SCXI-1303 32-Channel Isothermal Terminal Block

This guide describes how to install and use the SCXI-1303 terminal block with SCXI-1102,SCXI-1102B, SCXI-1102C, and SCXI-1100 modules.

Introduction

The SCXI-1303 32-channel isothermal terminal block is a shielded board with screw terminals that connect to the SCXI-1102/B/C and the SCXI-1100 modules. The SCXI-1303 has a high-accuracy thermistor, cold-junction temperature sensor, and an isothermal copper plane to minimize the temperature gradients across the screw terminals when you measure with thermocouples.

The terminal block has 78 screw terminals for easy connection. Thirty-two pairs of screw terminals connect to the 32 differential inputs of the SCXI modules. One pair of terminals connects to the module’s chassis ground pins. Three terminals connect to the SCXI module OUTPUT and AOREF pins and to the SCXIbus guard. All of the other terminals—OUT0+, OUT0–, OUT1+, OUT1–, OUT2+, OUT2–, OUT3+, OUT3–, and AIREF—are reserved for future use.

The terminal block has a pullup resistor connected between CH+ and +5 V and a bias resistor connected between CH– and chassis ground. These resistors help you detect open thermocouples by detecting saturation of the module amplifier output.

What You Need to Get Started

To set up and use your SCXI-1303, you will need the following items:

- ❑ SCXI-1303 32-channel isothermal terminal block
- ❑ *SCXI-1303 32-Channel Isothermal Terminal Block Installation Guide*

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- ❑ SCXI chassis
- ❑ SCXI-1102/B/C or SCXI-1100 module
- ❑ One package of four 10 MΩ resistor networks
- ❑ No. 1 and No. 2 Phillips-head screwdrivers
- ❑ $^{1}/_{10}$ in. and $^{1}/_{4}$ in. flathead screwdrivers
- ❑ Long-nose pliers

Changing Resistor Networks

Use long-nose pliers to remove or replace the resistor networks in the sockets; be careful not to damage the network package. Make sure pin 1 of each network is in the correct position in the socket. Refer to Figure 4 to locate pin 1 for each resistor network socket.

Each resistor network is labeled with descriptive numbers on the left front side, and pin 1 is located directly beneath the darkened symbol within these numbers. The 10 Ω resistor network is labeled *100* (10×10^0 Ω); the 10 MΩ resistor network is labeled *106* (10×10^6 Ω). Figure 1 shows examples of these resistors.

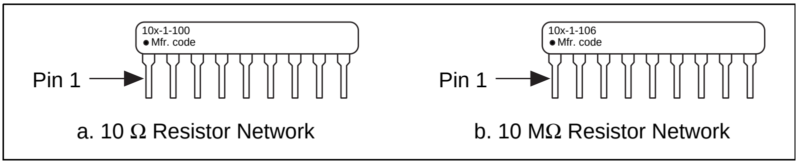


Figure 1. Resistor Networks

Open Thermocouple Detection

The SCXI-1303 circuitry helps you detect an open thermocouple. To detect whether any thermocouple is open, check whether the corresponding SCXI module channel is saturated. The SCXI-1303 has pullup and bias resistors that saturate the channel by applying +5 V at the input of the open channel. Notice that this will result in saturation to either of the positive or negative rails.

SCXI-1102/B/C Module

You can replace the 10 Ω bias resistor networks (factory shipping configuration) in the SCXI-1303 with the 10 MΩ resistor networks supplied in the kit. With the 10 MΩ resistor networks, it does not matter whether your signal is ground-referenced or floating. The channels with open thermocouples will saturate at all sample rates of the module. To replace your resistor networks, refer to the *Changing Resistor Networks* section.

SCXI-1100 Module

For the open thermocouple channel to saturate without disturbing the measurements on any other channel, use an interchannel delay of 200 μs at a gain of 100 or higher, which corresponds to a sample rate of 5 kHz.

With the 10 Ω bias resistors installed in the SCXI-1303, you can measure accurately at the module's maximum sampling rate, but the open thermocouple channel may not saturate if the interchannel delay is less than 200 μs or if the sample rate is more than 5 kHz at a gain of 100 or higher.

If you want fast open-thermocouple detection and you have a short thermocouple or if high accuracy is not important, you can replace the pullup resistors with a lower value resistor network. For example, you could replace the pullup resistor network with a 1 MΩ, 10-pin bused configuration resistor network (not supplied) and have a sample rate of 20 kHz (interchannel delay of 50 μs typical). With a 10 Ω bias resistor network, the current leakage would be 5 μA (5 V/1 MΩ), which may result in a larger offset error because of thermocouple lead resistance. To replace your resistor networks, refer to the *Changing Resistor Networks* section.

Errors Due to Open-Thermocouple Detection Circuitry

Open-thermocouple detection circuitry can cause two types of measurement errors. These errors are the results of common-mode voltage at the input of the SCXI module and current leakage into your signal leads.

Common-Mode Voltage at the Input of the SCXI Module

With 10 MΩ pullup and bias resistors, a common-mode voltage of 2.5 VDC will develop if the thermocouple is floating. At a gain of 100, the common-mode rejection of the SCXI-1102/B/C module is sufficiently high that the resulting offset voltage is negligible.

If your application demands extremely high accuracy, you can eliminate this offset error by calibrating your system. You can also remove the pullup resistor, giving up the open-thermocouple detection feature in the process or use the 10 Ω bias resistor networks, which will bring the common-mode voltage down to nearly 0 VDC.

Current Leakage

The open thermocouple detection circuitry results in a small current leakage into the thermocouple. With the 10 MΩ bias and pullup resistor networks, the current leakage results in a negligible error. With the 10 Ω bias resistor, the 10 MΩ pullup resistor connected to 5 VDC causes a current leakage of approximately 0.5 µA (5 V/10 MΩ) to flow into the unbroken thermocouple. If the thermocouple is very long, a voltage drop can develop in the thermocouple because of lead resistance. For example, if you have a 24 AWG J-type thermocouple that is 20 feet long, a voltage drop of approximately 8.78 µV (0.878 Ω/double ft × 20 double ft × 0.5 µA) can develop in the thermocouple, which corresponds to an error of 0.18° C.

If your application demands very high accuracy, you may want to eliminate this error by removing the appropriate pullup resistor network or by calibrating the system offset.

Temperature Sensor Output and Accuracy

The SCXI-1303 temperature sensor outputs 1.91 to 0.58 V from 0° to 55° C and has an accuracy of ±0.5° C over the 15° to 35° C range and ±0.9° C over the 0° to 15° and 35° to 55° C ranges[1].

National Instruments software can convert a thermistor voltage to the thermistor temperature for the circuit diagram shown later in this guide. In LabVIEW, you can use the Convert Thermistor Reading virtual instrument (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

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

[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.

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

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.

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

The SCXI-1102/B/C has a 2 Hz filter on the $V_{TEMPOUT}$ signal.

The SCXI-1100 does not have a filter on the $V_{TEMPOUT}$ signal. Therefore, use an average of a large number of samples to obtain the most accurate measurement. Noisy environments require more samples for greater accuracy.

Configuring the Resistor Networks

Note ***A package of 10 MΩ resistor networks is included in the SCXI-1303 kit. If you are using the SCXI-1102/B/C module, you can install these resistor networks as RP1, RP2, RP3, and RP4. With this recommended configuration, it does not matter whether the thermocouples are ground-referenced or floating.***

The SCXI-1303 terminal block has a pullup resistor connected between CH+ and +5 V and a bias resistor connected between CH– and chassis ground. Figure 2 shows how the pullup and bias resistors are connected to the CH± inputs.

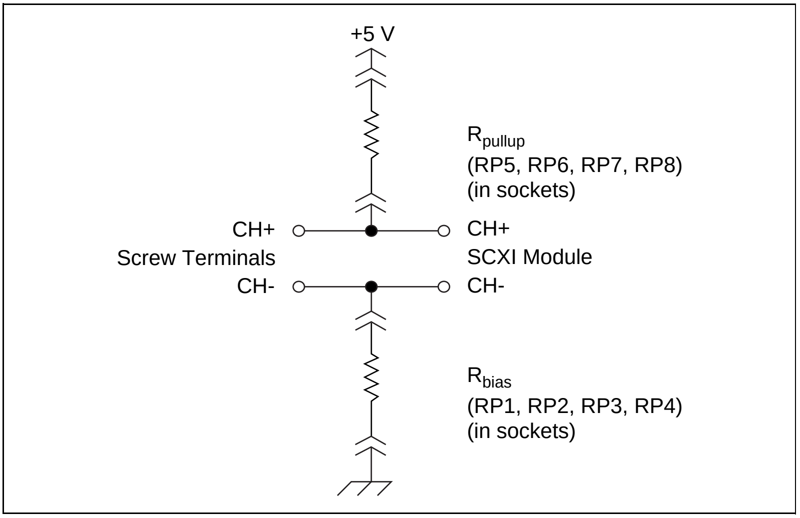


Figure 2. Resistor Connections

Table 1 shows the relationship between the channel input signals and the resistor networks.

Table 1. Channel Input Signals and Resistor Networks

Channel	Pullup Resistor Network	Bias Resistor Network
0–7	RP5	RP1
8–15	RP6	RP2
16–23	RP7	RP3
24–31	RP8	RP4

Table 2 shows which resistor networks to use for your SCXI module, signal type, and application.

Table 2. Selecting the Appropriate Resistor Networks

Module	Bias Resistor	Pullup Resistor	Source Impedance	Signal (Floating or Ground-referenced)	Open Thermocouple Detection?	Comments
SCXI-1102 /B/C	10 MΩ	10 MΩ	Low	Both	Yes	Recommended configuration for the SCXI-1102/B/C
	10 Ω	10 MΩ	Low	Floating	Yes	Factory-shipping configuration
	10 Ω	None	High or low	Floating	No	—
	None	None	High or low	Ground-referenced	No	—
SCXI-1100	10 MΩ	10 MΩ	—	—	—	Not recommended
	10 Ω	10 MΩ	Low	Floating	Yes	Factory-shipping configuration
	10 Ω	None	High or low	Floating	No	—
	None	None	High or low	Ground-referenced	No	—
low source impedance ≤50 Ω high source impedance >50 Ω						

Warning ***Connecting an external ground-referenced signal with the 10 Ω bias resistor network in place may cause permanent damage to the resistor network and the traces on the SCXI-1303 printed circuit board. National Instruments is NOT liable for any damage or injuries resulting from improper signal connections.***

Signal Connection

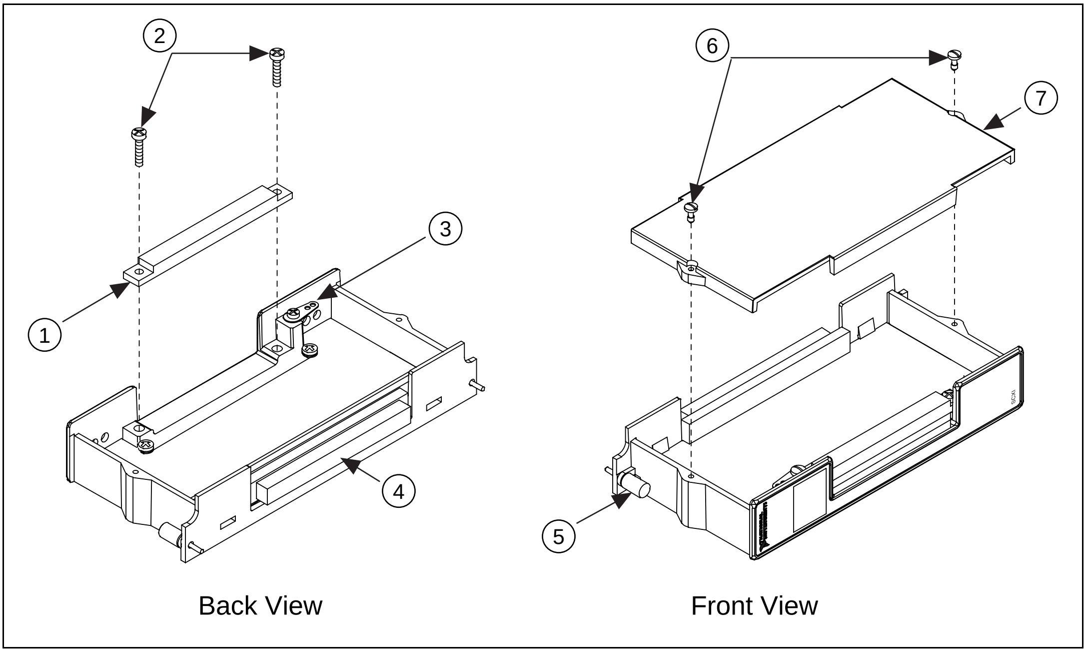
When connecting your signals to the SCXI-1303, follow the labeling on the SCXI-1303 for the appropriate module, as indicated in Figure 4.

To connect the signal to the terminal block, perform the following steps, referring to Figures 3 and 4 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. Run the signal wires through the strain-relief opening. You can add insulation or padding if necessary.
4. Prepare your signal wire by stripping the insulation no more than 7 mm.

5. 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.
6. Tighten the screw terminal to a torque of 5–7 in.-lb.
7. Connect your shield or earth ground to the earth ground solder lug.
8. Reinstall the strain-relief bar and tighten the strain-relief screws.
9. Reinstall the top cover and tighten the top cover screws.
10. Connect the terminal block to the module front connector as explained in the *Installation* section later in this guide.

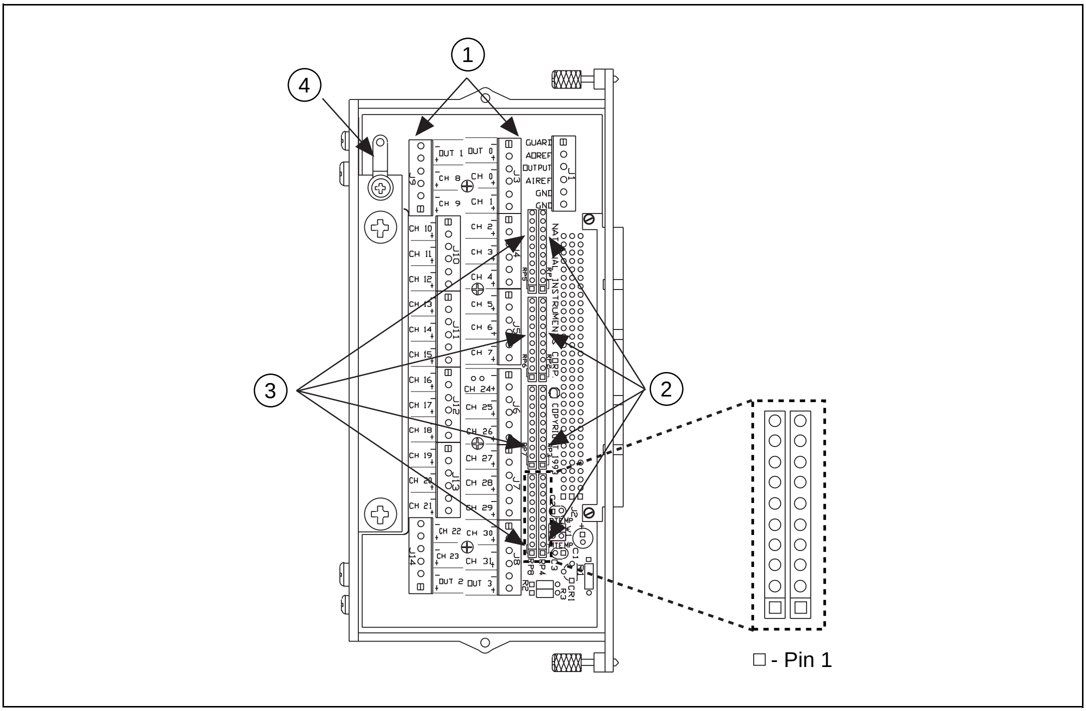
Figure 3 shows the SCXI-1303 terminal block parts locator diagram.



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

Figure 3. SCXI-1303 Parts Locator Diagram

Figure 4 shows the SCXI-1303 signal connections.



1 Screw Terminals 2 Bias Resistor Networks	3 Pullup Resistor Networks	4 Product Name, Assembly Number, Revision Letter, and Serial Number.

Figure 4. SCXI-1303 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. Tighten the top and bottom thumbscrews on the back of the terminal block to hold it securely in place.

☞ **Note** ***For accurate cold-junction compensation, place the SCXI chassis away from an 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

Cold-junction sensor

Accuracy[1] ....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

Temperature Sensor Circuit Diagram

The circuit diagram in Figure 5 provides optional details about the SCXI-1303 temperature sensor.

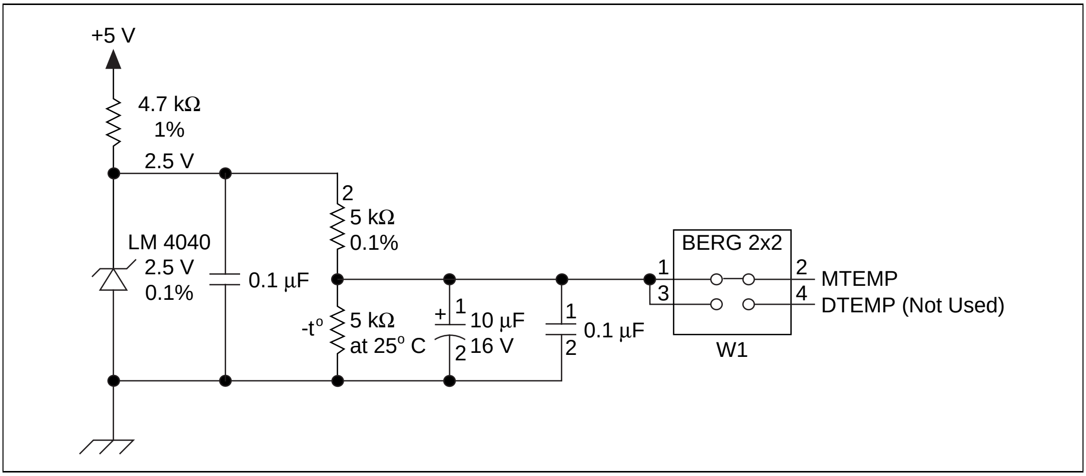


Figure 5. Temperature Sensor Circuit Diagram

[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.

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