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SCXI™

SCXI-1112 User Manual

8-Channel Direct-Connect Thermocouple Amplifier Module

NATIONAL INSTRUMENTS™

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About This Manual

This manual describes the electrical and mechanical aspects of the SCXI-1112 module and contains information concerning its installation and operation.

The SCXI-1112 module is a member of the National Instruments Signal Conditioning eXtensions for Instrumentation (SCXI) Series for the National Instruments data acquisition (DAQ) plug-in devices. This module is designed for conditioning thermocouple signals. The SCXI-1112 module has eight differential analog input channels and eight cold-junction sensor channels.

Conventions Used in This Manual

The following conventions are used in this manual.

< >	Angle brackets containing numbers separated by an ellipsis represent a range of values associated with a port, bit, or signal name (for example, ACH<0..7> stands for the signals ACH0 through ACH7).
	This icon to the left of bold italicized text denotes a note, which alerts you to important information.
	This icon to the left of bold italicized text denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash.
bold italic	Bold italic text denotes a note, caution, or warning.
italic	Italic text denotes emphasis, a cross reference, or an introduction to a key concept.
MIO board	Refers to the multichannel I/O DAQ boards that have *MIO* in their names, such as the AT-MIO-16 and the NEC-MIO-16E-4.
`monospace`	Denotes text or characters that are to be literally input 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, variables, filenames, and extensions, and for statements and comments taken from program code.
PC	Refers to the IBM PC/XT, the IBM PC AT, and compatible computers.

SCXIbus	Refers to the backplane in the chassis. A signal on the backplane is referred to as the SCXIbus <signal name> line (or signal). The SCXIbus descriptor may be omitted when the meaning is clear. Descriptions of some SCXIbus signals are in Chapter 3, *Signal Connections*.
Slot 0	Refers to the power supply and control circuitry in the SCXI chassis.

Abbreviations, acronyms, metric prefixes, mnemonics, symbols, and terms are listed in the *Glossary*.

National Instruments Documentation

The *SCXI-1112 User Manual* is one piece of the documentation set for your data acquisition system. You could have any of several manuals, depending on the hardware and software in your system. Use the manuals you have as follows:

- *Getting Started with SCXI*—This is the first manual you should read. It gives an overview of the SCXI system and contains the most commonly needed information for the modules, chassis, and software.
- Your SCXI module user manuals—Read these manuals next for detailed information about signal connections and module configuration. They also explain in greater detail how the module works and contain application hints.
- Your DAQ hardware user manuals—These manuals have detailed information about the DAQ hardware that plugs into or is connected to your computer. Use these manuals for hardware installation and configuration instructions, specification information about your DAQ hardware, and application hints.
- Software documentation—Examples of software documentation you may have are the LabVIEW and LabWindows/CVI manual sets and the NI-DAQ documentation. After you set up your hardware system, use either the application software documentation or the NI-DAQ documentation to help you write your application. If you have a large and complicated system, look through the software documentation before you configure your hardware.
- Accessory installation guides or manuals—If you are using accessory products, read the terminal block and cable assembly installation guides.
- SCXI chassis manual—Read your chassis manual for maintenance information and installation instructions.

1 Introduction

This chapter describes the SCXI-1112 module, lists what you need to get started with your SCXI-1112 module, and provides an overview of your software options.

About the SCXI-1112 Module

This module amplifies and filters thermocouple signals. The SCXI-1112 has eight differential analog input channels and eight cold-junction sensor channels. On each channel, the SCXI-1112 has a 3-pole lowpass filter with a 2 Hz cutoff frequency to reject 60 Hz noise. Each channel also has an amplifier with a fixed gain of 100. You can multiplex the SCXI-1112 inputs to a single output that drives a single DAQ device channel.

You can auto-zero and calibrate the SCXI-1112. There is a voltage reference onboard that you can access to perform external calibration. You can use the auto-zeroing circuitry to remove offset voltages.

The SCXI-1112 modules are designed for use with National Instruments E Series MIO devices or SCXI-1200 modules. You can multiplex several SCXI-1112 modules and other SCXI modules into a single channel on the DAQ device, greatly increasing the number of analog input signals that you can digitize.

Detailed specifications of the SCXI-1112 module are listed in Appendix A, *Specifications*.

What You Need to Get Started

To install and use your SCXI-1112 module, you will need the following items:

- ❑ The SCXI-1112 module
- ❑ *SCXI-1112 User Manual*
- ❑ SCXI chassis or PXI combination chassis

- ❑ Data acquisition device
- ❑ NI-DAQ version 6.6 or later

Software Programming Choices

You have several options to choose from when programming your National Instruments DAQ and SCXI hardware. You can use National Instruments application software, or a third-party programming environment. In either case, you must use NI-DAQ driver software.

National Instruments Application Software

ComponentWorks contains tools for data acquisition and instrument control built on NI-DAQ driver software. ComponentWorks provides a higher-level programming interface for building virtual instruments through standard OLE controls and DLLs. With ComponentWorks, you can use all of the configuration tools, resource management utilities, and interactive control utilities included with NI-DAQ.

LabVIEW features interactive graphics, a state-of-the-art user interface, and a powerful graphical programming language. The LabVIEW Data Acquisition VI Library, a series of VIs for using LabVIEW with National Instruments DAQ hardware, is included with LabVIEW. The LabVIEW Data Acquisition VI Library is functionally equivalent to NI-DAQ software.

LabWindows/CVI features interactive graphics, a state-of-the-art user interface, and uses the ANSI standard C programming language. The LabWindows/CVI Data Acquisition Library, a series of functions for using LabWindows/CVI with National Instruments DAQ hardware, is included with the NI-DAQ software kit. The LabWindows/CVI Data Acquisition Library is functionally equivalent to the NI-DAQ software.

VirtualBench features virtual instruments that combine DAQ products, software, and your computer to create a stand-alone instrument with the added benefit of the processing, display, and storage capabilities of your computer. VirtualBench instruments load and save waveform data to disk in the same format that can be used in popular spreadsheet programs and word processors.

Using ComponentWorks, LabVIEW, LabWindows/CVI, or VirtualBench software will greatly reduce the development time for your data acquisition and control application.

NI-DAQ Driver Software

The NI-DAQ driver software is included at no charge with all National Instruments DAQ devices. NI-DAQ has an extensive library of functions that you can call from your application programming environment. These functions include routines for analog input (A/D conversion), buffered data acquisition (high-speed A/D conversion), analog output (D/A conversion), waveform generation, digital I/O, counter/timer operations, SCXI, RTSI, self-calibration, messaging, and acquiring data to extended memory.

NI-DAQ also internally handles the complex communication between the computer and the plug-in device, such as programming interrupts and DMA controllers. NI-DAQ maintains a consistent software interface among its different versions so that you can change platforms with minimal modifications to your code. Figure 1-1 illustrates the relationship between NI-DAQ and your National Instruments application software.

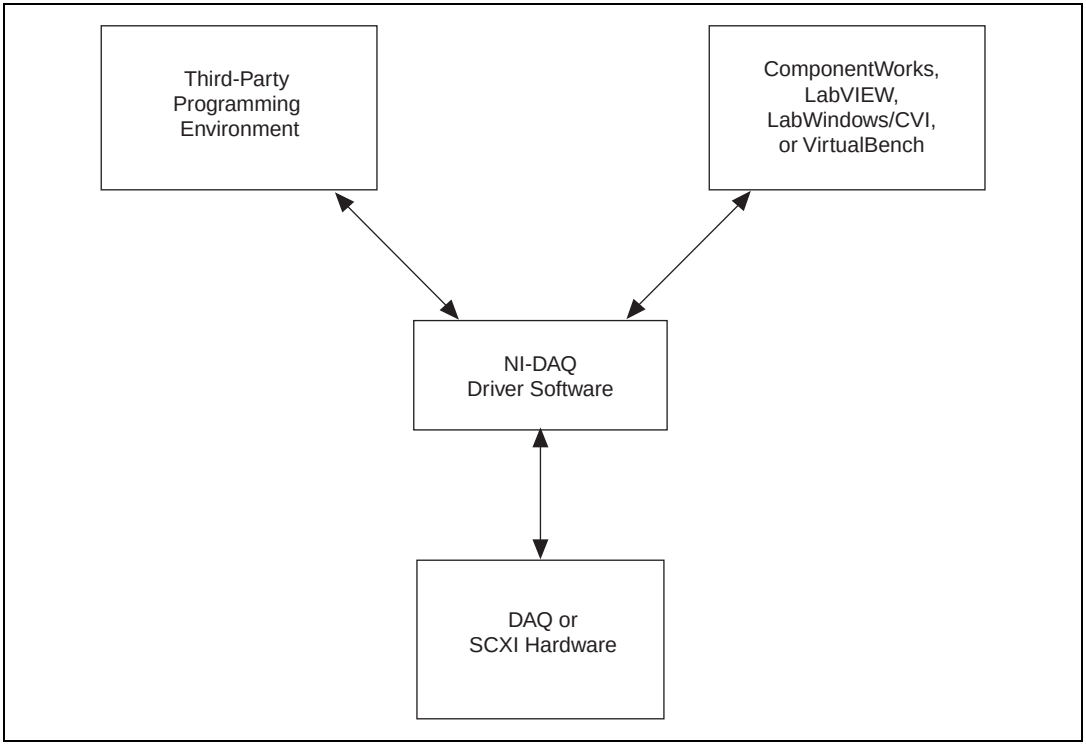


Figure 1-1. The Relationship between the Programming Environment, NI-DAQ, and Your Hardware

2

SCXI-1112 Module Installation

This chapter explains how to unpack an SCXI-1112 module and install it into your SCXI chassis.

Unpacking

Your SCXI-1112 module is shipped in an antistatic package to prevent electrostatic damage to the module. Electrostatic discharge can damage several components on the module. To avoid such damage while handling the module, take the following precautions:

- Ground yourself via a grounding strap or by holding a grounded object.
- Touch the antistatic package to a metal part of your SCXI chassis before removing the module from the package.
- Remove the module from the package and inspect the module for loose components or any other sign of damage. Notify National Instruments if the module appears damaged in any way. *Do not* install a damaged module into your SCXI chassis.
- *Never* touch the exposed pins of connectors.

Module Installation

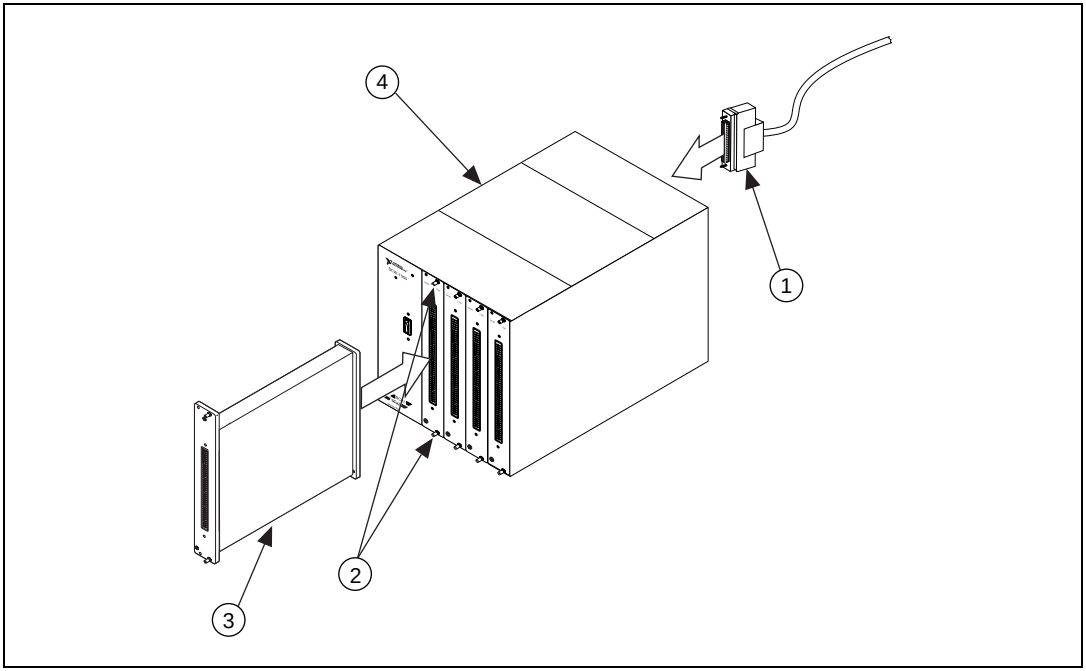
You can install the SCXI-1112 module in any available SCXI chassis slot. The following are general installation instructions; consult your SCXI chassis documentation for specific instructions and warnings:

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-1112 module into a chassis that is turned on.
3. Insert the SCXI-1112 module into the module guides. Gently push the module into the slot until the front of the module is flush with the front of the chassis. If a cable assembly has already been installed in the rear of the slot, the module and cable assembly must be firmly engaged; however, do not *force* the module into place.

4. Rotate the thumbscrews clockwise to fasten the front of the SCXI-1112 module to the top and bottom threaded strips of your SCXI chassis.
5. If this module is to be connected to an MIO DAQ device, insert the metal cable adapter of the SCXI-1349 cable assembly to the rear signal connector on the SCXI-1112 module. Fasten the metal cable adapter to the rear threaded strip using the screws. Attach the loose end of the cable to the MIO DAQ device.

Note Consult your cable assembly installation guide for more information.

6. Make sure the cable assembly is securely fastened at both ends.
7. Turn on the SCXI chassis.
8. Turn on the computer or reconnect it to your chassis.



1 Cable
2 Thumbscrews
3 SCXI-1112 Module
4 Chassis

Figure 2-1. Installing the SCXI-1112

The SCXI-1112 module is installed. You are now ready to configure your module using Measurement & Automation Explorer.

Configuration and Self-Test

Run Measurement & Automation Explorer to configure and test your SCXI-1112. If you need help during the configuration process, open the Measurement & Automation help file by selecting **Help Topics** from the **Help** menu. Follow these steps to configure your SCXI system:

1. Double-click the **Measurement & Automation Explorer** icon on your desktop.
   - If you have added new modules to an existing chassis, go to step 4.
   - If you inserted modules into an empty chassis, go to step 2.
2. Add a new chassis to the configured Devices and Interfaces by holding down the right mouse button on **Devices and Interfaces** and selecting **Insert**. Select the appropriate chassis from the list box and click **OK**.
3. Configure the chassis by selecting a **Chassis ID**. This is an integer that uniquely identifies the chassis in a data acquisition application. Select the **Chassis Address**. This is needed to address the chassis in a multi-chassis 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. If you are using multiple chassis, refer to your SCXI chassis user manual for further information. For remote SCXI chassis, you also need to select the **Baud Rate** and **COM Port**. After completing the chassis configuration, click **Next.**
4. You now have the choice of either automatically detecting which modules are installed in the chassis or manually adding them.
   - If you have just added the chassis to **Devices and Interfaces** and are using an MIO DAQ device, you can automatically detect the modules.
   - If the chassis is already listed under **Devices and Interfaces**, you must add new modules manually.

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

Auto-Detecting Modules

If you selected auto-detect, you must have your chassis connected to your DAQ device, except in the case of a remote chassis, which you should connect to the computer using a serial port cable.

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

1. Make sure the chassis power is turned on.
2. Do the *Configuration and Self-Test* section if you have not already done so.
3. Select **Yes** under **Auto-Detect modules?** and click **Next**. If your chassis is a remote SCXI chassis, go to step 6.
4. Select your communication path and click **Next**.
5. If modules were detected, select the module connected to your DAQ device as your communication path.
6. Click **Finish**.

Your Measurement & Automation Explorer software should now recognize your SCXI chassis and SCXI module(s). If the software did not recognize your modules, check your cable connections and retry auto-detecting or try installing the modules manually before taking troubleshooting measures. If the software recognized any module as an SCXI custom module, you may be using the wrong version of NI-DAQ. You must use NI-DAQ 6.6 or later.

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. Click the + next to the **Devices and Interfaces** icon.
2. Locate your SCXI chassis in the displayed list. Display the list of modules in the chassis by clicking the + next to the **Chassis** icon.
3. Right-click on 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 may be using the incorrect version of NI-DAQ. You must use NI-DAQ 6.6 or later.
5. When configuring your module, 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**. 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.**

If you need to manually install more SCXI-1112 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 make changes in your module configuration, see the next section, *Configuring the SCXI-1112*, later in this chapter. If your configuration is complete, test the system as described in *Self-Test Verification* later in this chapter to ensure that your SCXI system is communicating with the DAQ device.

Configuring the SCXI-1112

To configure your SCXI-1112 after auto-detection, or to alter your original configuration selections, you must use Measurement & Automation Explorer. Perform the following steps to configure your SCXI-1112:

1. Double-click the **Measurement & Automation Explorer** icon on your desktop.
2. Click the + next to the **Devices and Interfaces** icon.
3. Locate the SCXI chassis in the list. Display the list of modules in the chassis by clicking the + next to the **Chassis** icon.
4. Right-click on the SCXI-1112 module you want to configure and select **Properties**. Click on the **General** tab. If the module you are configuring is connected to a National Instruments DAQ device, select the cabled device by using the **Connected to** control. 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.** If the module you are configuring is not connected to a National Instruments DAQ device, select **none**.

Your SCXI chassis and SCXI module(s) should now be configured properly. Read the *Self-Test Verification* section to ensure that your SCXI system is communicating with the DAQ device.

Self-Test Verification

To test the successful configuration of your system, follow the steps that follow after entering the Measurement & Automation Explorer utility:

1. Verify that the chassis power is on and that the chassis is correctly connected to a DAQ device.
2. Click the + next to the **Devices and Interfaces** icon.
3. From the list that appears, locate the chassis you want to test. Right-click on the chassis and select **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 application software. If the test did not complete successfully, see the following section for troubleshooting steps.

Troubleshooting Self-Test Verification

If the configuration software does not verify your chassis configuration, take the following steps to successfully complete your system configuration:

1. If you get the warning message **Unable to test chassis at this time**, you have not designated at least one module as connected to a DAQ device. Return to the *Configuring the SCXI-1112* section and change the configuration of the cabled module in your system from **Connected to: None** to **Connected to: Device *x***.
2. If you get the warning message **Failed to find**, followed by the module codes and the message **Unable to communicate with chassis**, take the following troubleshooting actions:
   a. Make sure that the SCXI chassis is powered on.
   b. Make sure the cable to the SCXI system is properly connected to a National Instruments DAQ device.
   c. Inspect the cable for any bent pins.
   d. Make sure you are using the correct National Instruments cable.
   e. Test your DAQ device to verify it is working properly. See your DAQ device user manual for more information.
3. If you get the warning message **Failed to find**, followed by the module codes and then the message **Instead found: module with ID 0X*xx***, return to the *Configuring the SCXI-1112* section and make sure the correct module is in the specified slot. Delete the incorrect module and

then add the correct module as described in the *Manually Adding Modules* section.

4. If you get the warning message **Failed to find** followed by a module code and then the message **Slot *x* is empty**, check to see if the configured module is installed in the specified slot. If not, install the module by referring to the section, *Module Installation*. If the module is installed in the correct slot, turn off the chassis, remove the module as specified in *Removing the SCXI-1112 from an SCXI Chassis*, and verify that no connector pins are bent on the rear signal connector. Reinstall the module as described in *Module Installation*, ensuring the module is properly aligned in the slot.
5. After checking the items that precede, return to the *Self-Test Verification* section and retest your SCXI chassis.

Removing the SCXI-1112

This section describes how to remove the SCXI-1112 from an SCXI chassis.

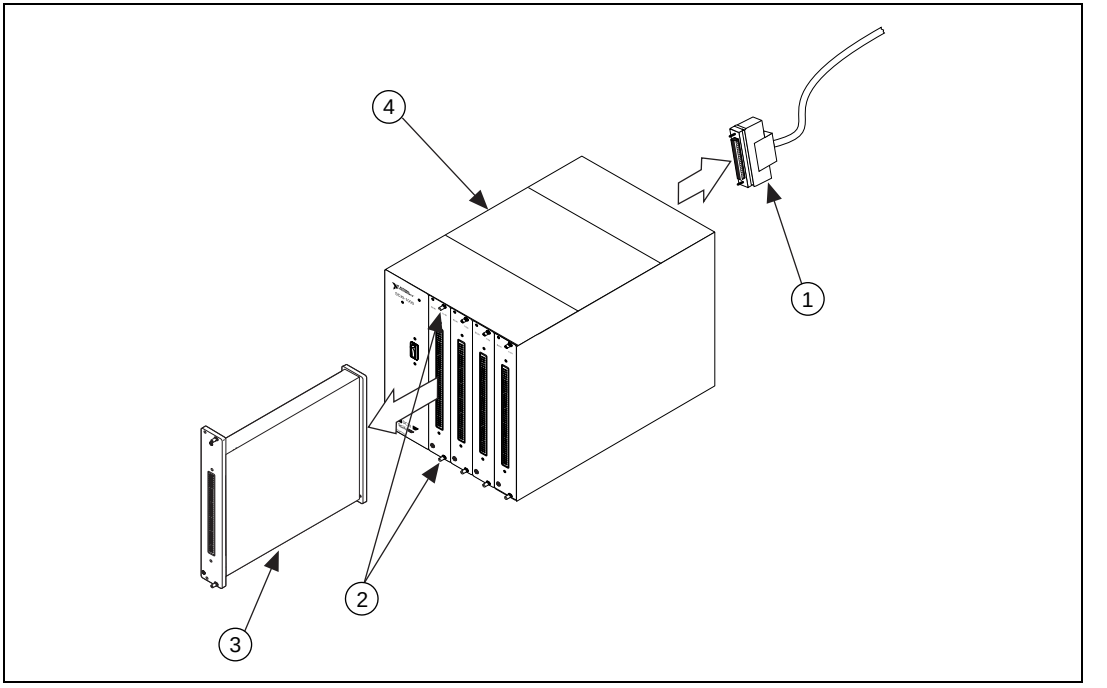
Removing the SCXI-1112 from an SCXI Chassis

Only a qualified person who has read and understands all the safety information in this manual should remove an SCXI module. You need the following items to complete this task:

- SCXI chassis or PXI combination chassis with the SCXI-1112 module(s) 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-1112 module from an SCXI chassis, use the following steps while referring to Figure 2-2:

1. Disconnect the cable running from the SCXI chassis to the DAQ device.
2. Remove all thermocouples connected to the SCXI-1112.
3. Turn off the SCXI chassis power. Do not remove the SCXI-1112 module from a chassis that is turned on.
4. Rotate counter-clockwise the thumbscrews securing the SCXI-1112 to the chassis until they are loose, but do not completely remove the thumbscrews.
5. Remove the SCXI-1112 by pulling steadily on both thumbscrews until the module slides completely out.



1 Cable	3 SCXI-1112 Module	4 Chassis
2 Thumbscrews		

Figure 2-2. Removing the SCXI-1112

Removing Modules from Software

To remove a module from software, follow these steps after entering the Measurement & Automation Explorer utility.

1. Click the + next to the **Devices and Interfaces** icon.
2. Locate your SCXI chassis in the list. Display the list of modules in the chassis by clicking the + next to the **Chassis** icon.
3. Right-click on the module or chassis you want to delete and click **Delete**.
4. You will be 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 module(s) are now removed from the Measurement & Automation Explorer software.

3

Signal Connections

This chapter describes the input and output signal connections to the SCXI-1112 module via the module front and rear signal connectors. This chapter also includes connection instructions for the signals on the SCXI-1112 module connectors.

Caution Static electricity is a major cause of component failure. To prevent damage to the electrical components in the module, take antistatic precautions whenever removing a module from the chassis or whenever handling a module.

Front Connector

Figure 3-1 shows the thermocouple input assignments for the SCXI-1112 module front connector.

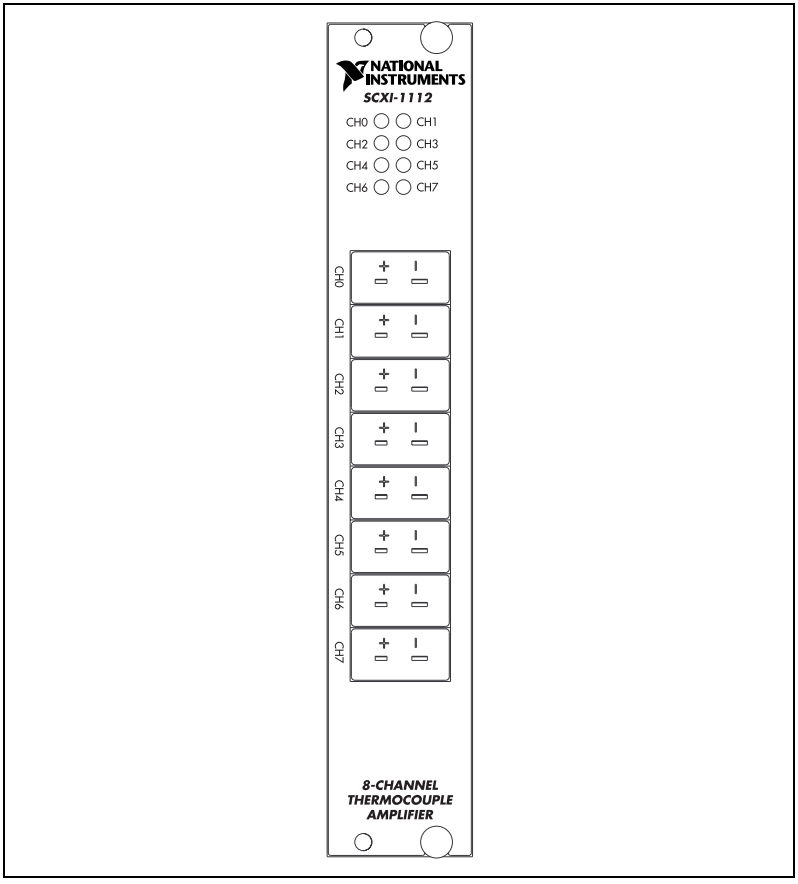


Figure 3-1. SCXI-1112 Module Front Connector Pin Assignments

Analog Input Signal Connections

The differential input signal range of an SCXI-1112 module input channel is ±0.1 V. This differential input range is the maximum measurable voltage difference between the positive and negative channel inputs. The common-mode input signal range of an SCXI-1112 module input channel is ±11 V. This common-mode input range for either the positive or the negative channel input is the maximum input voltage that will result in a valid measurement. Each channel includes input protection circuitry to withstand the accidental application of voltages up to ±42 VAC peak or VDC.

Caution Exceeding the input damage level (±42 VAC peak or VDC between input channels and chassis ground) can damage the SCXI-1112 module, the SCXIbus, and the DAQ device. Furthermore, applying a voltage greater than ±42 VAC peak or VDC to the SCXI-1112 is an electrical shock hazard. National Instruments is *not* liable for any damages or injuries resulting from exceeding these voltage limits.

Note Exceeding the differential or common-mode input channel ranges results in a distorted signal measurement.

Cold-Junction Sensors

Each channel of the SCXI-1112 has a built in cold-junction sensor. You can access these sensors through software to perform thermocouple cold-junction compensation.

In LabVIEW, read the cold-junction sensor (thermistor) for channel *x* using the string `cjtemp`*x*. Using analog input functions in NI-DAQ, refer to the cold-junction sensor for the channel *x* using the integer –(1 + *x)*.

Auto-Zero Calibration Switches

Each channel of the SCXI-1112 has an auto-zero calibration switch. When this switch is closed, the input signal is disconnected and the differential input terminals of the channel are shorted together and grounded. Any voltage reading taken with this switch closed is a measure of the combined voltage offset of the module and DAQ device. You can subtract this reading from subsequent readings, when the auto-zero calibration switch is open, to correct these readings for the system offset error corresponding to that particular SCXI-1112 channel.

In LabVIEW, close the auto-zero calibration switch and take a reading on channel x by providing the channel string `calgnd`*x* to an analog input DAQ VI. During multichannel scanning, you cannot combine `calgnd`*x* and normal or virtual channel names such as `ob0 ! sc1 ! md2 ! 0:3` or `temperature1` in the same channel string array. Auto-zero calibration readings must be taken by themselves.

For information on how to do auto-zero calibration using NI-DAQ function calls, see the `SCXI_Calibrate_Setup` entry in the *NI-DAQ Function Reference Manual for PC Compatibles.*

Rear Signal Connector

Note If you are using the SCXI-1112 module with a National Instruments DAQ device and cable assembly, you do not need to read the remainder of this chapter. If you are using the SCXI-1180 feedthrough panel, the SCXI-1343 rear screw-terminal adapter, or the SCXI-1351 one-slot cable extender with the SCXI-1112 module, read this section.

Figure 3-2 shows the SCXI-1112 module rear signal connector pin assignments.

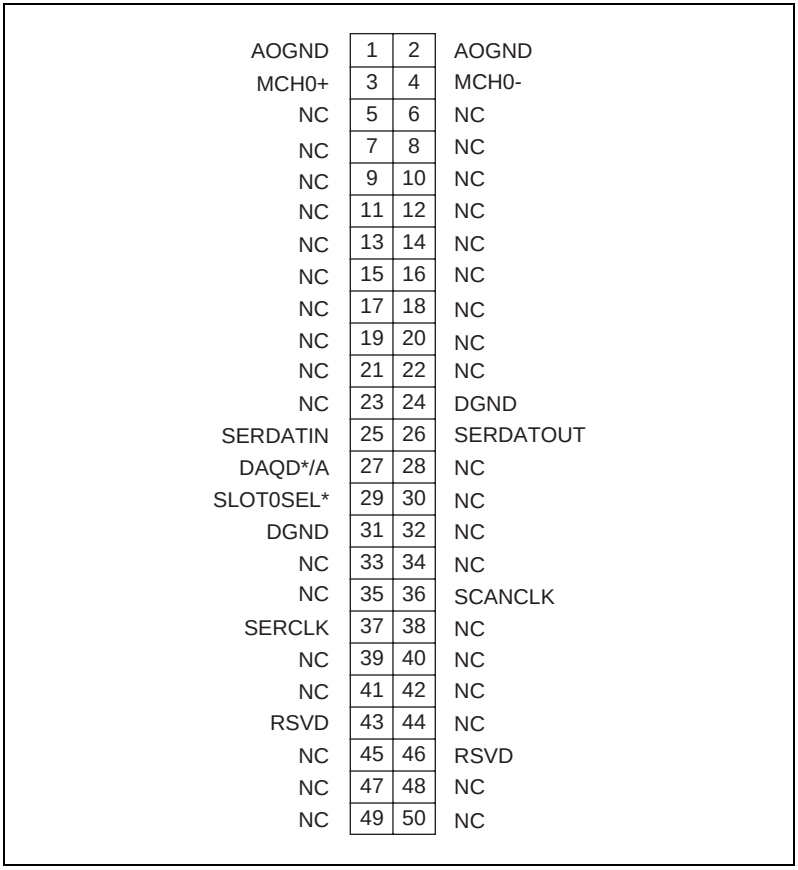


Figure 3-2. SCXI-1112 Module Rear Signal Connector Pin Assignments

Rear Signal Connector Pin Descriptions

The rear signal connector on the cabled module is the interface between the DAQ device and all modules in the SCXI chassis.

Pin	Signal Name	Direction	Description
1, 2	RSVD	Output	Reserved
3	MCH0+	Output	Positive Module Analog Output—This pin connects to the positive side of the differential analog input channel 0 of the DAQ device.
4	MCH0-	Output	Negative Module Analog Output—In the reset state of the module, this pin is configured to connect to the analog reference.
24, 33	DGND	—	Digital Ground—These pins supply the reference for DAQ device digital signals and are tied to the module digital ground.
25	SERDATIN	Input	Serial Data In—The DAQ device uses this signal to program modules in all slots.
26	SERDATOUT	Output	Serial Data Out—A cabled module uses this signal to return data from any module to the DAQ device.
27	DAQD*/A	Input	DAQ Device Data/Address Line—The DAQ device asserts this signal to indicate to the module whether the incoming serial stream is data or address information.
29	SLOT0SEL*	Input	Slot 0 Select—The DAQ device asserts this signal low to indicate that the SERDATIN line information is going to the Slot 0 controller instead of a module.
36	SCANCLK	Input	Scan Clock—A rising edge indicates to the scanned SCXI module that the DAQ device has taken a sample and causes the module to advance channels.
37	SERCLK	Input	Serial Clock—This signal clocks the data on the SERDATIN and SERDATOUT lines.
43, 46	RSVD	Input	Reserved
All other pins are not connected.			

Caution The SCXI-1112 module analog outputs are not overvoltage protected. Applying external voltages to these outputs can damage the SCXI-1112 module. National Instruments is *not* liable for any damages resulting from such signal connections.

Note The SCXI-1112 module analog outputs are short-circuit protected.

Digital I/O Signal Connections

Pins 24 through 27, 29, 33, 36, 37, 43, and 46 constitute the digital I/O lines of the rear signal connector.

The SCXI-1112 module digital input and output signals correspond to the digital I/O lines of E Series MIO DAQ devices. Table 3-1 lists the equivalencies.

Table 3-1. SCXIbus to SCXI-1112 Module Rear Signal Connector to DAQ Device Pin Equivalencies

SCXIbus Line	SCXI-1112 Rear Signal Connector	E Series MIO DAQ Device
MOSI	SERDATIN	DIO0
D*/A	DAQD*/A	DIO1
INTR*	SLOT0SEL*	DIO2
SPICLK	SERCLK	EXTSTROBE*
MISO	SERDATOUT	DIO4
TRIG0	SCANCLK	SCANCLK

4

Theory of Operation

This chapter contains a functional overview of the SCXI-1112 module and explains the operation of each functional unit making up the SCXI-1112 module.

Functional Overview

The block diagram in Figure 4-1 illustrates the key functional components of the SCXI-1112 module.

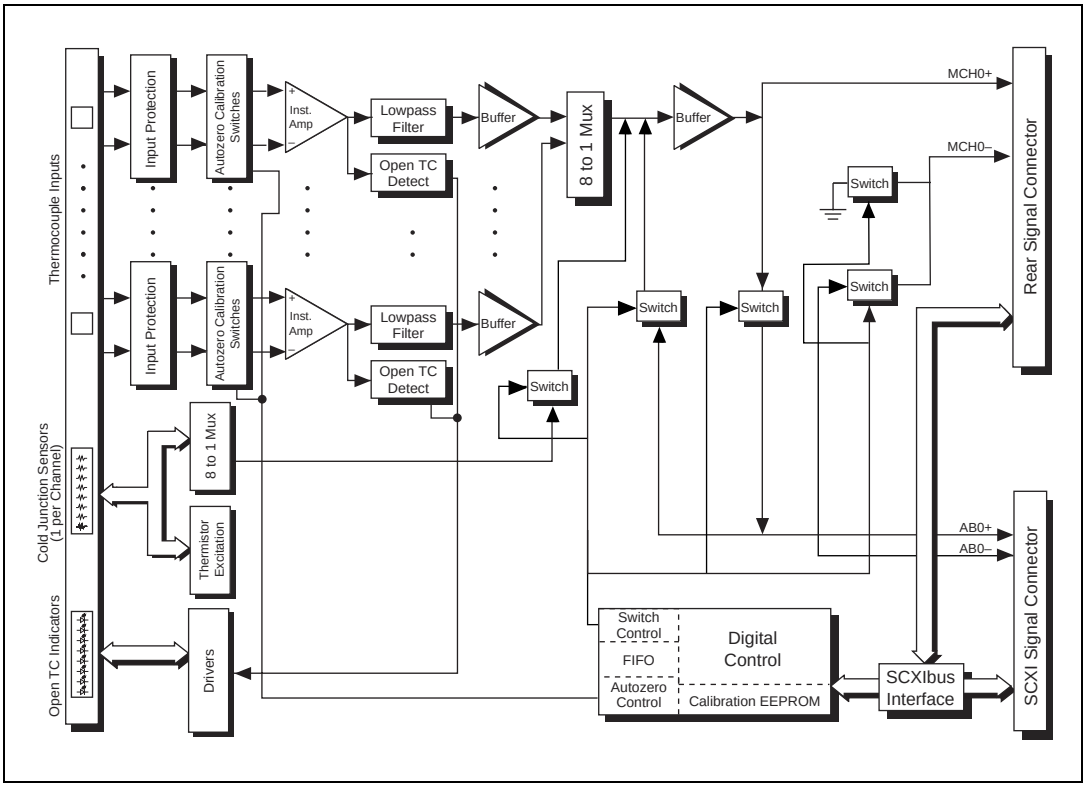


Figure 4-1. SCXI-1112 Module Block Diagram

The major components of the SCXI-1112 modules are as follows:

- Rear signal connector
- SCXIbus connector
- SCXIbus interface
- Digital control circuitry
- Analog circuitry

The SCXI-1112 modules consist of eight multiplexed input channels, each with a fixed gain of 100. Each input channel has its own lowpass filter. The SCXI-1112 modules also have a digital section for automatic control of channel scanning, temperature sensor selection, and calibration.

Rear Signal Connector, SCXIbus Connector, and SCXIbus Interface

The SCXIbus controls the SCXI-1112 module. The SCXIbus interface connects the rear signal connector to the SCXIbus, allowing a DAQ device to control the SCXI-1112 module and the rest of the chassis.

Digital Control Circuitry

The digital control circuitry consists of the Address Handler and the following registers: Module ID, Configuration, EEPROM, and Channel. The Address Handler controls which register is being addressed. The Module ID Register contains a code unique to the SCXI-1112 module. The Module ID is 33 decimal.

The Configuration Register configures the SCXI-1112 modules for the desired scanning mode and connection to the rear signal connector. The EEPROM Register is the address for interfacing with the module EEPROM, which contains calibration information. The Channel Register selects a channel for a single measurement or a start channel for a scan. Refer to *Software Programming Choices* in Chapter 1, *Introduction*, to learn about options for programming the control circuitry.

Analog Circuitry

The analog circuitry per channel consists of a lowpass filter and an amplifier with a fixed gain of 100. The CJSENSOR channel also has a buffered lowpass filter but has no amplifier. The channels and CJSENSOR are multiplexed to a single output buffer.

Analog Input Channels

Each of the eight analog input channels feeds to a separate amplifier with a fixed gain of 100. Then the signal passes through a three-pole lowpass filter.

The temperature sensor consists of a thermistor located inside the module next to its respective channel. The temperature sensor is for cold-junction compensation of thermocouples. The CJSENSOR channel also passes through a 2 Hz lowpass filter to reject unwanted noise. Along with the other eight input channels, the CJSENSOR is multiplexed to the output buffer, where it can be read by the DAQ device.

For measurement accuracy of 0.012% of full scale, the minimum interchannel delay is 3 µs. This is the smallest interval in which you can switch between analog channels on the module and still measure voltages accurately. The 3 µs interchannel delay gives you a maximum sampling rate of 333 kHz. Because this rate is higher than the bandwidth of a single SCXI-1112 channel (2 Hz), you can sample multiple channels on multiple SCXI modules without undersampling one of the SCXI-1112 channels.

Analog Bus Switch

The SCXI-1112 modules contain switches to place their analog output on the SCXIbus to pass the output to the SCXI module cabled to the DAQ device. The SCXI-1112 modules also contain switches to receive a signal placed on the SCXIbus by another SCXI module. The output buffer of the cabled module drives a received signal onto the MCH0+ line of the rear signal connector so that the DAQ device can read it. When a signal passes on the SCXIbus from the scanned SCXI module to the cabled SCXI module, the measurement is known as *indirect scanning*.

A

Specifications

This appendix lists the specifications for the SCXI-1112 modules. These specifications are typical at 25 °C unless otherwise noted.

Analog Input

Input Characteristics

Number of channels ..... 8 differential

Input signal ranges ..... ±100 mV

Max working voltage
(signal + common mode) ..... Each input should remain within ±10 V of CGND

Input damage level ..... ±42 VAC peak or VDC

Inputs protected..... CH<0..7>, CJSENSOR<0..7>

Transfer Characteristics

Nonlinearity ..... 0.005% FSR

Offset error

After calibration..... 20 µV max

Before calibration ..... 100 µV typ

Gain error (relative to calibration reference)

After calibration..... 0.005% of reading max

Before calibration ..... 0.1% of reading typ

Amplifier Characteristics

Input impedance

Normal powered on ..... >1 GΩ

Powered off..... 10 kΩ

Overload..... 10 kΩ

Input bias current .....±0.5 nA

Input offset current .....±1.0 nA

CMRR

50 to 60 Hz .....110 dB

DC.....75 dB min

Output range .....±10 V

Output impedance.....91 Ω

Dynamic Characteristics

Bandwidth.....2 Hz

Scan interval (per channel, any gain)

0.012%.....3 µs

0.0061%.....10 µs

System noise (referenced to input) .....5 μV_{rms}

Cold-junction sensor accuracy.....1.0 °C

Measurement accuracy

	Measurement Temperature °C						
TC Type	**–100**	**0**	**250**	**500**	**1000**	**1300**	**1700**
J	±0.9	±0.7	±0.7	±0.7	±0.9	—	—
K	±0.9	±0.7	±0.7	±0.7	±1.0	±1.2	—
N	±1.1	±0.8	±0.7	±0.7	±1.0	—	—
E	±0.9	±0.7	±0.7	±0.7	—	—	—
T	±1.0	±0.7	±0.8	±0.8 (400 °C)	—	—	—

Digital Signals

Absolute max voltage input rating ..... 5.5 V with respect to DGND

Digital input specifications (referenced to DGND)

V_{IH} input logic high voltage..... 2 V min

V_{IL} input logic low voltage..... 0.8 V max

I_I input current leakage ..... ±1 µA max

Digital output specifications (referenced to DGND)

V_{OH} output logic high voltage ..... 3.7 V min at 4 mA max

V_{OL} output logic low voltage..... 0.4 V max at 4 mA max

Filters

Cutoff frequency (–3 dB)..... 2 Hz

NMR (60 Hz) ..... 40 dB

Step response

To 0.1%..... 1 s

To 0.01% ..... 10 s

Stability

Recommended warm-up time ..... 20 min.

Offset temperature coefficient ..... 1 µV/°C

Gain temperature coefficient..... 10 ppm/°C

Physical

Dimensions..... 115 by 273 mm (4.54 by 10.75 in.)

I/O connector..... 50-pin male ribbon cable rear connector
96-pin male DIN C front connector

Environment

Operating temperature .....0 to 50 °C

Storage temperature .....–55 to 150 °C

Relative humidity .....5 to 90% noncondensing

Power Requirements

5 V supply.....15 mA max

±15 V supply (regulated
from ±24 V supply) .....150 mA max

B

Technical Support Resources

This appendix describes the comprehensive resources available to you in the Technical Support section of the National Instruments Web site and provides technical support telephone numbers for you to use if you have trouble connecting to our Web site or if you do not have internet access.

NI Web Support

To provide you with immediate answers and solutions 24 hours a day, 365 days a year, National Instruments maintains extensive online technical support resources. They are available to you at no cost, are updated daily, and can be found in the Technical Support section of our Web site at `www.natinst.com/support`.

Online Problem-Solving and Diagnostic Resources

- **KnowledgeBase**—A searchable database containing thousands of frequently asked questions (FAQs) and their corresponding answers or solutions, including special sections devoted to our newest products. The database is updated daily in response to new customer experiences and feedback.
- **Troubleshooting Wizards**—Step-by-step guides lead you through common problems and answer questions about our entire product line. Wizards include screen shots that illustrate the steps being described and provide detailed information ranging from simple getting started instructions to advanced topics.
- **Product Manuals**—A comprehensive, searchable library of the latest editions of National Instruments hardware and software product manuals.
- **Hardware Reference Database**—A searchable database containing brief hardware descriptions, mechanical drawings, and helpful images of jumper settings and connector pinouts.
- **Application Notes**—A library with more than 100 short papers addressing specific topics such as creating and calling DLLs, developing your own instrument driver software, and porting applications between platforms and operating systems.

Software-Related Resources

- **Instrument Driver Network**—A library with hundreds of instrument drivers for control of standalone instruments via GPIB, VXI, or serial interfaces. You also can submit a request for a particular instrument driver if it does not already appear in the library.
- **Example Programs Database**—A database with numerous, non-shipping example programs for National Instruments programming environments. You can use them to complement the example programs that are already included with National Instruments products.
- **Software Library**—A library with updates and patches to application software, links to the latest versions of driver software for National Instruments hardware products, and utility routines.

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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}
t-	tera-	10^{12}

Numbers/Symbols

+5 V	+5 volt signal
°	degrees
Ω	ohms
%	percent
±	plus or minus

A

A	amperes
AC	alternating current
ACH	analog input channel signal
A/D	analog-to-digital
AIGND	analog input ground signal

ANSI	American National Standards Institute
auto-zero	the technique of internally shorting the internal circuit while disconnecting the measurement to compensate for temperature-induced offset voltage errors

C

C	Celsius
CGND	chassis ground signal
channel	pin or wire lead to which you apply or from which you read the analog or digital signal. Analog signals can be single-ended or differential. For digital signals, you group channels to form ports. Ports usually consist of either four or eight digital channels.
CJSENSOR	cold-junction sensor
CMRR	common-mode rejection ratio

D

D/A	digital-to-analog
D*/A	Data/Address
DAQ	data acquisition—(1) collecting and measuring electrical signals from sensors, transducers, and test probes or fixtures and inputting them to a computer for processing; (2) collecting and measuring the same kinds of electrical signals with A/D and/or DIO boards plugged into a computer, and possibly generating control signals with D/A and/or DIO boards in the same computer
dB	decibel—the unit for expressing a logarithmic measure of the ratio of two signal levels: dB=20log10 V1/V2, for signals in volts
DC	direct current

device	a plug-in data acquisition board, card, or pad that can contain multiple channels and conversion devices. Plug-in boards, PC cards, and devices such as the DAQPad-1200, which connects to your computer parallel port, are all examples of DAQ devices. SCXI modules are distinct from devices, with the exception of the SCXI-1200, which is a hybrid.
DGND	digital ground signal
DIFF	differential configuration
differential input	an analog input consisting of two terminals, both of which are isolated from computer ground, whose difference is measured
DIN	Deutsche Industrie Norme
DIO	digital input/output
DNL	differential nonlinearity—a measure in LSB of the worst-case deviation of code widths from their ideal value of 1 LSB
drivers/driver software	software that controls a specific hardware device such as a DAQ device

F

F	farads
FIFO	first-in first-out memory buffer—the first data stored is the first data sent to the acceptor. FIFOs are often used on DAQ devices to temporarily store incoming or outgoing data until that data can be retrieved or output. For example, an analog input FIFO stores the results of A/D conversions until the data can be retrieved into system memory, a process that requires the servicing of interrupts and often the programming of the DMA controller. This process can take several milliseconds in some cases. During this time, data accumulates in the FIFO for future retrieval. With a larger FIFO, longer latencies can be tolerated. In the case of analog output, a FIFO permits faster update rates, because the waveform data can be stored on the FIFO ahead of time. This again reduces the effect of latencies associated with getting the data from system memory to the DAQ device.
FSR	full-scale reading

G

G	gain

H

hex	hexadecimal
Hz	hertz—the number of scans read or updates written per second

I

ID	identifier
in.	inches
INTR*	Interrupt
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

L

LED	light-emitting diode
LSB	least significant bit

M

MIO	multifunction input/output
MISO	master in, slave out
MOSI	master out, slave in
MSB	most significant bit

N

NC	not connected (signal)
NMR	normal mode rejection

R

rms	root mean square—the square root of the average value of the square of the instantaneous signal amplitude; a measure of signal amplitude
RSVD	reserved bit
RTSI	real-time system integration

S

S	samples
s	seconds
SCANCLK	scan clock signal
SCXI	Signal Conditioning eXtensions for Instrumentation—the National Instruments product line for conditioning low-level signals within an external chassis near sensors so only high-level signals are sent to DAQ devices in the noisy PC environment
SERCLK	serial clock signal
SERDATIN	serial data input signal
SERDATOUT	serial data output signal
signal conditioning	the manipulation of signals to prepare them for digitizing
SLOT0SEL*	Slot 0 select signal
SPICLK	serial peripheral interface clock

T

TRIG0	trigger 0
TTL	transistor-transistor logic

V

V	volts
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
V_{IH}	volts, input high
V_{IL}	volts, input low
V_{in}	volts in
V_{OH}	volts, output high
V_{OL}	volts, output low

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