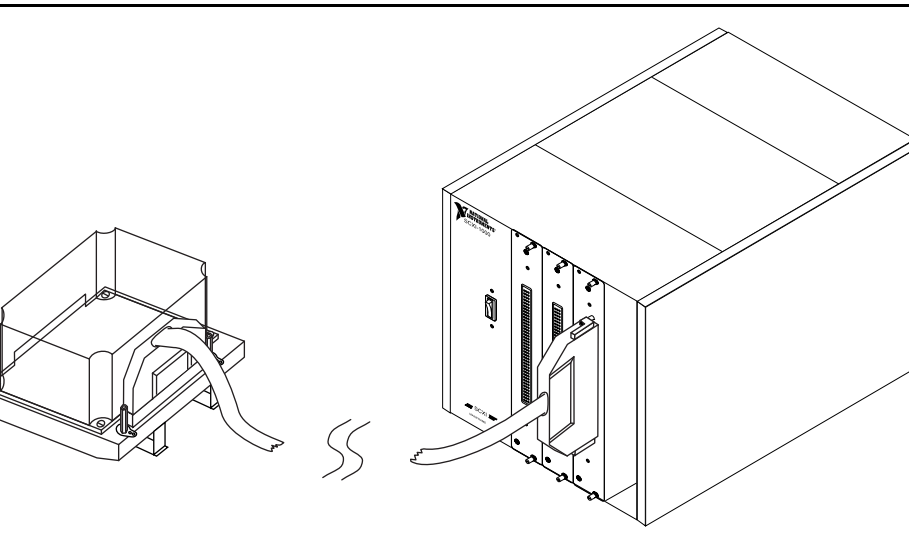


Figure 5. The Completed Installation

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.

   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.

2. Install the SCXI chassis using the appropriate chassis rack-mount kit.

Signal Connection

The following warnings contain important safety information concerning the use of hazardous voltage levels with TBX-1328 terminal blocks.

Warnings: ***SHOCK HAZARD: Only qualified personnel aware of the dangers involved should use the TBX-1328. If signal wires are connected to the terminal block, dangerous voltage levels may exist even when the equipment is turned off. Before you remove or work with any installed terminal block, disconnect the AC power line or any high-voltage sources (>30 Vrms and 42.4 V peak, or 60 VDC) that may be connected to the terminal block. National Instruments is NOT liable for any damages or injuries due to misuse of high-voltage signals connected to the terminal block.***

When using the terminal block with high voltage levels, you must insulate all signal wires appropriately to the highest voltage the terminal block may come in contact with. National Instruments is NOT liable for any damages or injuries resulting from inadequate signal wire insulation.

Any CHASSIS GROUND terminal on your terminal block is for grounding high-impedance sources such as a floating source (1 mA maximum). Do not use these terminals as safety earth grounds.

Operating common-mode voltage must not exceed 250 Vrms between channels or from any channel to earth.

Read the next section, *Voltage Drops and Strain Gauge*, before proceeding with the signal connections.

Voltage Drops and Strain Gauge

When you use the SCXI-1121 with the TBX-1328 to measure strain gauges, a small amount of voltage drop will develop 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:

$$V_{drop} = [R_{TL}/(R_{TL} + R_{SG})] \times V_{ex}$$

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 x 0.21 Ω/m x 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, which 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 may 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.

Notice that 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 as done above, then input it along with your other strain gauge parameters into the conversion formula provided in your data acquisition software packages. Or, locate the load closer to your SCXI module by using shorter cable lengths, or use heavy-gauge wire to connect to the TBX-1328.

Wiring Instructions

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 the parts locator diagram, Figure 6. Refer to Figures 4 and 6 as you perform the following instructions:

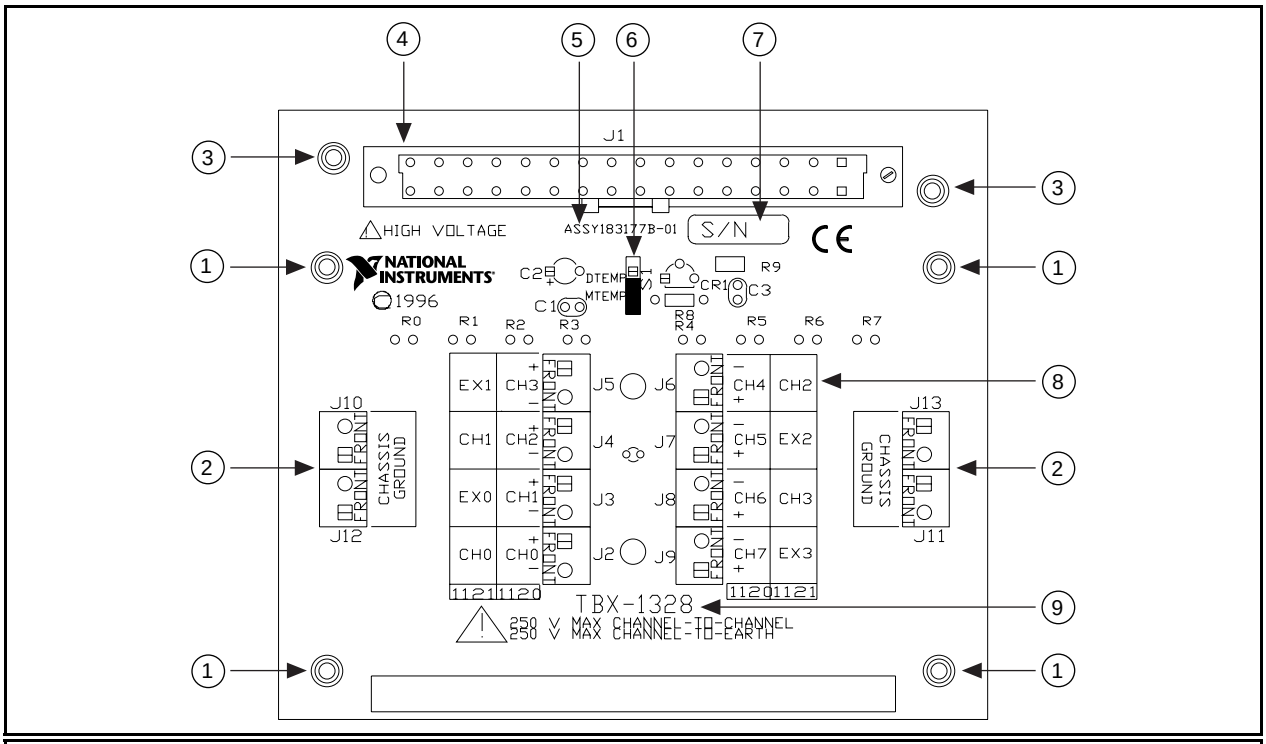
1. Remove the TBX-1328 terminal block cover by unscrewing the four captive cover screws in the cover corners. These screws stay attached to the cover without falling out.

2. Connect the signal wires to the screw terminals. Refer to your SCXI module user manual for examples of how to connect to field signals and loads. Notice that the CHASSIS GROUND terminals are connected to the SCXI chassis via 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 installation and signal connection are now complete. Figure 6 shows the TBX-1328 parts locator diagram.



1	Cover Mounting Nut	4	Cable Mating Connector	7	Serial Number
2	Chassis Ground Screw Terminals	5	Assembly Number	8	Signal Wire Screw Terminals
3	Backshell Mounting Nut	6	Switch S1	9	Product Name

Figure 6. TBX-1328 Terminal Block Parts Locator Diagram

Temperature Sensor and Jumper Configuration

Warning: ***SHOCK HAZARD: Refer to the*** *Signal Connection* ***section before connecting signals.***

To enable you to use thermocouples with the SCXI-1120 and SCXI-1121 modules, the TBX-1328 terminal block has a high-accuracy temperature sensor for cold-junction compensation.

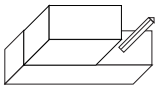
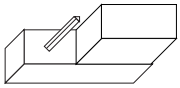
SCXI-1120 Connection

You can connect the temperature sensor to the SCXI-1120 module in either of two ways:

- Multiplexed Temperature Sensor (MTEMP) mode—Set the TBX-1328 switch S1 to MTEMP position. This mode connects the temperature sensor to the MTEMP pin (C4) on the SCXI module front connector and multiplexes the sensor output at the SCXI module output multiplexer along with the amplifier outputs. This is the factory-default setting.

- Direct Temperature Sensor (DTEMP) mode—Set the TBX-1328 switch S1 to DTEMP position. This mode connects the temperature sensor to a separate DAQ channel via pin 18 (MCH7-) on the SCXI module rear signal connector when you set the jumper W41 in the SCXI-1120 module to position 2–3, as shown in Table 1.

Table 1. SCXI-1120 Jumper W41 Configuration

SCXI-1120 Jumper W41 Position	Description
	Configures the temperature sensor for the DTEMP mode.
	Configures the temperature sensor for MTEMP mode (factory setting).

In both the MTEMP and DTEMP modes, the reference to the temperature sensor signal is the SCXI-1120 analog ground that is connected to MCH0- in the MTEMP mode, or to OUTREF or AOGND (with the SCXI-1120 module jumper W46 set in position AB-R2 or AB-R0, respectively) in the DTEMP mode.

SCXI-1121 Connection

You can connect the temperature sensor to the SCXI-1121 module in two ways:

- Multiplexed Temperature Sensor (MTEMP) mode—Set the TBX-1328 terminal block switch S1 to the MTEMP position. This mode connects the temperature sensor to the MTEMP pin (C4) on the SCXI module front connector and multiplexes the sensor at the SCXI module output multiplexer along with the amplifier outputs. This is the factory-default setting.

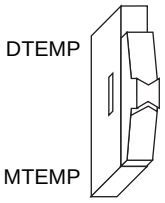
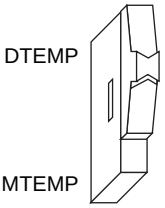
- Direct Temperature Sensor (DTEMP) mode—Set the TBX-1328 terminal block switch S1 to the DTEMP position. This mode connects the temperature sensor to a separate DAQ channel via MCH4± (pins 11 and 12) on the SCXI module rear signal connector.

In both the MTEMP and DTEMP modes, the reference to the temperature sensor signal is the SCXI-1121 analog ground that is connected to MCH0- in the MTEMP mode or to MCH4- in the DTEMP mode (jumper W1 in the DTEMP position connects MCH4+ to the temperature sensor). Notice that MCH4- is continuously connected to the SCXI-1121 ground, whereas MCH0- is switched through the output multiplexer.

Terminal Block Switch Configuration

One switch comprises both the MTEMP and DTEMP positions; thus, you can use only one configuration at a time. The parking position for the switch is the MTEMP position; the temperature sensor is disabled until you select it via the software (MTEMP mode only). Table 2 shows the TBX-1328 terminal block switch settings.

Table 2. TBX-1328 Terminal Block Switch S1 Configuration

Switch S1 Position	Description	Temperature Sensor Connection	
		SCXI-1120	SCXI-1121
	MTEMP mode selected; factory setting; parking position	Connects the sensor output to the SCXI module output multiplexer	Connects the sensor output to the SCXI module output multiplexer
	DTEMP mode selected	Connects the sensor to the MCH7- signal on the SCXI module rear signal connector via SCXI module jumper W41	Connects the sensor to the MCH4+ signal on SCXI module rear signal connector

Temperature Sensor Output and Accuracy

The TBX-1328 temperature sensor voltage output varies from 1.91 to 0.58 V over the temperature range 0° to 55° C, and has an accuracy of ±0.5° C over the 15° to 35° C temperature range and ±0.9° C over the 0° to 15° and 35° to 55° C temperature ranges[1].

To select and read the temperature sensor, refer to your data acquisition software documentation for programming information

Alternatively, you can use the following formulas to convert the cold-junction sensor voltage to cold-junction temperature:

$$T(°C) = T_K - 273.15$$

where T_K is the temperature in Kelvin

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

$a = 1.295361 \times 10^{-3}$
$b = 2.343159 \times 10^{-4}$
$c = 1.018703 \times 10^{-7}$
R_T = resistance of the thermistor in Ω

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

$V_{TEMPOUT}$ = 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: ***$V_{TEMPOUT}$ varies from 1.91 V (at 0° C) to 0.58 (at 55° C). For best resolution, use the maximum gain for this signal range on the analog input channel of your DAQ device.***

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

[1]Includes the combined effects of the temperature sensor accuracy and the temperature difference between the temperature sensor and any screw terminal. The temperature sensor accuracy includes tolerances in all component values, the effects caused by temperature and loading, and self-heating.

Temperature Sensor Circuit Diagram

The circuit diagram in Figure 7 provides details about the TBX-1328 temperature sensor.

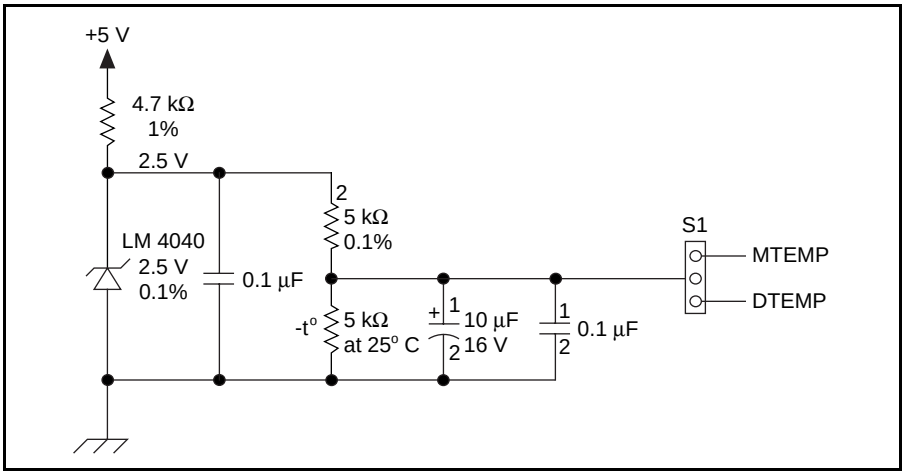


Figure 7. Temperature Sensor Circuit Diagram

Specifications

Cold-junction sensor

Accuracy[2]	0.5° from 15° to 35° C 0.9° from 0° to 15° and 35° to 55° C
Repeatability	0.2° from 15° to 35° C
Output	1.91 to 0.58 V from 0° to 55° C

Maximum working voltage (signal + common mode)	Each input should remain within 250 Vrms of ground and any other channel
Compatible DIN rails	DIN EN 50 022 DIN EN 50 035
Terminal block dimensions	12.7 x 7.62 x 11.18 cm (5 x 3 x 4.4 in.)

[2]Includes the combined effects of the temperature sensor accuracy and the temperature difference between the temperature sensor and any screw terminal. The temperature sensor accuracy includes tolerances in all component values, the effects caused by temperature and loading, and self-heating.