SCXI™

SCXI-1581 User Manual

Worldwide Technical Support and Product Information

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Conventions

The following conventions are used in this manual:

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

This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash.

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 bold   Bold text in this font denotes the messages and responses that the computer automatically prints to the screen. This font also emphasizes lines of code that are different from the other examples.

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Installing and Configuring the SCXI-1581

This chapter provides information for the SCXI-1581 module installation, configuration, and removal.

About the SCXI-1581

The SCXI-1581 module provides 32 channels of 100 µA current excitation. You can use the SCXI-1581 in any application that requires 100 µA fixed current excitation. The SCXI-1581 is configured using Measurement & Automation Explorer (MAX).

Installing the Software

Follow these instructions to install your SCXI-1581 software:

1. Install your application development environment (ADE) if you have not already done so. National Instruments ADEs have release notes containing software installation instructions.

2. Install NI-DAQ, which came with your DAQ device. NI-DAQ version 6.9.1 or higher is required to configure your SCXI-1581 module. If you do not have NI-DAQ version 6.9.1 or higher, you can either contact a National Instruments sales representative to request it on a CD or download the latest NI-DAQ version at no cost from the National Instruments web site, `ni.com/download`.

Safety Information

⚠ **Cautions**   Do *not* operate the device in an explosive atmosphere or where there may be flammable gases or fumes.

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 SCXI-1581 can come in contact.

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 DAQ devices 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.

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 SCXI-1581 module *must* be used with a UL-listed SCXI chassis.

Installing the SCXI-1581

The following section describes how to install your SCXI-1581 for use with SCXI chassis and National Instruments DAQ devices.

Unpacking

Your SCXI-1581 module is shipped in an antistatic package to prevent electrostatic damage to the module.

⚠ **Caution**   *Never* touch the exposed pins of connectors.

Electrostatic discharge can damage several components in the module. To avoid such damage while handling the module, take the following precautions:

- Ground yourself using a grounding strap or by holding a grounded object.
- Touch the antistatic package to a metal part of your plugged-in computer chassis before removing the module from the package.

Remove the module from the package and inspect the module for loose components or any sign of damage. Notify National Instruments if the module appears damaged in any way. Do *not* install a damaged module into your SCXI chassis.

Store your SCXI-1581 module in the antistatic package when not in use.

Installing the SCXI-1581 Module into the SCXI Chassis

You need the following items to complete the installation:

- SCXI-1581
- SCXI chassis or PXI combination chassis
- 1/4 in. flathead screwdriver

✎ **Note**   The SCXI-1581 has no user-serviceable parts. Disassembly of the module for any reason can void its warranty and nullify its accuracy specification.

To install your SCXI-1581 module into the SCXI chassis, follow these steps while referring to Figure 1-1:

1. Turn off the computer that contains the DAQ device, or disconnect it from your SCXI chassis.

2. Turn off the SCXI chassis. Do *not* insert the SCXI-1581 module into a chassis that is turned on.

3. Insert the SCXI-1581 into an open slot in the SCXI chassis. Gently slide the module into the slot guides and push it toward the back of the chassis until the front face of the module is flush with the front of the chassis.

4. Insert any other SCXI modules into the remaining slots in the same manner as described in step 3.

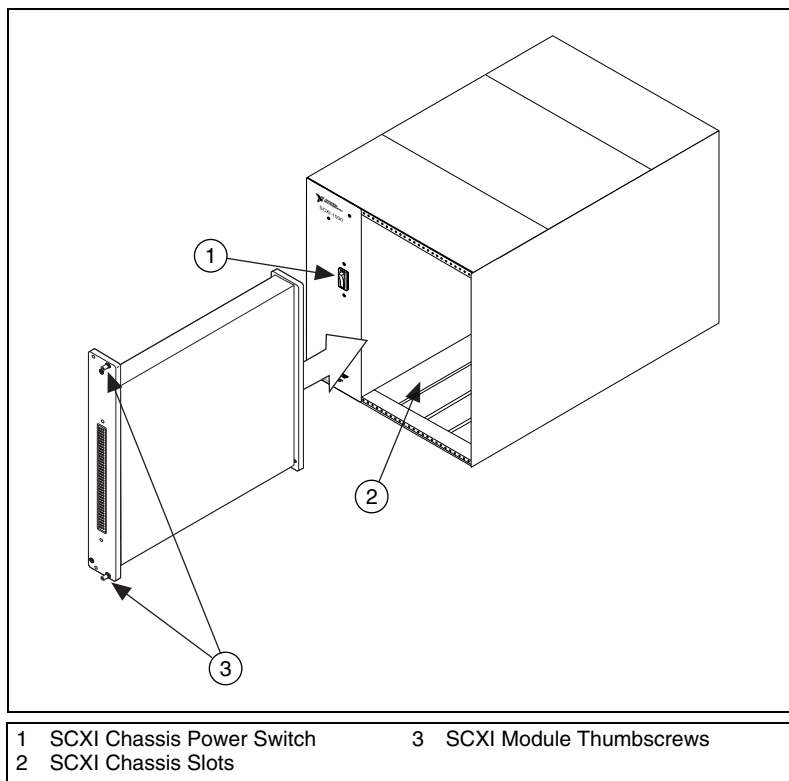5. Secure all the SCXI modules to the SCXI chassis using both thumbscrews.

| 1 | SCXI Chassis Power Switch | 3 | SCXI Module Thumbscrews |
| 2 | SCXI Chassis Slots | | |

Figure 1-1. Installing the SCXI-1581 Module

To complete your SCXI-1581 installation, follow the procedure in the appropriate sections that follow.

Connecting the SCXI-1581 to a DAQ Device for Multiplexed Scanning in an SCXI Chassis

In this configuration, you can multiplex the input channels of the SCXI analog-input modules into a single channel of your DAQ device. You need the following items for this installation:

- SCXI chassis with the SCXI module(s) installed
- SCXI cable assembly, which consists of a cable adapter and a cable
- An installed National Instruments DAQ device
- 1/4 in. flathead screwdriver

Consult your SCXI chassis documentation, other SCXI module documentation, and DAQ device documentation for additional instructions and warnings. You should have already installed your SCXI-1581 module and any other SCXI modules in the chassis according to their installation instructions.

In your chassis, you must select one of the analog-input modules or the SCXI-1581 in the chassis as the cabled module, the module to which the SCXI cable assembly connects. If the chassis contains at least one simultaneous-sampling module, such as the SCXI-1520, SCXI-1530/1531, and SCXI-1140, select it as the cabled module; otherwise, select one of the remaining analog-input modules or the SCXI-1581.

Note   The SCXI-1581 module is *not* an analog-input module.

To connect the chassis to a DAQ device for multiplexed operation, complete the following steps while referring to Figure 1-2:

1. Turn off the SCXI chassis.
2. Turn off the computer that contains the DAQ device.
3. Insert the cable adapter into the back of the SCXI chassis aligned with the module that you intend to connect to the DAQ device. See the installation guide for your cable assembly for more information.
4. Connect the cable to the back of the cable adapter, ensuring that the cable fits securely.

5. Connect the other end of the cable to the DAQ device you are using to control the SCXI system.

6. Check the cable installation, making sure the connectors and cable adapter are securely fastened at both ends.

7. Turn on the SCXI chassis.

8. Turn on the computer.

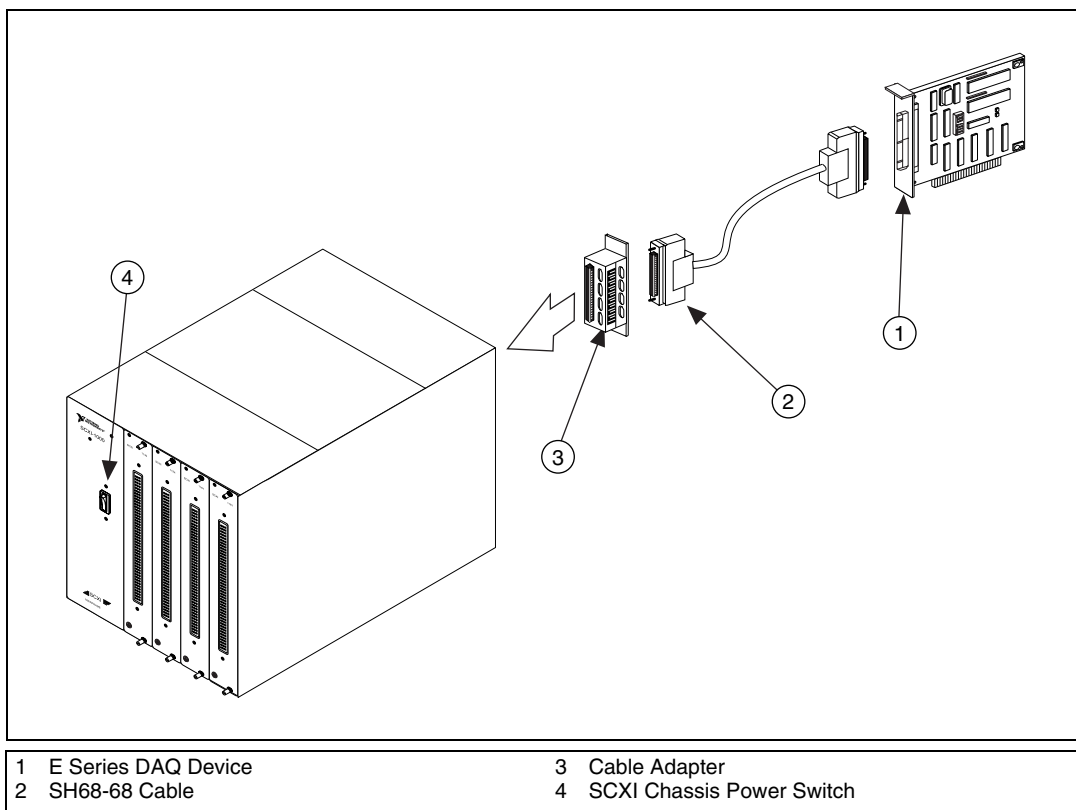| 1 | E Series DAQ Device | 3 | Cable Adapter |
| 2 | SH68-68 Cable | 4 | SCXI Chassis Power Switch |

Figure 1-2. Connecting an SCXI Chassis to a DAQ Device

If you have already installed the appropriate software, refer to the *Configuration and Self-Test* section to configure the SCXI-1581 module(s) for multiplexed mode operation.

Connecting the SCXI-1581 to a DAQ Device for Multiplexed Scanning in a PXI Combination Chassis

In this configuration, you can multiplex the input channels of the SCXI analog-input modules into a single channel of your DAQ device in a combination PXI chassis. You need the following items for this installation:

- PXI combination chassis (PXI-1010 or PXI-1011) with the SCXI module(s) installed

- National Instruments PXI MIO DAQ device installed in the right-most PXI slot

Consult your PXI chassis documentation, other SCXI module documentation, and DAQ device documentation for additional instructions and warnings. You should have already installed your software, SCXI-1581 module, and any other SCXI modules in the chassis according to their installation instructions. To use the SCXI-1581 module in multiplexed mode with a DAQ device in a PXI combination chassis, follow these steps:

1. No cables are required between the SCXI-1581 and the DAQ device if the National Instruments PXI DAQ device is installed in the right-most PXI slot. You can configure this device to control the SCXI system using an internal bus that connects the PXI chassis to the SCXI chassis. If the DAQ device for controlling the SCXI system is not installed in the right-most slot of the PXI combination chassis, assemble the system as described in the *Connecting the SCXI-1581 to a DAQ Device for Multiplexed Scanning in an SCXI Chassis* section.

2. Turn on the SCXI portion of the PXI combination chassis.

You should have already installed the appropriate software. See the *Configuration and Self-Test* section to configure the SCXI-1581 for multiplexed mode operation.

Configuration and Self-Test

Run MAX to configure and test your SCXI-1581. If you need help during the configuration process, select **Help»Help Topics»NI-DAQ** from the menu. Follow these steps to configure your SCXI system:

1. Launch **Measurement & Automation Explorer**.

2. Expand **Devices and Interfaces**.

   - If you added new modules to an existing chassis, go to step 6.

   - If you inserted modules into an empty chassis, go to step 3.

3. Add a new chassis to the configured devices and interfaces by right-clicking **Devices and Interfaces** and selecting **Create New**.

4. Select the appropriate chassis from the list box and click **Finish**.

5. Configure the chassis:

   a. Select a **Chassis ID**. This ID is an integer value you choose to uniquely identify the chassis for programming and scanning.

   b. Select the **Chassis Address**. This selection is needed to address the chassis in a multichassis SCXI system. Unless you are using multiple chassis with the same DAQ device, select a Chassis Address of zero, which is the factory-default setting of all SCXI chassis. A chassis address of zero is indicated by setting all of the chassis address DIP switches to the *OFF* position. If you are using multiple chassis or one or more of the chassis address DIP switches is not in the *OFF* position, refer to your SCXI chassis user manual for further information.

   c. Click **Finish**.

6. You can now choose to automatically detect which modules are installed in the chassis or you can manually add them.

   • If you have just added the chassis to **Devices and Interfaces** and are using an E Series DAQ device, you can automatically detect the modules.

   • If the chassis was already listed in **Devices and Interfaces**, you must add new modules manually.

Go to the appropriate following section to continue the software configuration of your chassis.

Auto-Detecting Modules

If you selected auto-detect, you must have connected the SCXI chassis to your DAQ device.

Before auto-detecting modules, follow the steps in the *Configuration and Self-Test* section.

To auto-detect your SCXI module(s), follow these steps:

1. Make sure the chassis is turned on.

2. Select **Yes** under **Auto-Detect modules** and click **Next**.

3. Select your communication path and click **Next**.

4. If modules were detected, select the module connected to your DAQ device as your communication path.

5. Click **Finish**.

6. MAX should now recognize your SCXI chassis and SCXI module(s). If MAX did not recognize your modules, check your cable connections and retry auto-detecting, or try installing the modules manually before taking troubleshooting measures. If MAX recognized any module as an SCXI custom module, you have an old version of NI-DAQ. If you do not have NI-DAQ version 6.9.1 or higher, you can either contact a National Instruments sales representative to request it on a CD or download the latest NI-DAQ version at no cost from the National Instruments web site, ni.com/download. If you need to change the module configuration, refer to the *Configuring the SCXI-1581* section in this chapter.

Manually Adding Modules

If you did not auto-detect your SCXI modules, you must add each of your modules separately. If you are still in the Chassis Configuration window, select **No** under **Auto-Detect modules** and click **Finish**. Use the following steps to manually add modules:

1. Display the list of devices and interfaces by expanding **Devices and Interfaces**.

2. The chassis you selected is displayed in the list. Display the list of modules in the chassis by expanding **Chassis**.

3. Right-click the appropriate installation slot and click **Insert**.

4. Select the module installed in that slot and click **Next**. If the appropriate module name does not appear on the list, you might have an old version of NI-DAQ. If you do not have NI-DAQ version 6.9.1 or higher, you can either contact a National Instruments sales representative to request it on a CD or download the latest NI-DAQ version at no cost from the National Instruments web site, ni.com/download.

5. Configure your module as follows:

   a. If the selected module is connected to a National Instruments DAQ device, select that device by using the **Connected to** control. If it is not, select **none**.

   b. If you want this DAQ device to control the chassis, confirm that there is a check in the checkbox labeled **This device will control the chassis**.

   c. Select the accessory you are using with this module.

   d. When you have completed configuration, click **Finish**.

If you need to manually install more SCXI-1581 modules in your chassis, repeat steps 3 through 5 to configure each module.

Your SCXI chassis and SCXI module(s) should now be configured properly. If you need to change your module configuration, see the *Configuring the SCXI-1581* section. If your configuration is complete, test the system as described in the *Verifying and Self-Testing the Configuration* section to ensure your SCXI system is communicating properly with the DAQ device.

Configuring the SCXI-1581

To configure your SCXI-1581 after auto-detection, or to alter your original configuration selections, you must use MAX. Perform the following steps to configure your SCXI-1581:

1. Launch **Measurement & Automation Explorer**.

2. Display the list of installed devices and interfaces by expanding **Devices and Interfaces**.

3. Locate the SCXI chassis in the list. Display the list of modules in the chassis by expanding **Chassis**.

4. Right-click the SCXI-1581 module you want to configure and select **Properties**. Click the **General** tab.

5. If the module you are configuring is connected to a National Instruments DAQ device, select that device by using the **Connected to** control. If you want this DAQ device to control the chassis, confirm there is a check in the checkbox labeled **This device will control the chassis**. If the module you are configuring is not connected to a National Instruments DAQ device, select **none**.

6. Click the **Accessory** tab. Select the accessory you are using with this module. When all of your configurations are completed, click **OK**.

Your SCXI chassis and SCXI module(s) should now be configured properly. You should now test the system in the section that follows to ensure your SCXI system is communicating properly with the DAQ device.

Verifying and Self-Testing the Configuration

To test the successful configuration of your system, follow these steps after opening MAX:

1. Verify that the chassis power is on and is correctly connected to a DAQ device.

2. Display the list of devices and interfaces by expanding **Devices and Interfaces**.

3. From the list that appears, locate the chassis you want to test. Right-click the chassis and click **Test**.

4. If the communication test is successful, a message `The chassis has been verified` appears. Click **OK**.

Your SCXI system should now operate properly with your ADE software.

Removing the SCXI-1581

This section shows you how to remove the SCXI-1581 from an SCXI chassis.

Removing the SCXI-1581 from an SCXI Chassis

You need the following items to complete this task:

•   SCXI chassis or PXI combination chassis with the SCXI-1581 module installed

•   1/4 in. flathead screwdriver

Consult the documentation for your SCXI/PXI chassis and accessories for additional instructions and warnings. To remove the SCXI-1581 module from an SCXI chassis, follow these steps while referring to Figure 1-3:

1. Turn off the SCXI/PXI chassis power.

2. If the SCXI-1581 is the cabled module, disconnect the cable running from the SCXI-1581 to the DAQ device.

3. Remove any terminal block that connects to the SCXI-1581.

4. Turn off the SCXI chassis. Do *not* remove the SCXI-1581 module from a chassis that is powered on.

5. Rotate the thumbscrews that secure the SCXI-1581 to the chassis counter-clockwise until they are loose, but do not completely remove the thumbscrews from the SCXI-1581.

6. Remove the SCXI-1581 by pulling steadily on both thumbscrews until the module slides completely out.

1	Cable	4	Terminal Block
2	SCXI Module Thumbscrews	5	SCXI Chassis Power Switch
3	SCXI-1581	6	SCXI Chassis

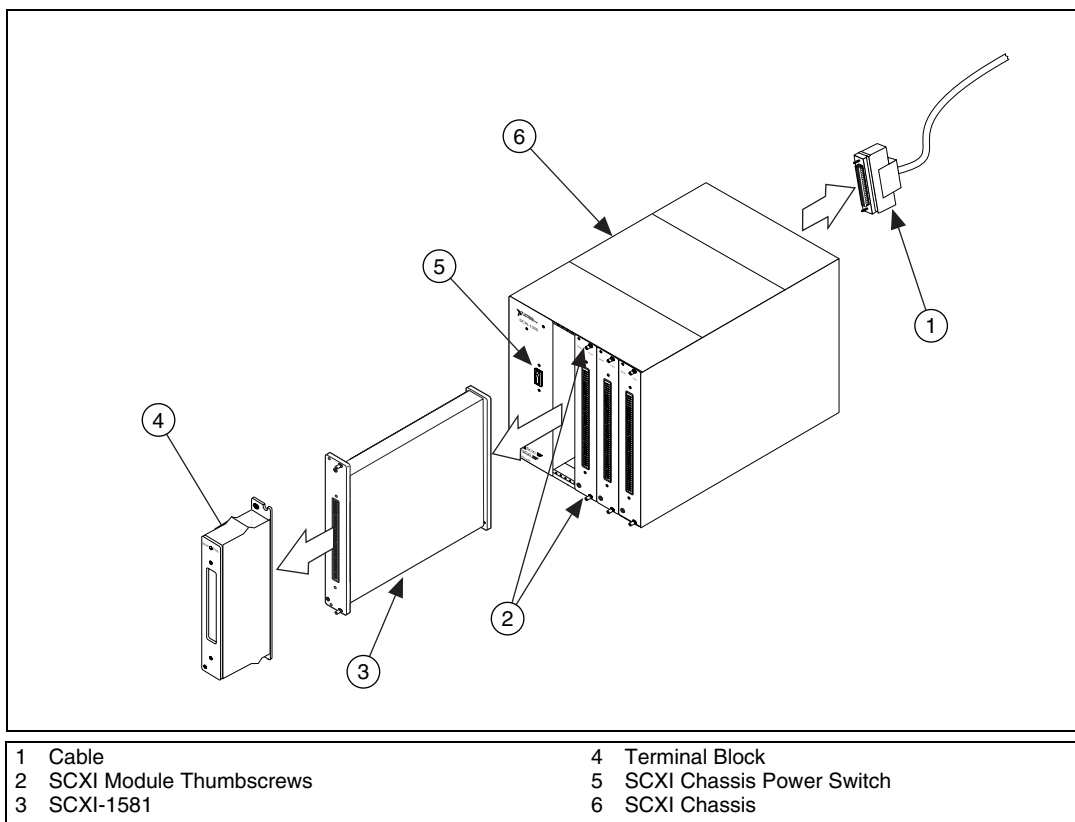**Figure 1-3.** Removing the SCXI-1581

Removing the SCXI-1581 from Measurement & Automation Explorer

To remove a module from MAX, perform these steps after launching MAX:

1. Display the list of installed devices and interfaces by expanding **Devices and Interfaces**.

2. Locate the chassis in the list of installed devices. Display the list of modules in the chassis by expanding **Chassis**.

3. Right-click the module or chassis you want to delete and click **Delete**.

4. You are presented with a confirmation window. Click **Yes** to continue deleting the module or chassis or **No** to cancel this action.

Note   Deleting the SCXI chassis deletes all modules in the chassis. All configuration information for these modules is also lost.

Your SCXI chassis and/or SCXI module(s) should now be removed from the list of installed devices in MAX.

2

Using the SCXI-1581

This chapter discusses operation of the current sources, signal connections, and scanning related to using the SCXI-1581 module.

Operation of the Current Sources

The current sources on the SCXI-1581 continuously provide 32 channels of 100 µA current excitation. These current sources are on whenever the SCXI chassis is powered-on. The current sources on the SCXI-1581 are designed to be accurate to within ±0.05% of the specified value with a temperature drift of no more than ±5 ppm/°C. The high accuracy and stability of these current sources makes them especially well suited to measuring resistance to a high degree of accuracy.

Signal Connections

The pin assignments for the SCXI-1581 front signal connector are shown in Table 2-1. The terminal assignments are as follows:

- EX<0..31>+ are the positive output terminals of the current excitation channels.

- EX<0..31>– are the negative terminals of the current excitation channels. These pins are connected to the SCXI chassis ground.

- CGND is connected to the SCXI chassis ground.

✎ **Note** The positive terminals are listed in Column C and the negative terminals are listed in Column B. The pins labeled RSVD are reserved. Do *not* make any connections to these pins. The pins labeled NC are not connected. See Appendix B, *Accessories*, for a list of accessories that provide an interface between field wiring and the front signal connector. See Appendix D, *Measuring Temperature with Resistive Transducers*, for information about connecting resistive transducers to the SCXI-1581.

Table 2-1. Front Signal Connector Pin Assignments

Pin Number	Column A	Column B	Column C
32	NC	EX0–	EX0+
31	NC	EX1–	EX1+
30	NC	EX2–	EX2+
29	NC	EX3–	EX3+
28	RSVD	EX4–	EX4+
27	RSVD	EX5–	EX5+
26	RSVD	EX6–	EX6+
25	RSVD	EX7–	EX7+
24	NC	EX8–	EX8+
23	NC	EX9–	EX9+
22	NC	EX10–	EX10+
21	NC	EX11–	EX11+
20	RSVD	EX12–	EX12+
19	RSVD	EX13–	EX13+
18	NC	EX14–	EX14+
17	NC	EX15–	EX15+
16	NC	EX16–	EX16+
15	NC	EX17–	EX17+
14	NC	EX18–	EX18+
13	NC	EX19–	EX19+
12	NC	EX20–	EX20+
11	NC	EX21–	EX21+
10	NC	EX22–	EX22+
9	NC	EX23–	EX23+
8	NC	EX24–	EX24+
7	NC	EX25–	EX25+

Table 2-1. Front Signal Connector Pin Assignments (Continued)

Pin Number	Column A	Column B	Column C
6	NC	EX26–	EX26+
5	NC	EX27–	EX27+
4	NC	EX28–	EX28+
3	NC	EX29–	EX29+
2	CGND	EX30–	EX30+
1	RSVD	EX31–	EX31+

Scanning Other SCXI Modules Through the SCXI-1581

When connected as the cabled module in an SCXI chassis, the SCXI-1581 can route the multiplexed signals from other SCXI modules to the DAQ device. The SCXI-1581 routes multiplexed signals from other SCXI modules to the DAQ device even though the SCXI-1581 does not have any analog-input channels.

Theory of Multiplexed Hardware Operation

When you configure a module for multiplexed operation, the routing of analog-input signals to the DAQ device depends on the module in the SCXI system to which the DAQ device is cabled. There are several possible scenarios for routing signals from the multiplexed modules to the DAQ device.

If the module you are scanning is not directly cabled to the DAQ device, the module sends its signals through the SCXIbus to the cabled module. The cabled module, whose routing is controlled by the SCXI chassis, routes the SCXIbus signals to the DAQ device through the MCH0 pins on its rear signal connector shown in Figure 2-1. Because the SCXI-1581 does not have any input channels to scan, multiplexed scanning is the only scanning mode that is possible when the SCXI-1581 is the cabled module.

If the module you are scanning is directly cabled to the DAQ device, the module routes its input signals through the MCH0 pins on its rear signal connector.

The power of SCXI multiplexed scanning is its ability to route many input channels to a single channel on the DAQ device. The number of channels you can scan in multiplexed mode is limited to 512 channels per chassis.

AIGND	1	2	AIGND
MCH0+	3	4	MCH0–
	5	6	
	7	8	
	9	10	
	11	12	
	13	14	
	15	16	
	17	18	
OUTREF	19	20	
	21	22	
	23	24	DIGGND
SERDATIN	25	26	SERDATOUT
DAQD*/A	27	28	
SLOT0SEL*	29	30	
	31	32	
DIGGND	33	34	
	35	36	SCANCLK
SERCLK	37	38	
	39	40	
	41	42	
	43	44	
	45	46	SYNC
	47	48	
	49	50	

Figure 2-1. Rear Signal Connector Pin Assignments

Immediately prior to a multiplexed scanning operation, the SCXI chassis is programmed with a module scan list that controls which module sends its output to the SCXIbus during a scan. Depending on which module you are scanning, you can give the list of channels in a random order or you are required to give the list in sequential order.

Please refer to the appropriate user manual for information regarding the procedure for scanning specific SCXI analog-input modules.

A

Specifications

This appendix lists the specifications for the SCXI-1581 modules. These specifications are typical at 25 °C unless otherwise noted.

Stability

Recommended warm-up time .... 10 min

Excitation

Channels .... 32 single-ended outputs

Current output .... 100 μA

Accuracy .... ±0.05%

Temperature drift .... ±5 ppm/°C

Output voltage compliance .... 10 V

Maximum resistive load .... 100 kΩ

Overvoltage protection .... ±40 V

Power Requirements From SCXI Backplane

V+ .... 18.5 to 25 VDC, 75 mA

V− .... −18.5 to −25 VDC, 23 mA

+5 V .... +4.75 to 5.25 VDC, 20.2 mA

Physical

Dimensions .... 3.0 by 17.2 by 20.3 cm
(1.2 by 6.9 by 8.0 in.)

Environment

Operating temperature ....0 to 50 °C

Storage temperature ....–20 to 70 °C

Relative humidity ....10 to 90% noncondensing

Safety

Designed in accordance with IEC 61010-1, EN61010-1, UL 3111-1, and CAN/CSA C22.2 No. 1010.1 for electrical measuring and test equipment

For use at altitudes up to 2,000 m

Installation Category I[1]

Pollution Degree 2

Regulatory Compliance

✎ **Note**   For full EMC and EMI compliance, you must operate this device with shielded cabling. See the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, click **Declaration of Conformity** at `ni.com/hardref.nsf`. This website lists the DoCs by product family. Select the appropriate product family, followed by your product, and a link to the DoC (in Adobe Acrobat format) appears. Click the Acrobat icon to download or read the DoC.

European

EMC..EN 61326 Group I Class A, 10m,
                                                     Table 1 Immunity

Safety ....EN 61010-1

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[1] Category I is signal level, that is, voltages on a printed wire board on the secondary of an isolation transformer.

North American

EMC .... FCC Part 15 Class A using CISPR
ICES003 via harmonization to
FCC Part 15

Australia & New Zealand

EMC .... AS/NZS 2064.1/2 (CISPR-11)

B

Accessories

This section lists and describes the optional accessories available for the SCXI-1581.

Table B-1. SCXI-1581 Accessories

Accessory	Description
SCXI-1300	Screw terminal block—a front-mounted general-purpose terminal block[1] that works with the SCXI-1581, SCXI-1100, SCXI-1102/B/C, and SCXI-1104/C modules. You can also use the SCXI-1300 with the SCXI-1181, and SCXI-1181K, modules.
SCXI-1310	Connector and shell assembly—an inexpensive alternative to a terminal block. You can solder field wiring to eyelet-type terminals for easy hook-and-solder signal connection.
TBX-96	DIN-rail mounted terminal block with 96 generic screw terminals that also works with the SCXI-1100, SCXI-1102/B/C, and SCXI-1104/C. One of the following cables is required to connect the TBX-96 to an SCXI module: – SH96-96 shielded cable, 1 m – R96-96 unshielded ribbon cable, 1 m
BNC-2095	BNC rack-mount accessory. See Appendix E, *Common Questions*, for information regarding connecting the SCXI-1581 to the BNC-2095.

[1] When connected to an SCXI-1581, you cannot measure the onboard temperature sensor.

C

Connectors

This appendix describes the front and rear signal connectors on the SCXI-1581.

Front Signal Connector

The front signal connector, shown in Table 2-1, *Front Signal Connector Pin Assignments*, is a special 96-pin DIN C male front connector through which all signal connections are made.

⚠ **Caution** Do *not* make signal connections to pins marked RSVD in Table 2-1, *Front Signal Connector Pin Assignments*.

Rear Signal Connector

The rear signal connector is a 50-pin male ribbon-cable connector used for analog signal connectivity and communication between the SCXI-1581 and the connected DAQ device. The rear signal connector is shown in Figure 2-1, *Rear Signal Connector Pin Assignments*. Grounding signals AIGND and OUTREF provide reference signals needed in the various analog input referencing modes on the DAQ device. In multiplexed mode, the MCH0 signal pair is used for sending analog signals from other modules to the connected DAQ device. If the module is directly connected to the DAQ device, the other analog channels of the DAQ device are available for general-purpose analog input because they are not connected to the SCXI-1581 in multiplexed mode.

The communication signals between the DAQ device and the SCXI system are SERDATIN, SERDATOUT, DAQD*/A, SLOT0SEL*, SERCLK, and SCANCLK. The digital ground, DIGGND on pins 24 and 33, provides a separate ground reference for the communication signals. SERDATIN, SERDATOUT, DAQD*/A, SLOT0SEL*, and SERCLK are the communication lines for programming the SCXI-1581. The SCANCLK and SYNC signals are the signals necessary for multiplexed mode scanning. If the DAQ device is connected to the SCXI-1581, these digital lines are unavailable for general-purpose digital I/O.

D

Measuring Temperature with Resistive Transducers

This appendix discusses RTDs and thermistors and describes how to connect resistive transducers to your signal conditioning system.

RTDs

A resistive-temperature detector (RTD) is a temperature-sensing device whose resistance increases with temperature. An RTD consists of a wire coil or deposited film of pure metal. RTDs are made of different metals and have different resistances, but the most popular RTD is made of platinum and has a nominal resistance of 100 Ω at 0 °C.

RTDs are known for their excellent accuracy over a wide temperature range. Some RTDs have accuracies as high as 0.01 Ω (0.026 °C) at 0 °C. RTDs are also extremely stable devices. Common industrial RTDs drift less than 0.1 °C/year, and some models are stable to within 0.0025 °C/year.

RTDs are sometimes difficult to measure because they have relatively low nominal resistance (commonly 100 Ω) that changes only slightly with temperature (less than 0.4 Ω/°C). To accurately measure these small changes in resistance, you need to use special configurations that minimize measured errors caused by lead-wire resistance.

Because an RTD is a passive resistive device, you must pass a current through it to produce a measurable voltage. This current causes the RTD to heat internally, which appears as an error. Self-heating is typically specified as the amount of power that raises the RTD temperature by 1 °C, given in units of mW/°C. You can minimize self-heating by using the smallest possible excitation current. The amount of self-heating also depends heavily on the medium into which you immerse the RTD. An RTD can self-heat up to 100 times higher in still air than in moving water.

The Relationship Between Resistance and Temperature in RTDs

Compared to other temperature-measurement devices, the output of an RTD is relatively linear with respect to temperature. The temperature coefficient, called alpha (α), differs between RTD curves. Although various manufacturers specify alpha differently, alpha is most commonly defined as the change in RTD resistance from 0 to 100 °C, divided by the resistance at 0 °C, divided by 100 °C:

$$\alpha(\Omega/\Omega/(^{\circ}C)) \ = \ \frac{R_{100} - R_0}{R_0 \times 100 \ ^{\circ}C}$$

where R_{100} is the resistance of the RTD at 100 °C, and R_0 is the resistance of the RTD at 0 °C.

For example, a 100 Ω platinum RTD with $\alpha = 0.003911$ has a resistance of 139.11 Ω at 100 °C.

Figure D-1 displays a typical resistance-temperature curve for a 100 Ω platinum RTD.
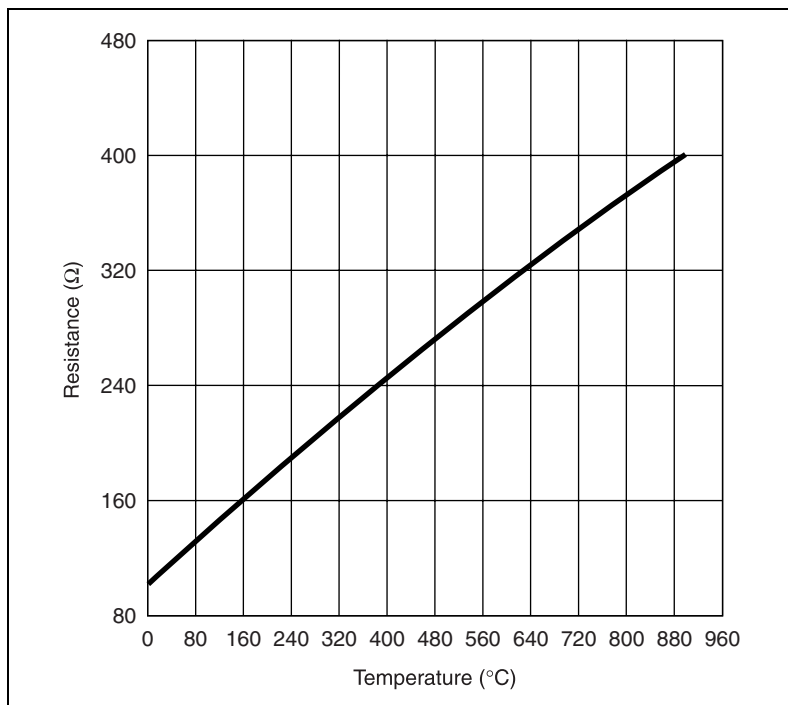
Figure D-1. Resistance-Temperature Curve for a 100 Ω Platinum RTD, $\alpha = 0.00385$

Although the resistance-temperature curve is relatively linear, accurately converting measured resistance to temperature requires curve fitting. The following Callendar-Van Dusen equation is commonly used to approximate the RTD curve:

$$R_T = R_0[1 + AT + BT^2 + C(T - 100)^3]$$

where R_T is the resistance of the RTD at temperature T, R_0 is the resistance of the RTD at 0 °C, A, B and C are the Callendar-Van Dusen coefficients shown in Table D-1, and T is the temperature in °C. Most platinum RTD curves follow one of three standardized curves—the DIN 43760 standard, the U.S. Industrial or American standard, or the International Temperature Scale (ITS-90) used with wire-wound RTDs.

Table D-1. Callendar-Van Dusen Coefficients

Standard	Temperature Coefficient α	A	B	C
DIN 43760	0.003850	3.9080×10^{-3}	-5.8019×10^{-7}	-4.2735×10^{-12}
American	0.003911	3.9692×10^{-3}	-5.8495×10^{-7}	-4.2325×10^{-12}
ITS-90	0.003926	3.9848×10^{-3}	-5.870×10^{-7}	-4.0000×10^{-12}

For temperatures above 0 °C, coefficient C equals 0, reducing this equation to a quadratic. If you pass a known current, I_{EX}, through the RTD and measure the output voltage developed across the RTD, V_0, you can solve for T as follows:

$$T = \frac{R_0 - \dfrac{V_0}{I_{EX}}}{-0.5\left(R_0 A + \sqrt{R_0^2 A^2 - 4R_0 B\left(R_0 - \dfrac{V_0}{I_{EX}}\right)}\right)}$$

where V_0 is the measured RTD voltage and I_{EX} is the excitation current. You can use the LabVIEW VI **Convert RTD Reading** to convert RTD voltage measurements into temperature readings. This VI is located in the **Data Acquisition»Signal Conditioning** function subpalette.

RTD Measurement Errors

Because the RTD is a resistive device, you must pass a current through the device and monitor the resulting voltage. However, any resistance in the lead wires that connect your measurement system to the RTD adds error to your readings. For example, consider a 2-wire RTD element connected to a measurement system that also supplies a constant current, I_{EX}, to excite the RTD. As shown in Figure D-2, the voltage drop across the lead resistances (labeled R_L) adds an error voltage to the measured voltage.
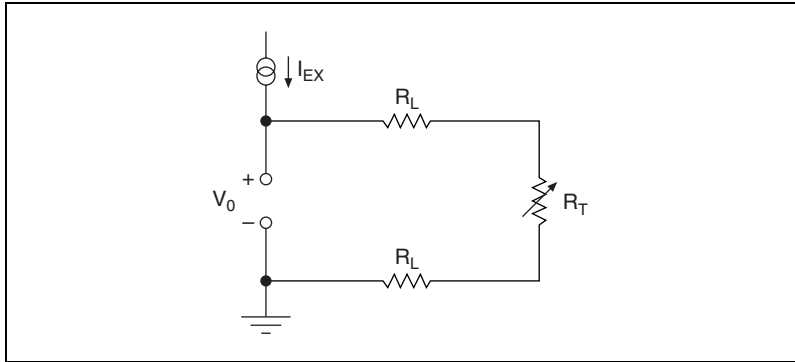
Figure D-2. 2-Wire RTD Measurement

For example, a lead resistance of 0.3 Ω in each wire adds a 0.6 Ω error to the resistance measurement. For a platinum RTD at 0 °C with α = 0.00385, the lead resistance equates to an error of approximately 0.6 Ω/(0.385 Ω/°C) = 1.6 °C.

The *Connecting Resistive Devices to the SCXI-1581* section describes different ways of connecting resistive devices to your SCXI system.

Thermistors

A thermistor is a piece of semiconductor made from metal oxides, pressed into a small bead, disk, wafer, or other shape, sintered at high temperatures, and finally coated with epoxy or glass. The resulting device exhibits an electrical resistance that varies with temperature.

There are two types of thermistors: negative temperature coefficient (NTC) thermistors, whose resistance decreases with increasing temperature, and positive temperature coefficient (PTC) thermistors, whose resistance increases with increasing temperature. NTC thermistors are more commonly used than PTC thermistors, especially for temperature measurement applications.

A main advantage of thermistors for temperature measurement is their extremely high sensitivity. For example, a 2,252 Ω thermistor has a sensitivity of –100 Ω/°C at room temperature. Higher resistance thermistors can exhibit temperature coefficients of –10 kΩ/°C or more. In comparison, a 100 Ω platinum RTD has a sensitivity of only 0.4 Ω/°C.

Also, the physically small size and low thermal mass of a thermistor bead allows a very fast response to temperature changes.

Another advantage of the thermistor is its relatively high resistance. Thermistors are available with base resistances (at 25 °C) ranging from hundreds to millions of ohms. This high resistance diminishes the effect of inherent resistances in the lead wires, which can cause significant errors with low resistance devices such as RTDs. For example, while RTD measurements typically require 3-wire or 4-wire connections to reduce errors caused by lead-wire resistances, 2-wire connections to thermistors are usually adequate.

The major trade-off for the high resistance and sensitivity of the thermistor is its highly nonlinear output and relatively limited operating range. Depending on the type of thermistor, the upper range is typically limited to around 300 °C. Figure D-3 shows the resistance-temperature curve for a 2,252 Ω thermistor. The curve of a 100 Ω RTD is also shown for comparison.
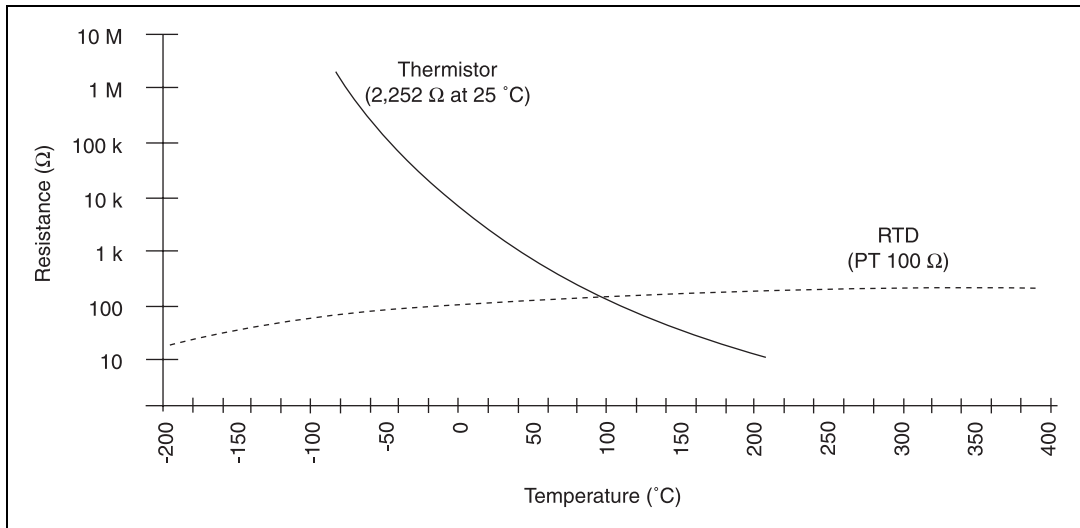
Figure D-3. Resistance-Temperature Curve for a 2,252 Ω Thermistor

The thermistor has been used primarily for high-resolution measurements over limited temperature ranges. However, continuing improvements in thermistor stability, accuracy, and interchangeability have prompted increased use of thermistors in a variety of applications.

Resistance/Temperature Characteristic of Thermistors

The resistance-temperature behavior of thermistors is highly dependent upon the manufacturing process. Therefore, thermistor curves are not standardized to the extent that thermocouple or RTD curves are standardized. Typically, thermistor manufacturers supply the resistance-versus-temperature curves or tables for their particular devices. You can, however, approximate the thermistor curve relatively accurately with the Steinhart-Hart equation:

$$T(°\text{K}) = \frac{1}{a_0 + a_1 \ln(R_T) + a_2 [\ln(R_T)]^3}$$

where $T(°\text{K})$ is the temperature in degrees Kelvin, equal to $T(°\text{C}) + 273.15$, and R_T is the resistance of the thermistor. You can obtain the coefficients a_0, a_1, and a_2 from the thermistor manufacturer, or calculate them from the resistance-versus-temperature curve. You can use the LabVIEW VI **Convert Thermistor Reading** to convert thermistor voltage measurements into temperature readings. This VI is located in the **Data Acquisition»Signal Conditioning** function subpalette.

Thermistor Measurement Circuits

Because the thermistor is a resistive device, you must pass a current through the thermistor to produce a voltage that the data acquisition system can measure. The high resistance and high sensitivity of the thermistor simplify the necessary measurement circuitry and signal conditioning. Special 3-wire or 4-wire connections are not necessary. The most common technique is to use a constant-current source, and measure the voltage developed across the thermistor. As shown in Figure D-4, the measured voltage V_0 equals $R_T \times I_{EX}$.
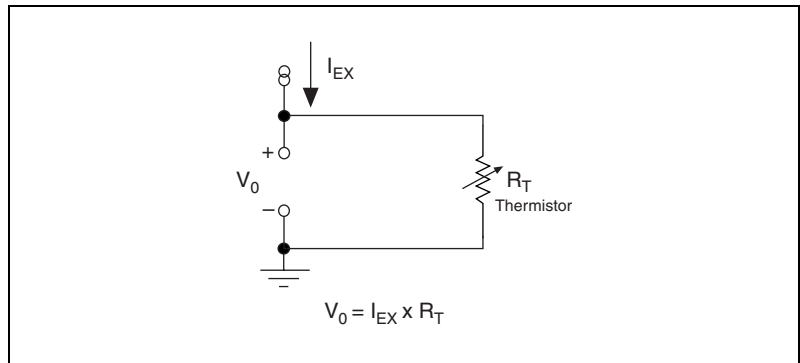
Figure D-4. Thermistor Measurement with Constant Current Excitation, I_{EX}

The level of the voltage output signal depends directly on the thermistor resistance and magnitude of the current excitation. Do *not* use a higher level of current excitation in order to produce a higher level output signal because the current causes the thermistor to heat internally, leading to temperature-measurement errors. This phenomena is called self-heating. When current passes through the thermistor, power dissipated by the thermistor equaling $(I_{EX}^2 R_T)$, heats the thermistor.

Thermistors, with their small size and high resistance, are particularly prone to these self-heating errors. Manufacturers typically specify this self heating as a dissipation constant, which is the power required to heat the thermistor 1 °C from ambient temperature (mW/°C). The dissipation constant depends heavily on how easily heat is transferred away from the thermistor, so the dissipation constant can be specified for different media—in still air, water, or oil bath. Typical dissipation constants range anywhere from less than 0.5 mW/°C for still air to 10 mW/°C or higher for

a thermistor immersed in water. A 2,252 Ω thermistor powered by a 1 mA excitation current dissipates:

$$I^2 R \ = \ 1\,\mathrm{mA}^2 \times 2{,}252 \ \Omega \ = \ 2.25\ \mathrm{mW}$$

If this thermistor has a dissipation constant of 10 mW/°C, the thermistor self-heats 0.225 °C. Therefore, carefully read self-heating specifications of your thermistors and choose your excitation current accordingly. If your thermistors have a small dissipation constant, minimize the level of your excitation current to minimize self-heating errors.

Connecting Resistive Devices to the SCXI-1581

You can connect resistive devices to your SCXI signal conditioning system in a 4-wire, 2-wire, or 3-wire configuration. The SCXI-1102B/C modules are 32-channel analog-input modules that are ideally suited for measuring DC or slowly varying voltages. Figures D-5 through D-9 illustrate various ways to connect sensors for current excitation and voltage measurements using the SCXI-1581 and the SCXI-1102B/C modules.

Refer to the appropriate ADE and SCXI documentation for information concerning setting appropriate voltage gains for the analog inputs.

You can use the SCXI-1300 terminal block to make signal connections to the SCXI-1581 and SCXI-1102 modules. When using the SCXI-1300 terminal block, terminals EX<0..31>+ and EX<0..31>– map to terminals CH<0..31>+ and CH<0..31>– respectively on the SCXI-1300 terminal block.

4-Wire Configuration

The 4-wire configuration, also referred to as a Kelvin connection, is shown in Figure D-5. The 4-wire configuration uses one pair of wires to deliver the excitation current to the resistive sensor and uses a separate pair of wires to sense the voltage across the resistive sensor. Because of the high input impedance of the differential amplifier, negligible current flows through the sense wires. This results in a very small lead-resistance voltage drop error. The main disadvantage of the 4-wire connection is the greater number of field wires required.
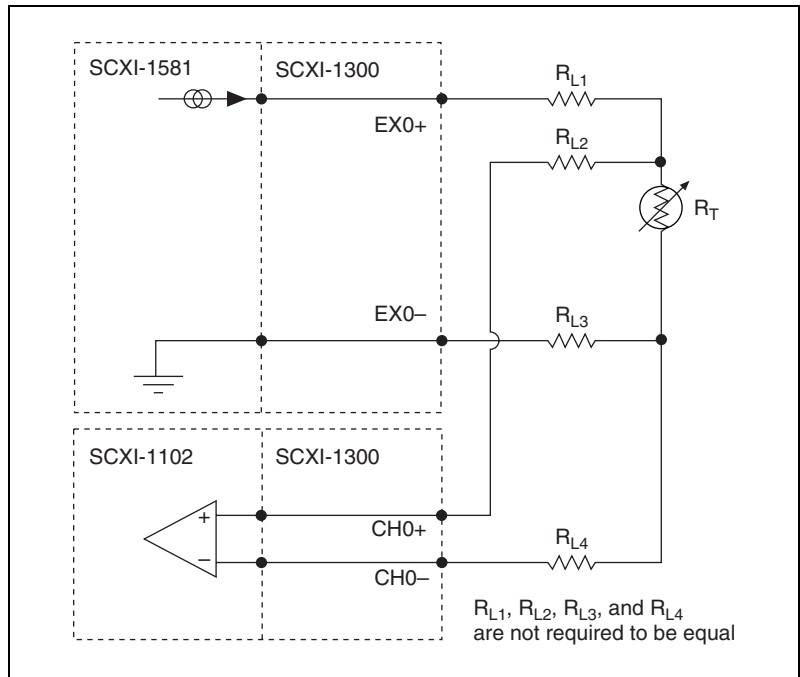
Figure D-5. 4-Wire Resistive Sensor Connected in a 4-Wire Configuration

2-Wire Configuration

The basic 2-wire configuration is shown in Figure D-6. In this configuration an error voltage (V_E) is introduced into the measurement equal to the excitation current (I_{EX}) times the sum of the two lead resistances, R_{L1} and R_{L2}. If we assume equal lead resistances, $R_{L1} = R_{L2} = R_L$, the magnitude of the error voltage is:

$$V_E = 2R_L\,I_{EX}$$

This is the most commonly used configuration for connecting thermistors to a signal conditioning system due to the negligible error introduced by the lead resistances.
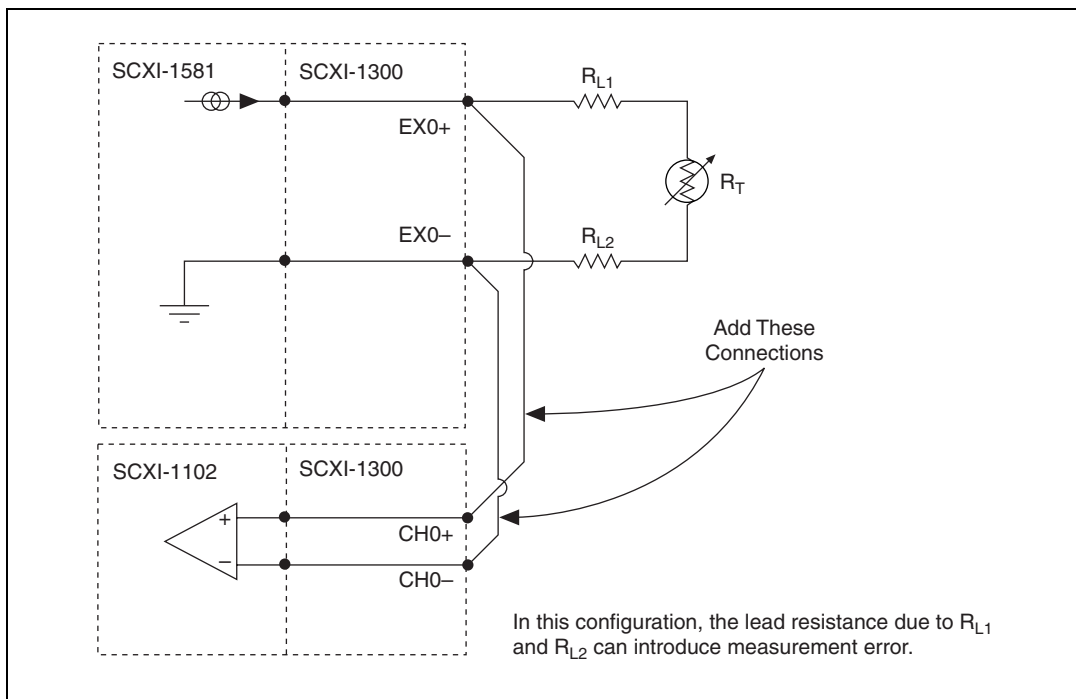
Figure D-6. 2-Wire Resistive Sensor Connected in a 2-Wire Configuration

3-Wire Resistive Sensor Connected in a 2-Wire Configuration

If you are using a 3-wire resistive sensor, you can reduce the error voltage by one-half over the 2-wire measurement by connecting the device as shown in Figure D-7. In this configuration, very little current flows through R_{L3} and therefore R_{L1} is the only lead resistance that introduces an error into the measurement. The resulting measurement error is:

$$V_E = R_{L1}\,I_{EX}$$

An advantage of this configuration is that it only requires a single jumper wire from the SCXI-1581 EX0+ terminal to the SCXI-1102B/C CH0+ terminal.
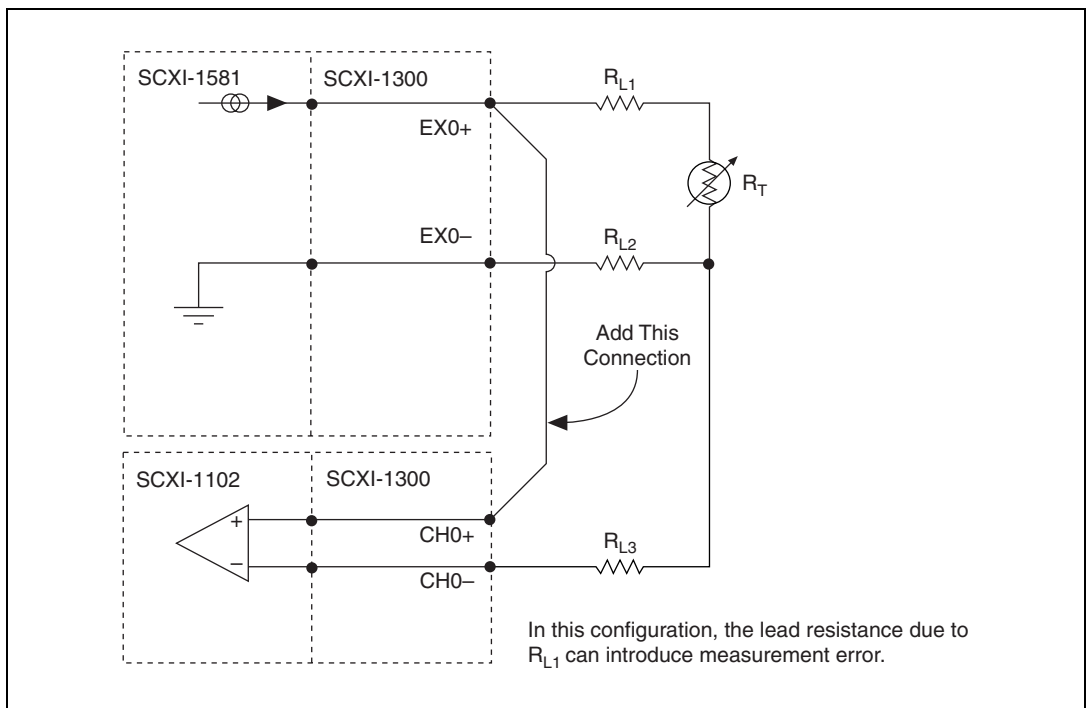
Figure D-7. 3-Wire Resistive Sensor Connected in a 2-Wire Configuration

Lead-Resistance Compensation Using a 3-Wire Resistive Sensor and Two Matched Current Sources

You can compensate for the errors introduced by lead-resistance voltage drops by using a 3-wire resistive sensor and two matched current sources connected as shown in Figure D-8.
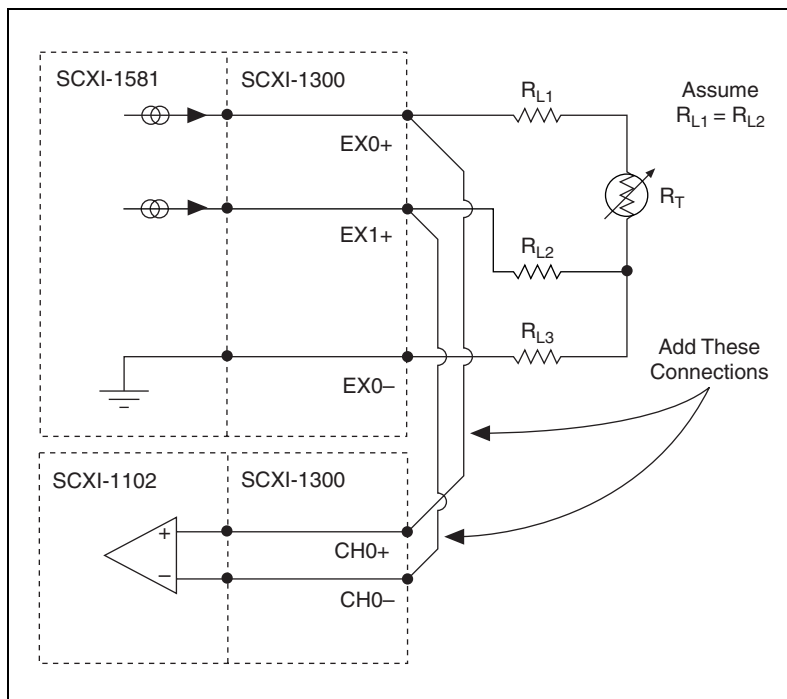
Figure D-8. 3-Wire Configuration Using Matched Current Sources

In this configuration, the lead-resistance voltage drop across R_{L3} is converted into a common-mode voltage that is rejected by the differential amplifier. Also, the polarity of the lead-resistance voltage drops across R_{L1} and R_{L2} are series opposing, relative to the inputs of the differential amplifier, eliminating their effect on the voltage measured across R_T.

Note R_{L1} and R_{L2} are assumed to be equal.

The effectiveness of this method depends on the matching of the current sources. Each current source on the SCXI-1581 has an accuracy of ±0.05%. This accuracy results in a worst-case matching of ±0.1%. As an example of the error introduced by this mismatch, consider a 3-wire resistive sensor with lead resistances of 10 Ω. The worst-case mismatch would result in a total error voltage (Ve_{RL}) across the lead resistances equal to:

$$Ve_{RL} = 4\delta R_L I_{EX}$$

where δ is the accuracy of the individual current sources, R_L is the individual lead resistance and I_{EX} is the value of the excitation current. For our example this voltage equates to 2 μV. Converting this voltage into a resistance by dividing by I_{EX} yields a resistance of 0.02 Ω. If this error were associated with the lead resistance of a 3-wire 100 Ω platinum RTD, the resulting temperature error, Te_{RL}, would be:

$$Te_{RL} = Ve_{RL} / (0.385\ I_{EX}) = 0.05195°$$

In contrast, if there were no lead-resistance compensation, a temperature error of 51.95 °C would result.

Lead-Resistance Compensation Using a 3-Wire Resistive Sensor and Two Differential Amplifiers

If the accuracy obtained by using a 3-wire device and matched current sources is not sufficient for your application, you can eliminate the error due to the mismatch of the current sources by using only one current source and two differential amplifiers. The 3-wire, 2-amplifier configuration is illustrated in Figure D-9.
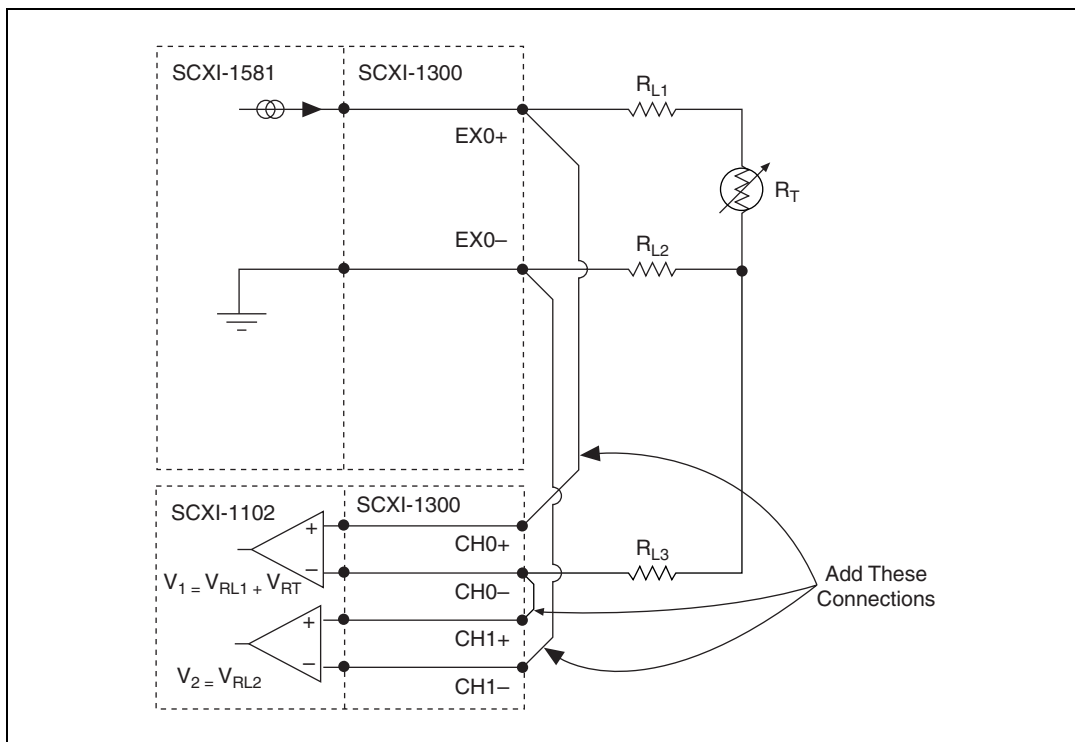

Figure D-9. 3-Wire Configuration Using Two Differential Amplifiers

In this configuration, two separate measurements are taken; the first, labeled V_1 in Figure D-9, is the sum of the voltage drops across the lead resistance R_{L1} and the resistive device R_T. If the voltage drop across R_{L1} and R_T is denoted as V_{RL1} and V_{RT} respectively, the expression for V_1 becomes:

$$V_1 = V_{RL1} + V_{RT}$$

The second measurement, labeled V_2 in Figure D-9, is equal to the voltage drop across the lead resistance R_{L2}, denoted as V_{RL2}. Therefore:

$$V_2 = V_{RL2}$$

If the lead resistances R_{L1} and R_{L2} are assumed equal, you can remove in software the error voltages due to the lead resistances by subtracting V_2 from V_1. In most 3-wire device applications the lead wires are all the same length and made of the same material, therefore substantiating the assumption of equal lead resistances.

E

Common Questions

This appendix lists common questions related to the use of the SCXI-1581.

Which version of NI-DAQ works with the SCXI-1581, and how do I get the most current version of NI-DAQ?

NI recommends NI-DAQ 6.9.1 or later. With earlier versions of NI-DAQ, you cannot auto-detect or list the SCXI-1581 in the chassis as a configured module. However, even if the slot containing the SCXI-1581 is configured as *empty*, the current outputs are fully functional as long as the chassis is powered on.

Visit our web site and follow the link, **Download Software»Drivers and Updates»Search Drivers and Updates**, and type in the keyword `NI-DAQ` to find the latest version of NI-DAQ for your operating system.

Can I use the SCXI-1581 with a version of NI-DAQ that works under the Macintosh Operating System (MacOS)?

At the time this manual was published, you cannot auto-detect or list the SCXI-1581 as a configured module using a version of NI-DAQ that works under MacOS. However, even if the slot containing the SCXI-1581 is configured as *empty*, the current outputs are fully functional as long as the chassis is powered on.

Is a register-level programming manual available for the SCXI-1581?

No. Register-level programming is not required in order to make the SCXI-1581 fully functional. The SCXI-1581 is fully operational at power-up.

Can the SCXI-1581 be the *cabled* module when there are also multiplexed analog-input modules in the chassis?

Yes, unless one or more of the multiplexed analog-input modules in the same chassis feature simultaneous sampling (such as the SCXI-1140, SCXI-1520, SCXI-1530, or SCXI-1531). In that case, a simultaneous-sampling module must be the cabled module.

Can the SCXI-1581 current outputs be interactively controlled in MAX or programmatically controlled using NI-DAQ function calls, LabVIEW, or Measurement Studio?

No. The current-output level is 100 µA as long as the chassis is powered on. You cannot power off or adjust the current output using MAX, NI-DAQ function calls, or an ADE such as LabVIEW or Measurement Studio. If you require this functionality, consider using an SCXI-1124 module or NI 670*X* device instead.

Can I create virtual channels for an SCXI-1581 current-output channel?

No. As discussed above, you cannot programmatically control the current outputs.

Can I connect *N* current-output channels in parallel to create a precision current source that provides $N \times 100$ µA?

This is not recommended. The accuracy or stability of the resulting current-output value is unpredictable.

Can I connect *N* current-output channels in series to achieve a higher terminal-voltage compliance limit?

No. Each current source is ground referenced. Therefore, you cannot place multiple current-outputs in series.

Are the SCXI-1581 current output channels isolated with respect to each other, the DAQ device, or ground?

No. The SCXI-1581 does not contain any isolation circuitry. All current outputs are referenced to chassis ground. If you require isolated current outputs, consider the SCXI-1124 module instead.

Can I modify the SCXI-1581 circuitry to generate current at a level different than 100 µA?

No. Do not attempt to modify any circuitry in the SCXI-1581.

Are there any user-serviceable parts inside the SCXI-1581?

No. There are no fuses, potentiometers, switches, socketed resistors, or jumpers inside the module. Disassembly of the module for any reason can void its warranty and nullify its accuracy specification.

Can I recalibrate the SCXI-1581 or return it to the factory for recalibration?

No. You cannot recalibrate the SCXI-1581 and it does not require factory recalibration. If a current source on the SCXI-1581 drifts out of specification over time, then a subcomponent has probably failed. If your SCXI-1581 fails to operate according to the published specifications, send it back to NI for repair or replacement.

Can I access the unused analog-input channels of the DAQ device if it is directly cabled to the SCXI-1581 in a single-chassis system?

Yes. DAQ device channels 1 through 7 are available to measure unconditioned signals. Use an SCXI-1180 or the 50-pin breakout connector on your SCXI-1346 or SCXI-1349 cable adapter to route signals to these channels.

Which digital lines are unavailable on the DAQ device if I am cabled to an SCXI-1581 module?

Table E-1 shows the digital lines that are used by the SCXI-1581 for communication and scanning. These lines are unavailable for general-purpose digital I/O if the SCXI-1581 is connected to the DAQ device.

Table E-1. SCXI-1581 Digital Signals

DAQ Signal Name	SCXI Signal Name	50-Pin Connector	68-Pin Connector	Direction[1]
DIO0	SERDATIN	25	52	Output
DIO4	SERDATOUT	26	19	Input
DIO1	DAQD*/A	27	17	Output
DIO2	SLOT0SEL*	29	49	Output
SCANCLK	SCANCLK	36	46	Output
[1] With respect to the DAQ device.				

Does short-circuiting a current-output channel do any damage to the SCXI-1581?

No. The SCXI-1581 delivers 100 µA into any load from 0 Ω to 100 kΩ.

Does open-circuiting a current-output channel damage the SCXI-1581? What is the open-circuit voltage level?

No. An SCXI-1581 current-output channel is not damaged if no load is connected. The open-circuit voltage is 12.4 VDC.

How can I tell if the SCXI-1581 is working?

First, disconnect all loads from the channel you are testing. Second, measure the current-output value using an ammeter. If the ammeter has a fuse, ensure that the fuse is not blown before performing the measurement. Alternatively, place a known resistance R (<100 kΩ) across the current output and use a voltmeter to measure the voltage drop across it. If the current output is working, you should measure $V = (100 \times 10^{-6} \text{ A}) \times R$, where R is given in Ω.

How does the screw-terminal labeling on the SCXI-1300 relate to the front signal connector on the SCXI-1581? In other words, if I want to use current-output channel x, where do I connect wires in the SCXI-1300?

CHx+ corresponds to EXx+. Likewise, CHx– corresponds to EXx–. You cannot use any screw terminals in the SCXI-1300 other than CHx+, CHx–, and chassis ground.

Can I use the BNC-2095 as an accessory for the SCXI-1581?

Yes. However, you must set all the slide switches on the back of the BNC-2095 for no bias-resistor connections to ground and no pull-up resistor connections to +5 V. In other words, set all switches on the rear of the BNC-2095 to the *OFF* (down) position.

When using an SCXI-1300 or BNC-2095 with the SCXI-1581, can I read the CJC sensor on these accessories?

No.

Can I use an SCXI-1303 terminal block as an accessory for the SCXI-1581?

This is not recommended. The SCXI-1303 is optimized for temperature measurement using thermocouples. It will work with the SCXI-1581, but only if you remove all resistor packs. See the *SCXI-1303 32-Channel Isothermal Terminal Block Installation Guide* for more information. As with the SCXI-1300 and BNC-2095, you cannot measure the CJC sensor.

Can I configure the SCXI-1581 in MAX for use in a chassis controlled by an SCXI-1200?

Yes. However, remember that you cannot auto-detect modules in a chassis controlled by an SCXI-1200.

F

Technical Support Resources

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`.

NI Developer Zone

The NI Developer Zone at `ni.com/zone` is the essential resource for building measurement and automation systems. At the NI Developer Zone, you can easily access the latest example programs, system configurators, tutorials, technical news, as well as a community of developers ready to share their own techniques.

Customer Education

National Instruments provides a number of alternatives to satisfy your training needs, from self-paced tutorials, videos, and interactive CDs to instructor-led hands-on courses at locations around the world. Visit the Customer Education section of `ni.com` for online course schedules, syllabi, training centers, and class registration.

System Integration

If you have time constraints, limited in-house technical resources, or other dilemmas, you may prefer to employ consulting or system integration services. You can rely on the expertise available through our worldwide network of Alliance Program members. To find out more about our Alliance system-integration solutions, visit the System Integration 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. Phone numbers for our worldwide offices are listed at the front of this manual.

Glossary

Prefix	Meaning	Value
p-	pico-	10^{-12}
n-	nano-	10^{-9}
μ-	micro-	10^{-6}
m-	milli-	10^{-3}
k-	kilo-	10^{3}
M-	mega-	10^{6}
G-	giga-	10^{9}
t-	tera-	10^{12}

Numbers/Symbols

%	percent
+	positive of, or plus
−	negative of, or minus
±	plus or minus
<	less than
>	greater than
≤	less than or equal to
≥	greater than or equal to
/	per
°	degree
Ω	ohms
+5 V (signal)	+5 VDC source signal

A

A	amperes
A/D	analog-to-digital
absolute accuracy	the maximum difference between the measured value from a data acquisition device and the true voltage applied to the input, typically specified as ± voltage
AC	alternating current
ADC	analog-to-digital converter—an electronic device, often an integrated circuit, that converts an analog voltage to a digital number
ADE	application development environment such as LabVIEW, LabWindows/CVI, Visual Basic, C, and C++
AGND	analog ground signal
AI	analog input
AIGND	analog input ground signal
amp	amplifier
amplification	a type of signal conditioning that improves accuracy in the resulting digitized signal by increasing signal amplitude relative to noise
ANSI	American National Standards Institute
AOGND	analog output ground
AOGND/GUARD	analog output ground
AOUT	analog output signal

B

bandwidth	the range of frequencies present in a signal, or the range of frequencies to which a measuring device can respond
bias current	the small input current flowing into or out of the input terminals of an amplifier

bipolar	a voltage range spanning both negative and positive voltages
bit	one binary digit, either 0 or 1

C

C	Celsius
CE	European emissions control standard
CFR	Code of Federal Regulations
CGND	chassis ground signal
CH	channel
channel	pin or wire lead to which you apply, or from which you read, an analog or digital signal. Analog signals can be single-ended or differential. For digital signals, channels (also known as lines) are grouped to form ports.
chassis	the enclosure that houses, powers, and controls SCXI modules
CHSGND	chassis ground
CLK	clock input signal
CMOS	complementary metal-oxide semiconductor
CMRR	common-mode rejection ratio—a measure of the ability of a differential amplifier to reject interference from a common-mode signal, usually expressed in decibels (dB)
CMV	*see* common-mode voltage
common-mode noise	noise that appears on both inputs of a differential amplifier
common-mode voltage	voltage that appears on both inputs of a differential amplifier
current excitation	a source that supplies the current needed by a sensor for its proper operation
cutoff frequency	the frequency that defines the upper end of the passband of a lowpass filter

D

D/A	digital-to-analog
D*/A	Data/Address
DAC	D/A converter—an electronic device, often an integrated circuit, that converts a digital number into a corresponding analog voltage or current
DAQ	data acquisition—(1) collecting and measuring electrical signals from sensors, transducers, and test probes or fixtures and processing the measurement data using a computer; (2) collecting and measuring the same kinds of electrical signals with A/D and/or DIO devices plugged into a computer, and possibly generating control signals with D/A and/or DIO devices in the same computer
DAQ device	a data acquisition device. Examples are DIO, E series MIO, and Lab/1200 plug-in data acquisition devices
DAQD*/A	the data acquisition device data/address line signal used to indicate whether the SERDATIN pulse train transmitted to the SCXI chassis contains data or address information
dB	decibel—the unit for expressing a logarithmic measure of the ratio of two signal levels: $dB=20\log_{10} V1/V2$, for signals in volts
DC	direct current
device	a plug-in data acquisition device, module, card, or pad that can contain multiple channels and conversion devices. SCXI modules are distinct from devices, with the exception of the SCXI-1200, which is a hybrid.
DGND	digital ground signal
DIFF	differential input configuration
differential amplifier	an amplifier with two input terminals, neither of which are tied to a ground reference, whose voltage difference is amplified
differential input	the two-terminal input to a differential amplifier
DIN	Deutsche Industrie Norme (German Industrial Standard)
DIO	digital input/output

DoC	Declaration of Conformity
DOUT	digital output signal
drivers/driver software	software that controls a specific hardware device such as a DAQ device

E

EEPROM	electrically erasable programmable read-only memory—ROM that can be erased with an electrical signal and reprogrammed. Some SCXI modules contain an EEPROM to store measurement-correction coefficients.
EMC	electromagnetic compliance
EMI	electromagnetic interference
EX+	positive excitation channel
EX–	negative excitation channel
excitation	a voltage or current source used to energize a sensor or circuit
EXTCLK	external clock signal
external trigger	a voltage pulse from an external source that causes a DAQ operation to begin

F

F	(1) Fahrenheit—a temperature measurement scale (2) farad—a measurement unit of capacitance
FIFO	first-in first-out memory buffer
filtering	a type of signal conditioning that allows you to remove unwanted frequency components from the signal you are trying to measure
FSC	front signal connector
FSR	full-scale range

G

G	gain
gain	the factor by which a signal is amplified, sometimes expressed in decibels
gain accuracy	a measure of deviation of the gain of an amplifier from the ideal gain
gain error	*see* gain accuracy

H

Hz	hertz—cycles per second of a periodic signal

I

I/O	input/output—the transfer of data to/from a computer system involving communications channels, operator interface devices, and/or data acquisition and control interfaces
IC	integrated circuit
ID	identifier
in.	inch or inches
indirect scanning	the measurement that occurs when a signal passes on the SCXIbus from the scanned SCXI module to the cabled SCXI module
input bias current	the current that flows into the inputs of a circuit
input damage level	the highest voltage level that you can apply to the module without damaging it
input impedance	the measured resistance and capacitance between the input terminals of a circuit
inst.	instrumentation
instrumentation amplifier	a very accurate differential amplifier with a high input impedance

J

jumper	a small rectangular device used to connect two adjacent posts on a circuit board. Jumpers are used on some SCXI modules and terminal blocks to either select certain parameters or enable/disable circuit functionality.

L

lead resistance	the small, but nonzero, resistance of a lead wire. The resistance varies with the lead length and ambient temperature. If the lead wire carries excitation current, this varying resistance can cause measurement error.
lowpass filter	a filter that passes signals below a cutoff frequency while blocking signals above that frequency
LPF	lowpass filter

M

m	meters
M	(1) Mega, the standard metric prefix for 1 million or 10^6, when used with units of measure such as volts and hertz; (2) mega, the prefix for 1,048,576, or 2^{20}, when used with B to quantify data or computer memory
max	maximum
MCH	multiplexed channel
MCHx–	negative analog output channel terminal for channel x
MCHx+	positive analog output channel terminal for channel x
min	(1) minutes (2) minimum
MIO	multifunction I/O
MIO device	refers to the multifunction I/O DAQ devices that have *MIO* or 60*XX* in their names
MISO	master-in-slave-out signal

MOSI	master-out-slave-in signal
multiplex	to route one of many input signals to a single output
multiplexed mode	an SCXI operating mode in which analog input channels are multiplexed into one module output so that your cabled DAQ device has access to the module's multiplexed output as well as the outputs of all other multiplexed modules in the chassis
mux	multiplexer—a switching device with multiple inputs that sequentially connects each of its inputs to its single output, typically at high speeds, in order to measure several signals with a single analog-to-digital converter

N

NC	not connected (signal)
NI-DAQ	the driver software needed in order to use National Instruments DAQ devices and SCXI components
noise	an undesirable electrical signal—Noise comes from external sources such as AC power lines, motors, generators, transformers, fluorescent lights, soldering irons, CRT displays, computers, electrical storms, welders, radio transmitters, and internal sources such as semiconductors, resistors, and capacitors. Noise corrupts signals you are trying to measure.
nonlinearity	For an amplifier, a measure of the maximum output deviation from an ideal linear response in units of percent relative to full scale. The ideal linear response is taken to be a straight line on a plot of measured output voltage to measured input voltage with the ends of the line connecting the extremes of the plot at the full-scale limits.
NRSE	nonreferenced single-ended mode—all measurements are made with respect to a common measurement system reference, but the voltage at this reference can vary with respect to the measurement system ground

O

offset error	the output of a system with a zero-volt input
OUT	output signal
OUTCLK	output clock signal

OUTPUT	output signal
output settling time	the amount of time required for the analog output voltage to reach its final value within specified limits
output voltage compliance	the largest voltage that can be generated across the output of a current source without the current going out of specification
OUTREF	output reference signal
overvoltage protection	maximum voltage that will not cause hardware damage

P

parallel mode	a type of SCXI operating mode in which the module sends each of its output channels directly to a separate analog input channel of the DAQ device connected to the module
passband	the range of input frequencies that are passed to the filter output without attenuation
PC	personal computer
port	(1) a digital port consisting of multiple I/O lines on a DAQ device (2) a serial or parallel interface connector on a PC
pp	peak to peak
ppm	parts per million
PXI	PCI eXtensions for Instrumentation—an open specification that builds on the CompactPCI specification by adding instrumentation-specific features

R

random scanning	the hardware capability to sequence through channels in a scan list in any order
R_L	lead resistance
RMA	Return Material Authorization
rms	root mean square—the square root of the average value of the square of the instantaneous signal amplitude; a measure of signal amplitude

rolloff	the ratio that a system attenuates signals in the stopband with respect to the passband, usually defined in decibels per octave
RSC	rear signal connector
RSE	referenced single-ended mode—all measurements are made with respect to a common reference measurement system or a ground. Also called a grounded measurement system.
RSVD	reserved bit, pin, or signal
RTD	resistance-temperature detector
RTI	referred to input—calculates a specification relative to the input range
RTO	referred to output
RTSI	real-time system integration
RTSI bus	real-time system integration bus—the National Instruments timing bus that connects DAQ devices directly, by means of connectors on top of the devices, for precise synchronization of functions

S

s	seconds
S	samples
S/s	samples per second—used to express the rate at which a DAQ device samples an analog signal
sample	an instantaneous measurement of a signal, normally using an analog-to-digital converter in a DAQ device
sample rate	the number of samples a system takes over a given time period, usually expressed in samples per second
scan	one or more analog samples taken at the same time, or nearly the same time. Typically, the number of input samples in a scan is equal to the number of channels in the input group. For example, one scan, acquires one new sample from every analog input channel in the group.
scan rate	the number of scans a system takes during a given time period, usually expressed in scans per second

SCANCLK	scan clock signal used to increment to the next channel after each DAQ device analog-to-digital conversion
SCXI	Signal Conditioning eXtensions for Instrumentation
SCXIbus	located in the rear of an SCXI chassis, the SCXIbus is the backplane that connects modules in the same chassis to each other
sensor	a type of transducer that converts a physical phenomenon into an electrical signal
SERCLK	serial clock signal used to synchronize digital data transfers over the SERDATIN and SERDATOUT lines
SERDATIN	serial data input signal
SERDATOUT	serial data output signal
serial mode	the mode by which SCXI-116x modules communicate digital information serially rather than in parallel
settling time	the amount of time required for a voltage to reach its final value within specified accuracy limits
signal conditioning	the manipulation of signals to prepare them for digitizing
Slot 0	refers to the power supply and control circuitry in the SCXI chassis
SLOT0SEL	slot 0 select signal
SPICLK	serial peripheral interface clock signal
SYNC	synchronization pulse for scanning (only used with modules featuring simultaneous sample and hold)

T

thermistor	a thermally sensitive resistor
TRIG0	trigger 0
TTL	transistor-transistor logic
transducer	a device capable of converting energy from one form to another
typ	typical

U

UL	Underwriters Laboratory
unipolar	a voltage range that only spans positive voltages

V

V	volts
VAC	volts, alternating current
VDC	volts, direct current
VI	virtual instrument—(1) a combination of hardware and/or software elements, typically used with a PC, that has the functionality of a classic stand-alone instrument; (2) a LabVIEW software module (VI), which consists of a front panel user interface and a block diagram program
virtual channels	channel names that can be defined outside the application and used without having to perform scaling operations
V_{rms}	volts, root mean square

W

W	watts
working voltage	the highest voltage with respect to ground that should be applied to an input terminal during normal use, normally well under the breakdown voltage for safety margin. Includes both the signal and common-mode voltages.

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