SCXI™

SCXI-1520 User Manual

Worldwide Technical Support and Product Information

ni.com

National Instruments Corporate Headquarters

11500 North Mopac Expressway   Austin, Texas 78759-3504   USA   Tel: 512 794 0100

Worldwide Offices

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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-1520

Introduction

This section provides an introduction to the SCXI-1520 module, its theory of operation, installation, and setup.

Note Descriptions in this *Introduction* explicitly refer to the first channel (channel 0); however, the same descriptions are applicable to the remaining seven channels.

About the SCXI-1520

The SCXI-1520 module is a nonisolated eight-channel module for interfacing to strain-gauge bridges and strain-gauge based sensors. With the SCXI-1520 and the accessory SCXI-1314 terminal block, you can:

- Connect to all bridge configurations, including quarter-bridge, half-bridge, and full-bridge
- Set the DC voltage excitation between 0 and 10 V at 0.625 V increments
- Automatically null the input signal to zero
- Set the analog input lowpass filter response between 10 Hz and 10 kHz at one of four widely spaced settings or bypass the analog input lowpass filter
- Set the analog input gain between 1 and 1000 at any one of 49 closely spaced settings
- Implement shunt calibration using two independent circuits
- Connect the bridge for remote-sense voltage excitation

You can configure all settings on a per-channel basis through software. The SCXI-1520 is configured using Measurement & Automation Explorer (MAX) or through function calls to NI-DAQ.

SCXI-1520 Theory of Operation

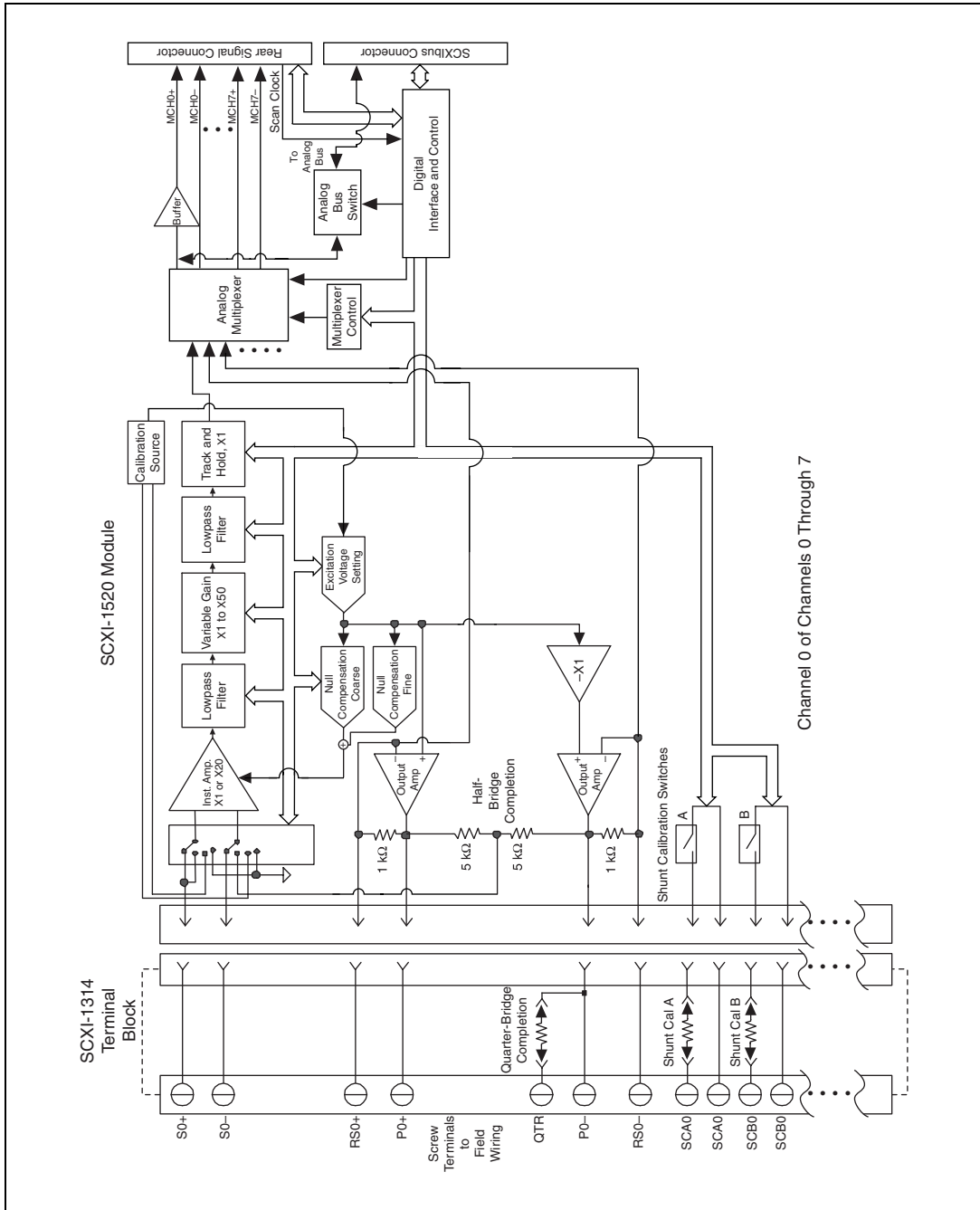Figure 1-1 is a block diagram of the SCXI-1520 and SCXI-1314. Only the first channel is shown.

Figure 1-1. Block Diagram of SCXI-1314/SCXI-1520 Combination

Analog Input

The analog input signal from the strain-gauge bridge is connected to S0+ and S0– of the terminal block. The signal passes through the terminal block to an electronic four position switch in the module. Figure 1-1 shows the switch in the first position where S0+ and S0– inputs connect directly to an instrumentation amplifier. This position is for full-bridge connections or general-purpose analog input.

The second position connects the negative input to the internal voltage divider between the excitation terminals. The internal voltage divider functions as bridge completion for half-bridge and quarter-bridge configurations.

The third switch position connects the amplifier input to a calibration voltage source inside the module for gain calibration, and the fourth position grounds both inputs for offset calibration.

The instrumentation amplifier stage presents a very high input impedance to external signals and passes only the differential signal. For overall module gain settings equal to or greater than 20, the gain of this stage is set to 20 so that the noise and offset drift of later stages is small in comparison to this stage. The instrumentation amplifier stage uses operational amplifiers with very low temperature drift and noise characteristics.

The signal from the instrumentation amplifier stage passes through a lowpass filter stage, a variable gain stage, another lowpass filter stage, and finally a track-and-hold stage before reaching the output multiplexer.

You can set the cutoff frequencies of the lowpass filter stages to 10 Hz, 100 Hz, 1 kHz, or 10 kHz. The overall response is a four-pole Butterworth response. You can also bypass the filters for maximum bandwidth.

The variable gain stage allows you to set the gain at many discrete settings between X1 and X50. These settings, along with the X1 or X20 setting of the instrumentation amplifier, permit the SCXI-1520 to have 48 closely spaced gain settings between X1 and X1000.

All track and hold stages for all channels go into hold mode at the beginning of a scan, and revert back to track mode at the end of a scan. Therefore, you can simultaneously sample all channels.

The multiplexer selects the conditioned analog signal from one of the eight channels for routing to the DAQ device through the rear signal connector or to the cabled module through the SCXI backplane using the SCXIbus connector. Digital circuitry controlling the multiplexer can sequence the

channel selection through a list of channels in any order; the ordering of channels need not be sequential. This is referred to as *random scanning*. The module includes first-in first-out (FIFO) memory for storing the channel scan list defined in your application code. NI-DAQ drivers load the FIFO based on the channel assignments you make in an application development environment such as LabVIEW. You need not explicitly program the module FIFO.

Excitation

The SCXI-1520 provides DC voltage for exciting a Wheatstone bridge. For half-bridge and full-bridge applications, the excitation voltage is available at terminal block connections P0+ and P0–. For quarter-bridge applications, connection is made to terminals P0+ and QTR0; the latter terminal allows connection to the quarter-bridge completion resistor.

Excitation voltage originates from two output buffers dedicated to each channel. Because each channel is controlled independently, a short circuit across the excitation terminals of one channel has no effect on the excitation of another channel. The output buffers have negative feedback connections at the terminal block remote-sense terminals, RS0+ and RS0–. You can run separate wires from the bridge to these terminals so that the amplifiers obtain feedback directly from the bridge, thereby forcing bridge voltage to equal the desired setting.

If you leave the remote sense terminal unconnected, internal 1 kΩ resistors provide feedback to the buffers from the P0+ and P0– terminals. Therefore, you need not install any jumpers between RS0+ and P0+, nor RS0– and P0–.

You can scan the remote sense terminals. The output multiplexer has input connections to the RS0+ and RS0– terminals. You can scan these terminals for monitoring and correction purposes, even if the remote sense terminals are not connected.

P0+ is always positive with respect to chassis ground, and P0– is always negative with respect to chassis ground. The inverting amplifier –X1 forces the voltage at P0– to equal the negative of the voltage at P0+. For example, if you set the module output for +5 V, P0+ is at +2.5 V with respect to ground, and P0– is at –2.5 V with respect to chassis ground. The excitation setting originates from an internal digital-to-analog converter (DAC). You can set the excitation voltage between 0 V and 10 V in 0.625 V increments. You can power a 350 Ω full-bridge at 10 V without exceeding the maximum power rating of the excitation source. The excitation outputs

are protected with surge suppressors that prevent either excitation output
terminal from exceeding 6 V with respect to chassis ground.

Note Chassis ground is at the same potential as earth ground when the chassis is plugged
into a standard 3-prong AC outlet. If P0– is connected to earth ground, the excitation source
does not function properly.

Null Compensation

Most strain gauge signal conditioners use a manually adjusted
potentiometer to remove an initial voltage offset from the Wheatstone
bridge. This is referred to as *null compensation*. In the SCXI-1520, null
compensation is performed electronically using software-controlled
electronic potentiometers. Two potentiometers are used, one for coarse
adjustments and the other for fine adjustments. The sum of the two
potentiometer signals is added to the analog input path to cancel the offset,
thus nulling the strain-gauge channel. The voltage input to the
potentiometers is a voltage proportional to the excitation voltage setting.
Thus, if the excitation voltage changes by a small amount due to a change
in temperature, the correction signal changes by the same amount and the
null is maintained.

For more information regarding nulling an SCXI-1520 channel, along with
the getting and setting of the coarse and fine potentiometer control values,
see *Null Potentiometers* in this chapter.

Shunt Calibration

The SCXI-1520 has two independent shunt calibration circuits available
at terminal sets SCA0 and SCB0 on the terminal block. Each shunt
calibration circuit consists of a resistor in series with a switch. The
SCXI-1520 uses an electronic switch that is not subject to wear-out. Also,
the electronic switch is galvanically isolated from ground; therefore, you
can connect the switch across any external bridge element. You can control
any individual shunt calibration switch or combination of shunt calibration
switches using software commands. The shunt calibration resistors in series
with each switch are socketed in the SCXI-1314 terminal block. You can
easily replace these resistors with your own. The resistors are RN-55 style
(standard 1/4 W). For resistor replacement instructions, refer to the
SCXI-1314 Universal Strain Terminal Block Installation Guide.

Installing the Software

You can control the SCXI-1520 in an application development environment (ADE) using NI-DAQ. The supported ADEs include LabVIEW, LabWindows/CVI, Visual Basic (ComponentWorks), C, and C++ environments. Follow these instructions to install your SCXI-1520 software:

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

2. Install the NI-DAQ software that came with your DAQ device. NI-DAQ version 6.9 or higher is required to configure and program your SCXI-1520 module. If you do not have NI-DAQ version 6.9 or higher, you can either contact a National Instruments sales representative to request it on a CD or download the latest NI-DAQ version from the National Instruments web site, `ni.com`

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-1520 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 boards connected to the SCXI chassis, the host computer, and the

SCXI device. National Instruments is *not* liable for any damages or injuries resulting from incorrect signal connections.

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

The terminal block *must* be used with a UL-listed SCXI chassis.

Installing the SCXI-1520

The following section describes how to install your SCXI-1520 for use with SCXI chassis and National Instruments DAQ devices.

Unpacking

Your SCXI-1520 module is shipped in an antistatic package to prevent electrostatic damage to the module. Electrostatic discharge can damage several components in the module. To avoid such damage in 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.

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

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-1520 module in the antistatic package when not in use.

Installing the SCXI-1520 Module into the SCXI Chassis

You need the following items to complete the installation:

- SCXI-1520

- SCXI chassis or PXI combination chassis

- 1/4 in. flathead screwdriver

To install your SCXI-1520 module into the SCXI chassis, follow these steps while referring to Figure 1-2:

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-1520 module into a chassis that is turned on.

3. Insert the SCXI-1520 into an open slot in the SCXI chassis. Gently guide 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.

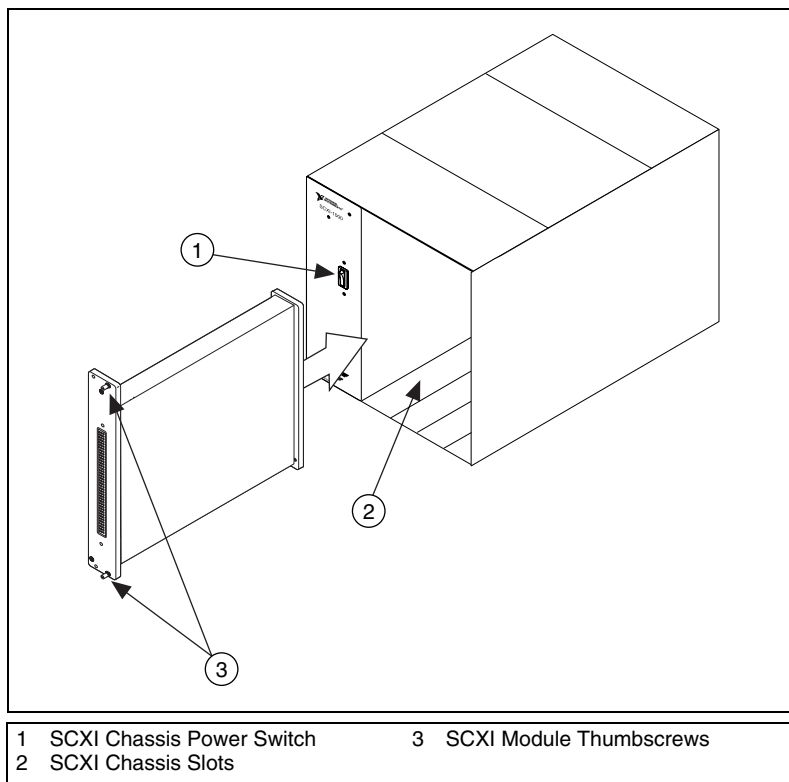5. Secure all the SCXI modules to the SCXI chassis using both thumbscrews.

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

Figure 1-2. Installing the SCXI-1520 Module

To complete your SCXI-1520 installation, follow the procedure in the appropriate sections that follow.

Connecting the SCXI-1520 to a DAQ Device for Multiplexed Scanning in an SCXI Chassis

In this configuration, you can multiplex all eight input channels of the SCXI-1520 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-1520 module and any other SCXI modules in the chassis according to their installation instructions.

In your chassis, you must select an analog input module with simultaneous sampling capability as the cabled module, to which the SCXI cable assembly will connect. This includes the SCXI-1520, SCXI-1530/1531, and SCXI-1140. If you cable to a module without simultaneous sampling capability, you will get an error message each time you run your application.

To connect the chassis to a DAQ device for multiplexed operation, complete the following steps while referring to Figure 1-3:

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.

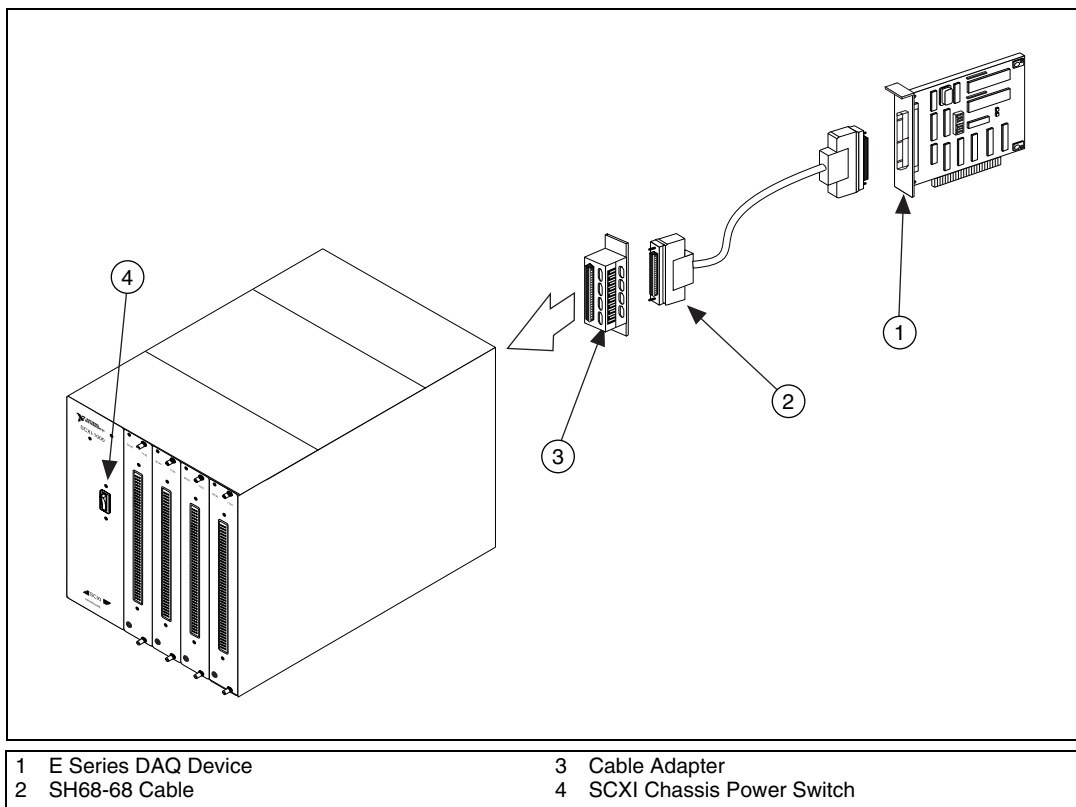| 1 | E Series DAQ Device | 3 | Cable Adapter |
| 2 | SH68-68 Cable | 4 | SCXI Chassis Power Switch |

Figure 1-3. 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-1520 module(s)
for multiplexed mode operation.

Connecting the SCXI-1520 to a DAQ Device for Multiplexed Scanning in a PXI Combination Chassis

In this configuration, you can multiplex all eight channels of your SCXI-1520 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-1520 module, and any other SCXI modules in the chassis according to their installation instructions. To use the SCXI-1520 module in multiplexed mode with a DAQ device in a PXI combination chassis, follow these steps:

1. No cables are required between the SCXI-1520 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 *Connecting the SCXI-1520 to a DAQ Device for Multiplexed Scanning in an SCXI Chassis*.

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-1520 for multiplexed mode operation.

Configuration and Self-Test

Run MAX to configure and test your SCXI-1520. 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.

2. Click the **+** next to the **Devices and Interfaces** icon.

    • 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 holding down the right mouse button on **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 is an integer value you choose to uniquely identify the chassis for programming and scanning.

    b. Select the **Chassis Address**. This 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.

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 *Configuration and Self-Test*.

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**.

Your MAX software 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 or higher, you can either contact a National Instruments sales representative or download the latest NI-DAQ version from the National Instruments web site, ni.com. If you need to change the module configuration, refer to *Configuring the SCXI-1520* 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 clicking the **+** next to the **Devices and Interfaces** icon.

2. The chassis you selected is displayed in the list. Display the list of modules in the chassis by clicking the **+** next to the **Chassis** icon.

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 or higher, you can either contact a National Instruments sales representative or download the latest NI-DAQ version from the National Instruments Web site, ni.com.

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 appropriate gain, filter bandwidth, excitation level, and bridge configuration setting for each channel on the SCXI-1520 (refer to *SCXI-1520 Configuration Settings* for a detailed description of each setting). Click **Next**.

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

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

If you need to manually install more SCXI-1520 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 *Configuring the SCXI-1520*. If your configuration is complete, test the system as described in *Verifying and Self-Testing the Configuration* to ensure your SCXI system is communicating properly with the DAQ device.

Configuring the SCXI-1520

To configure your SCXI-1520 after auto-detection, or to alter your original configuration selections, you must use MAX. Perform the following steps to configure your SCXI-1520:

1. Double-click the **Measurement & Automation Explorer** icon on your desktop.

2. Display the list of installed devices and interfaces by clicking 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 the SCXI-1520 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 **Channel** tab. Select the appropriate bridge configuration, gain, excitation voltage, and filter bandwidth for each channel. Refer to *SCXI-1520 Configuration Settings* for a detailed description of each setting. Click **Apply**.

7. 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 appropriate 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 clicking the **+** next to the **Devices and Interfaces** icon.

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. If the test did not complete successfully, see *Troubleshooting the Self-Test Verification* for troubleshooting steps.

SCXI-1520 Configuration Settings

This section describes how to set the bridge configuration, gain, excitation level, and filter bandwidth of each channel.

Bridge Configuration

You normally set the bridge configuration in MAX. The choices are quarter-bridge, half-bridge, or full-bridge configuration. When quarter-bridge or half-bridge configuration is selected, Terminal S*X*– (where *X* is a particular channel) is disconnected from the front signal connector and internally connected to a half-bridge completion network. Implementing quarter-bridge completion also involves making field wiring connections to the quarter-bridge completion resistor in the terminal block.

You can also programmatically set bridge completion from LabVIEW using the AI Parameter VI under the DAQ menu. A setting established through AI Parameter VI is only valid for the LabVIEW session and does not change the setting in MAX.

Excitation Level

You normally set the excitation voltage level in MAX. You can choose one of 17 voltage settings between 0 V and 10 V. To prevent the module from overheating, do not set the voltage greater than

$$(resistance\ connected\ between\ the\ excitation\ terminals) \times (28.6\ mA)$$

Note You need not include the loading effect of the internal half-bridge completion resistors in the above calculation.

Table 1-1 shows the maximum allowable excitation voltages for standard bridge configurations and resistances.

Table 1-1. Excitation Voltage for Configuration and Gauge Resistances

Configuration/ Sensor	Resistance	Excitation Voltage Range
Quarter- or Half-Bridge	120 Ω	0 to 6.250 V
	350 Ω	0 to 10 V
	1000 Ω	0 to 10 V

Table 1-1. Excitation Voltage for Configuration and Gauge Resistances (Continued)

Configuration/ Sensor	Resistance	Excitation Voltage Range
Full-Bridge or Full-Bridge Sensor	120 Ω	0 to 3.125 V
	350 Ω	0 to 10 V
	1000 Ω	0 to 10 V

You can also set the excitation voltage level from LabVIEW using AI Parameter VI under the DAQ menu. A setting established through AI Parameter VI is only valid for the LabVIEW session and does not change the setting in MAX.

Filter Bandwidth

You normally set the analog input bandwidth in MAX. You can choose 10 Hz, 100 Hz, 1kHz, 10 kHz, or filter-bypass mode.

You can also set the analog input bandwidth from LabVIEW using AI Parameter VI under the DAQ menu. A setting established through AI Parameter VI is only valid for the LabVIEW session and does not change the setting in MAX.

Null Potentiometers

In most cases, you do not explicitly set the null potentiometers, but instead allow driver software to automatically adjust them for you when you call the LabVIEW SCXI Strain Null VI or set up a virtual channel using MAX. However, if you want to explicitly set the potentiometers, you can write an application program that adjusts the settings of many channels at once, or restores a particular null setting between sessions without performing a nulling operation each time.

To explicitly set or get the control codes of the potentiometers, use the LabVIEW AI Parameter VI. An example of using the AI Parameter VI to control an SCXI-1520 is shown in Figure 2-10, *Using the AI Parameter VI to Set Up the SCXI-1520*.

Table 1-2 summarizes the range and scale of the control codes.

✎   **Note**   The control codes take on integer values. The span of correction for each
potentiometer depends on the channel gain setting.

Table 1-2. Control Codes for Coarse and Fine Null Potentiometers

Null Potentiometer	Range (Integer Values)	Mid-Scale	Module Channel Gain Settings	Approximate Correction Span at Analog Input
Coarse	0 to 127	62	≥20	$V_{EX}/10$
			<20	V_{EX}
Fine	0 to 4095	2047	≥20	$V_{EX}/100$
			<20	$V_{EX}/10$

Gain

If you address an SCXI-1520 channel using a virtual channel name, you
need not set the gain since MAX sets the gain for you. Otherwise, you
should first determine the full-scale limits of the SCXI-1520 input signal.
For common strain-gauge configurations where the gauge factor is 2.0, the
maximum input signal (in microvolts) is:

$$\text{quarter-bridge} = (\textit{max strain}) \times (\textit{excitation voltage}) \times (0.5 \ \mu V/V/\mu \varepsilon)$$

$$\text{half-bridge} = (\textit{max strain}) \times (\textit{excitation voltage}) \times (1.0 \ \mu V/V/\mu \varepsilon)$$

$$\text{full-bridge} = (\textit{max strain}) \times (\textit{excitation voltage}) \times (2.0 \ \mu V/V/\mu \varepsilon)$$

If you are using a strain-gauge-based sensor, use the
manufacturer-specified sensitivity (usually expressed in the units of
millivolts per volt) to determine the maximum input signal. The maximum
input signal is:

$$(\textit{max input signal voltage}) \ = \ \frac{(\textit{sensor sensitivity}) \times (\textit{excitation voltage}) \times (\textit{maximum input})}{(\textit{sensor full-scale input})}$$

For example, if you have a 0–500 psi pressure sensor with 3.0 mV/V
sensitivity, an excitation voltage of 10 V, and a maximum pressure of
200 psi, your maximum signal is:

$$(3.0 \ \text{mV/V}) \times (10 \ \text{V}) \times (200 \ \text{psi}) \div (500 \ \text{psi}) = 12 \ \text{mV}$$

If you are using an SCXI channel string in an application such as LabVIEW, Measure, or Visual Basic, set the channel gain indirectly by providing the quantity calculated above as a channel input-limit parameter. If you are using LabVIEW in the previous example, set the upper channel limit to +0.012 V and the lower channel limit to 0.0 V. When you enter channel input limits, you do not need to enter or configure the gain in MAX since the gain is set automatically based on the channel input-limit parameter.

If you do not provide channel input limits in an application that uses SCXI channel strings, the gain the SCXI-1520 uses is the setting entered in MAX. For example, if you are using a DAQ device that has a maximum analog input range of ±10 V and you have a maximum input to the SCXI-1520 of +12 mV, set the gain in MAX to the setting closest to

$$10 \text{ V} \div 12 \text{ mV} = 833$$

but *less* than 833. A larger gain setting saturates the DAQ device input for a 12 mV signal. In this example, the closest lesser setting for the SCXI-1520 is 750.

If you are performing basic I/O in a C-based application, you must use the NI-DAQ function `SCXI_Set_Gain` to set the gain.

Troubleshooting the Self-Test Verification

If the Self-Test Verification did not verify your chassis configuration, check the following items to successfully complete system configuration:

- 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 *Configuring the SCXI-1520* and change the configuration of the cabled module in your system from **Connected to: None** to **Connected to: Device *x***.

- 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:

    - Make sure the SCXI chassis power is on.

    - Make sure the cable between the SCXI chassis and DAQ device is properly connected.

    - Inspect the cable connectors for bent pins.

- – Make sure you are using the correct National Instruments cable assembly.

    - – Test your DAQ device to verify it is working properly. See your DAQ device user manual for more information.

- If you get the warning message **Failed to find**, followed by module codes and the message **Instead found: module with ID 0Xxx**, return to *Configuring the SCXI-1520* and make sure the correct module is in the specified slot. Delete the incorrect module as described in *Removing the SCXI-1520 from Measurement & Automation Explorer* and add the correct module as described in *Manually Adding Modules*.

- If you get the warning message **Failed to find**, followed by a module code and 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 *Installing the SCXI-1520 Module into the SCXI Chassis*. If the module is installed in the correct slot, turn off the chassis, remove the module as specified in *Removing the SCXI-1520 from an SCXI Chassis*, and verify that no connector pins are bent on the rear signal connector. Reinstall the module as described in *Installing the SCXI-1520 Module into the SCXI Chassis*, ensuring the module is fully inserted and properly aligned in the slot.

- After checking the preceding items, return to *Verifying and Self-Testing the Configuration* and retest your SCXI chassis.

If these measures do not successfully configure your SCXI system, see Appendix D, *Common Questions*, for more information.

Removing the SCXI-1520

This section shows you how to remove the SCXI-1520 from an SCXI chassis.

Removing the SCXI-1520 from an SCXI Chassis

You need the following items to complete this task:

- SCXI chassis or PXI combination chassis with the SCXI-1520 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-1520 module from an SCXI chassis, take these steps while referring to Figure 1-4:

1. If the SCXI-1520 is the cabled module, disconnect the cable running from the SCXI-1520 to the DAQ device.

2. Remove any terminal block that connects to the SCXI-1520.

3. Turn off the SCXI chassis. Do *not* remove the SCXI-1520 module from a chassis that is powered on.

4. Rotate the thumbscrews that secure the SCXI-1520 to the chassis counter-clockwise until they are loose, but do not completely remove the thumbscrews.

5. Remove the SCXI-1520 by pulling steadily on both thumbscrews until the module slides completely out.
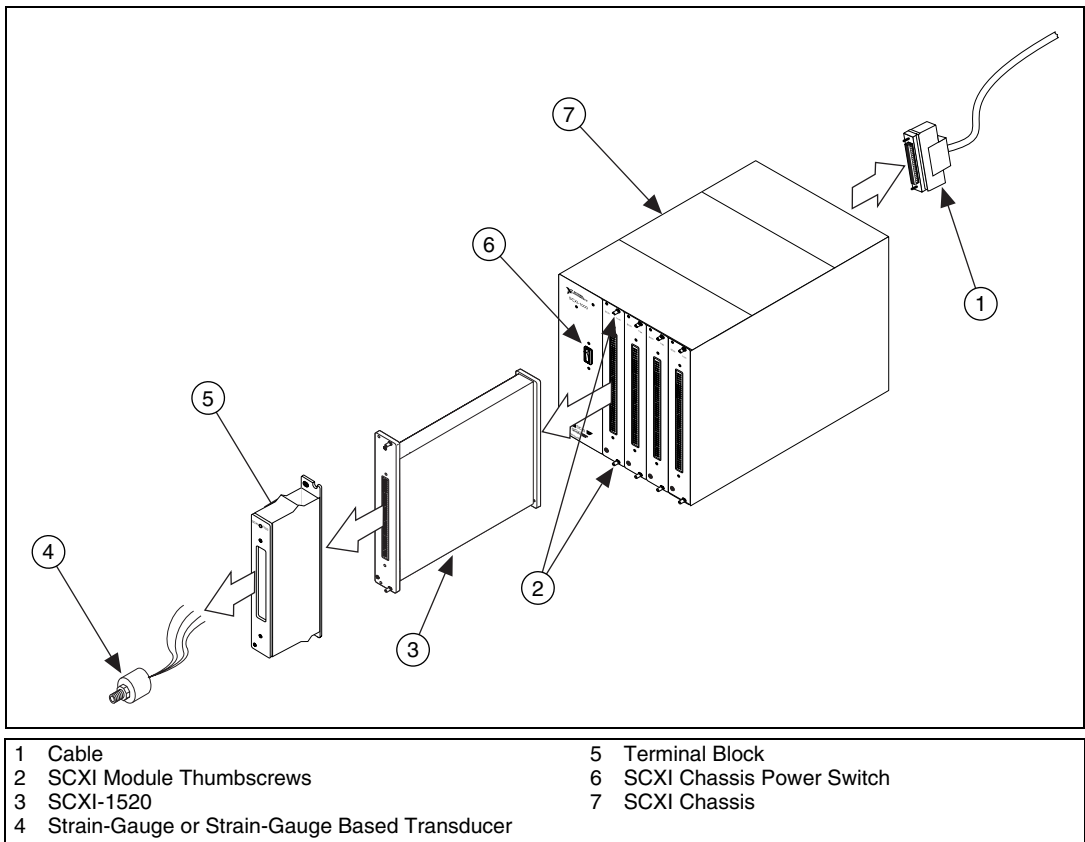

1	Cable	5	Terminal Block
2	SCXI Module Thumbscrews	6	SCXI Chassis Power Switch
3	SCXI-1520	7	SCXI Chassis
4	Strain-Gauge or Strain-Gauge Based Transducer		

Figure 1-4. Removing the SCXI-1520

Removing the SCXI-1520 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 clicking the **+** next to the **Devices and Interfaces** icon.

2. Locate the chassis in the list of installed devices. Display the list of modules in the chassis by clicking the **+** next to the **Chassis** icon.

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

Taking Measurements Using the SCXI-1520

This chapter discusses how to take measurements using the SCXI-1520. Basic information regarding signal connection, channel setup, and scanning is discussed.

Connecting Signals

This section describes how to interface the SCXI-1520 to strain gauges and strain-gauge based transducers.

Pin Assignments

The pin assignments for the SCXI-1520 front signal connector are shown in Table 2-1. The terminal assignments are as follows:

- SX+ and SX– are for analog input.
- RSX+ and RSX– are for remote sense.
- PX+ and PX– are for excitation output.
- SCAX are for shunt calibration circuit A.
- SCBX are for shunt calibration circuit B.

The negative terminals are listed in Column B and the positive terminals are listed in Column C. The pins labeled RSVD are reserved. Do *not* make any connections to these pins. See Appendix B, *Accessories*, for a list of accessories that provide an interface between field wiring and the front signal connector.

Table 2-1. Front Signal Connector Pin Assignments

Pin Number	Column A	Column B	Column C
32	SCB0	S0–	S0+
31	SCB0	RS0–	RS0+
30	SCB1	P0–	P0+
29	SCB1	SCA0	SCA0
28	RSVD	S1–	S1+
27	RSVD	RS1–	RS1+
26	RSVD	P1–	P1+
25	RSVD	SCA1	SCA1
24	SCB2	S2–	S2+
23	SCB2	RS2–	RS2+
22	SCB3	P2–	P2+
21	SCB3	SCA2	SCA2
20	RSVD	S3–	S3+
19	RSVD	RS3–	RS3+
18	RSVD	P3–	P3+
17	RSVD	SCA3	SCA3
16	SCB4	S4–	S4+
15	SCB4	RS4–	RS4+
14	SCB5	P4–	P4+
13	SCB5	SCA4	SCA4
12	RSVD	S5–	S5+
11	RSVD	RS5–	RS5+
10	RSVD	P5–	P5+
9	RSVD	SCA5	SCA5
8	SCB6	S6–	S6+
7	SCB6	RS6–	RS6+

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

Pin Number	Column A	Column B	Column C
6	SCB7	P6–	P6+
5	SCB7	SCA6	SCA6
4	RSVD	S7–	S7+
3	RSVD	RS7–	RS7+
2	RSVD	P7–	P7+
1	RSVD	SCA7	SCA7

Connecting to Strain Gauges

Figures 2-1 through 2-7 show the connections made to common strain-gauge bridge configurations. In the figures and equations that follow, these acronyms and formulas apply:

ε = Measured strain

ε_S = Simulated strain

GF = Gauge Factor

v = Poisson's ratio

$$V_r = \left(\frac{V_{SIGNAL}}{V_{EX}}\right)_{STRAINED} - \left(\frac{V_{SIGNAL}}{V_{EX}}\right)_{UNSTRAINED}$$

Rg = Gauge resistance

Rs = Shunt calibration resistor value

R_L = Line resistance (one conductor)

$$U = \frac{-R_g}{4R_s - 2R_g}$$

V_{EX} = Excitation voltage

V_{SIGNAL} = Signal voltage

R_X = Resistance of bridge elements

✎   **Notes**   The names given the strain-gauge configurations in Figures 2-1 though 2-7 directly correspond to bridge selections in the LabVIEW Convert Strain Gauge Reading VI. You find this VI on the function subpalette **Data Acquisition»Signal Conditioning**. Using this VI, you wire the SCXI-1520 analog input reading to V_{SG}, the initial analog input reading with the system unstrained to V_{init}, and the excitation voltage to V_{EX}.

The default configuration setting for the SCXI-1520 is quarter bridge.
You must use MAX, the NI-DAQ function SCXI_Configure_Connection, or the LabVIEW AI Parameter VI to change the bridge configuration, in addition to making the correct signal connections to the terminal block or front signal connector.

The parameter U, as defined above, is the ratio of expected signal voltage to excitation voltage with the shunt calibration circuit engaged. Parameter U appears in the equations for simulated strain.

Quarter-Bridge Configuration I

The connections for quarter-bridge configuration I are shown in Figure 2-1.

✎   **Note**   S– is left unwired.
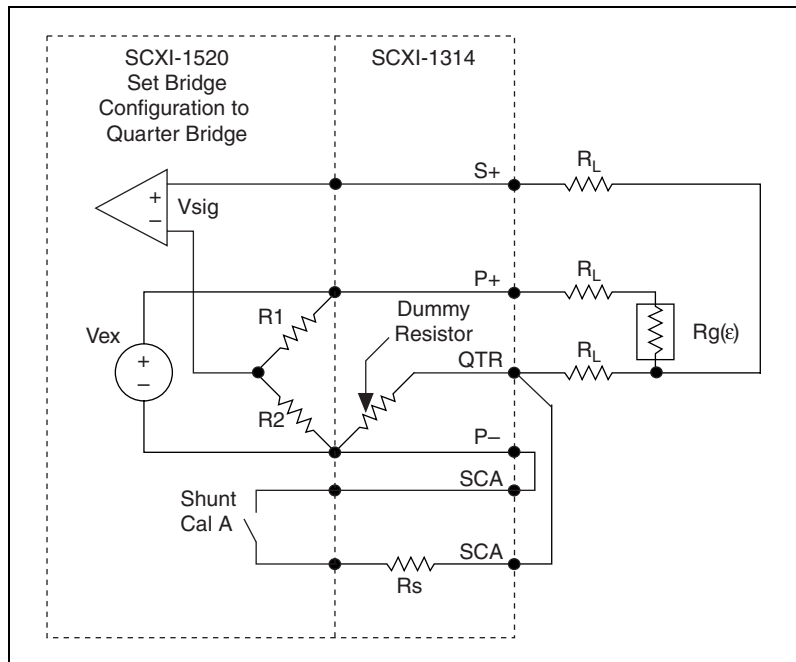
Figure 2-1. Quarter-Bridge Configuration I

For this configuration the equations for measured strain and simulated strain are, respectively:

$$\varepsilon = \frac{-4V_r}{GF(1+4V_r)} \times \left(1 + \frac{R_L}{R_g}\right)$$

$$\varepsilon_s = \frac{-4U}{GF(1+4U)}$$

Notes   The value of the dummy resistor must equal the nominal resistance of the strain gauge.

To minimize temperature drift errors, the strain gauge must have a self-temperature-compensation (STC) number that corresponds to the thermal expansion coefficient of the material under test. STC gauges have a temperature sensitivity that counteracts the thermal expansion coefficient of the test specimen. The STC number approximately equals the thermally induced change in strain with change in temperature and is expressed in units of microstrain per degree Fahrenheit. For example, if the test specimen is aluminum, use a gauge with an STC number of 13; if the test specimen is steel, use a gauge with an STC number of six.

To minimize temperature drift errors in the wiring, use the three-wire connection shown in Figure 2-1. The wires connected to terminals S+ and QTR carry the same current and are in adjacent elements of the bridge. Therefore, any temperature-related changes in voltage drop across R_L cancel, leaving V_{SIGNAL} unchanged.

In Figure 2-1, the shunt calibration circuit simulates tensile strain.

You can neglect the wiring resistance, R_L, if shunt calibration is performed or if wiring length is short.

Quarter-Bridge Configuration II

The connections for quarter-bridge configuration II are shown in Figure 2-2. For this configuration, the equations for measured strain and simulated strain are, respectively:

$$\varepsilon = \frac{-4V_r}{GF(1+4Vr)} \times \left(1 + \frac{R_L}{R_g}\right)$$

$$\varepsilon_s = \frac{-4U}{GF(1+4U)}$$
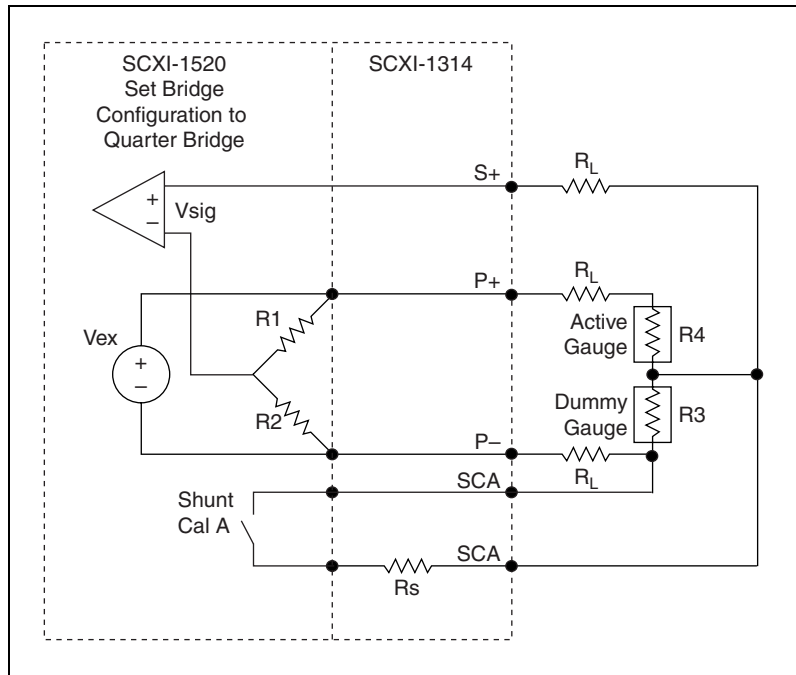
✎ **Note** S– and QTR are left unwired.

Figure 2-2. Quarter-Bridge Configuration II

✎ **Notes** The dummy strain gauge must always be unstrained and mounted to the same type of material as the active gauge. The dummy gauge temperature must closely track the temperature of the active gauge.

Gauges need not have a self-temperature-compensation number corresponding to the material type of the test specimen.

As shown in Figure 2-2, for greatest calibration accuracy, use separate wires between the bridge and the SCA terminals. Do not directly connect S+ or P– to the SCA terminals inside the SCXI-1314 terminal block unless the strain-gauge cable length is very short.

You can neglect wiring resistance, R_L, if shunt calibration is performed or if the lead length is short.

The nominal values of R_3 and R_4 equal R_g.

Half-Bridge Configuration I

The connections for half-bridge configuration I are shown in Figure 2-3. For this configuration the equations for measured strain and simulated strain are, respectively:

$$\varepsilon = \frac{-4V_r}{GF[(1+v)-2V_r(v-1)]} \times \left(1 + \frac{R_L}{R_g}\right)$$

$$\varepsilon_s = \frac{-4U}{GF[(1+v)-2U(v-1)]}$$

Note   S– is left unwired.
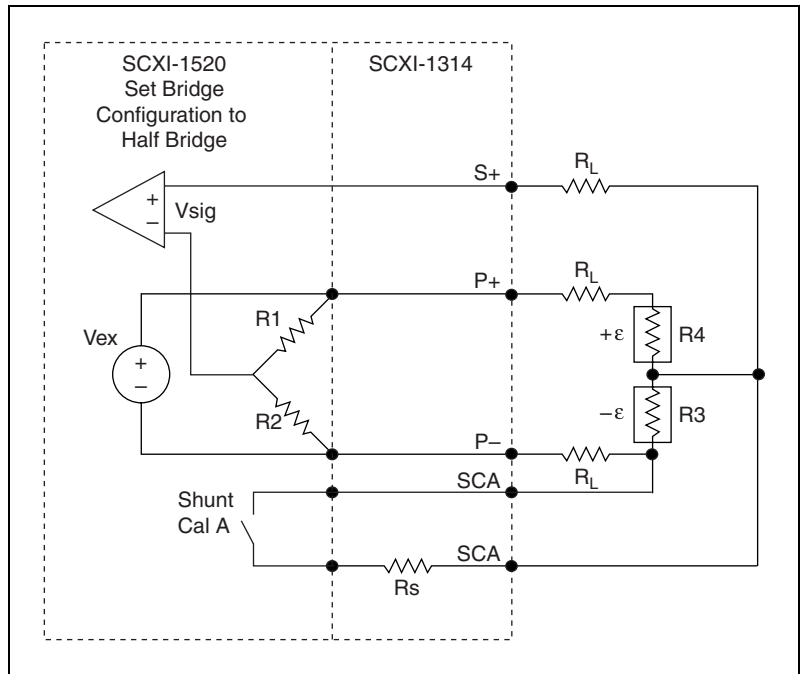
Figure 2-3. Half-Bridge Configuration I

Notes Half-bridge configuration I requires one strain gauge to undergo tensile strain while the other strain gauge undergoes compressive strain of the same magnitude. This configuration is often used to measure bending strain where the strain gauges are mounted on opposite sides of a beam.

The strain gauges need not have a particular self-temperature-compensation number.

As shown in Figure 2-3, for greatest calibration accuracy, use separate wires between the bridge and the SCA terminals. Do not directly connect S+ or P– to the SCA terminals inside the SCXI-1314 terminal block unless the strain-gauge cable length is very short.

You can neglect wiring resistance, R_L, if shunt calibration is performed or if lead length is short.

The nominal values of R_3 and R_4 equal R_g.

Half-Bridge Configuration II

The connections for half-bridge configuration II are shown in Figure 2-4. For this configuration the equations for measured strain and simulated strain are, respectively:

$$\varepsilon = \frac{-2V_r}{GF} \times \left(1 + \frac{R_L}{R_g} \right)$$

$$\varepsilon_s = \frac{-2U}{GF}$$

Note S– is left unwired.
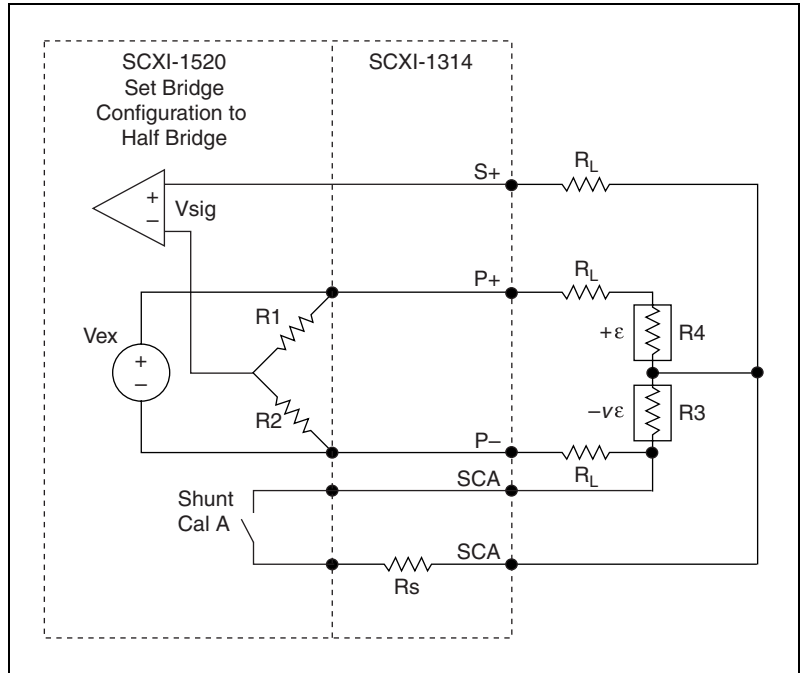
Figure 2-4. Half-Bridge Configuration II

Notes   In half-bridge configuration II, R4 is mounted along the principal axis of the stress field and R3 is mounted transverse to the axis of the stress field. Use this configuration in applications where no stress exists along the axis of the transverse strain gauge.

Strain gauges need not have a particular self-temperature-compensation number.

As shown in Figure 2-4, for greatest calibration accuracy, use separate wires between the bridge and the SCA terminals. Do not directly connect S+ or P– to the SCA terminals inside the SCXI-1314 terminal block unless the strain-gauge cable length is very short.

You can neglect wiring resistance, R_L, if shunt calibration is performed or if the lead length is short.

The nominal values of R_3 and R_4 equal R_g.

Full-Bridge Configuration I

The connections for full-bridge configuration I are shown in Figure 2-5. For this configuration the equations for measured strain and simulated strain are, respectively:

$$\varepsilon = \frac{-V_r}{GF}$$

$$\varepsilon_s = \frac{-U}{GF}$$
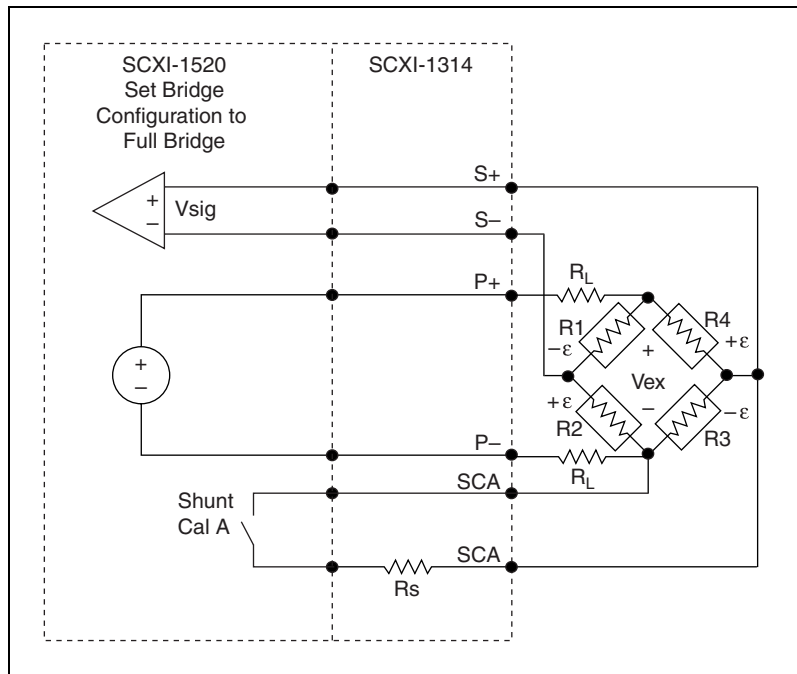
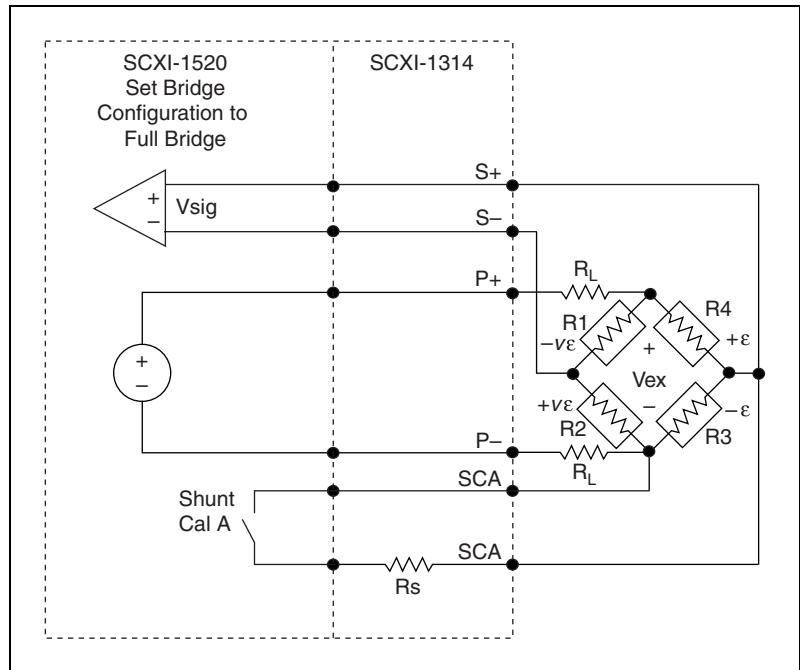**Figure 2-5.** Full-Bridge Configuration I

Notes   Strain gauges need not have a particular self-temperature-compensation number.

As shown in Figure 2-5, for greatest calibration accuracy, use separate wires between the bridge and the SCA terminals. Do not directly connect S+ or P– to the SCA terminals inside the SCXI-1314 terminal block unless the strain-gauge cable length is very short.

V_{EX} in the equations for full-bridge configuration I (contained within terms V_r and U) is understood to be the excitation voltage at the bridge. The equations apply if remote-sense

leads connect RS+ and RS– to the top and bottom corners of the bridge, as shown in Figure 2-8. If V_{EX} is assumed to be the excitation voltage at the SCXI-1520 module, multiply the expression for measured strain by $(1 + 2R_L / Rg)$ to account for the voltage drop in the excitation leads.

The nominal values of R_1, R_2, R_3, and R_4 equal R_g.

Full-Bridge Configuration II

The connections for full-bridge configuration II are shown in Figure 2-6. For this configuration the equations for measured strain and simulated strain are, respectively:

$$\varepsilon = \frac{-2V_r}{GF(1 + v)}$$

$$\varepsilon_s = \frac{-2U}{GF(1 + v)}$$

Figure 2-6. Full-Bridge Configuration II

> **Notes**   Full-bridge configuration II is sometimes used for strain measurement of bending beams. R3 and R4 are positioned along the beam axis and on opposite sides of the beam, and R1 and R2 are positioned transverse to the beam axis and on opposite sides of the beam.

Strain gauges need not have a particular self-temperature-compensation number.

As shown in Figure 2-6, for greatest calibration accuracy, use separate wires between the bridge and the SCA terminals. Do not directly connect S+ or P– to the SCA terminals inside the SCXI-1314 terminal block unless the strain-gauge cable length is very short.

V_{EX} in the equations above is understood to be the excitation voltage at the bridge. The equations apply if remote-sense leads connect RS+ and RS– top the to and bottom corners of the bridge, as shown in Figure 2-8. If V_{EX} is assumed to be the excitation voltage at the SCXI-1520 module, multiply the expression for measured strain by $(1 + 2R_L / R_g)$ to account for the voltage drop in the excitation leads.

The nominal values of R_1, R_2, R_3, and R_4 equal R_g.

Full-Bridge Configuration III

The connections for full-bridge configuration III are shown in Figure 2-7. For this configuration, the equations for measured strain and simulated strain are, respectively:

$$\varepsilon = \frac{-2V_r}{GF[(v+1) - V_r(v-1)]}$$
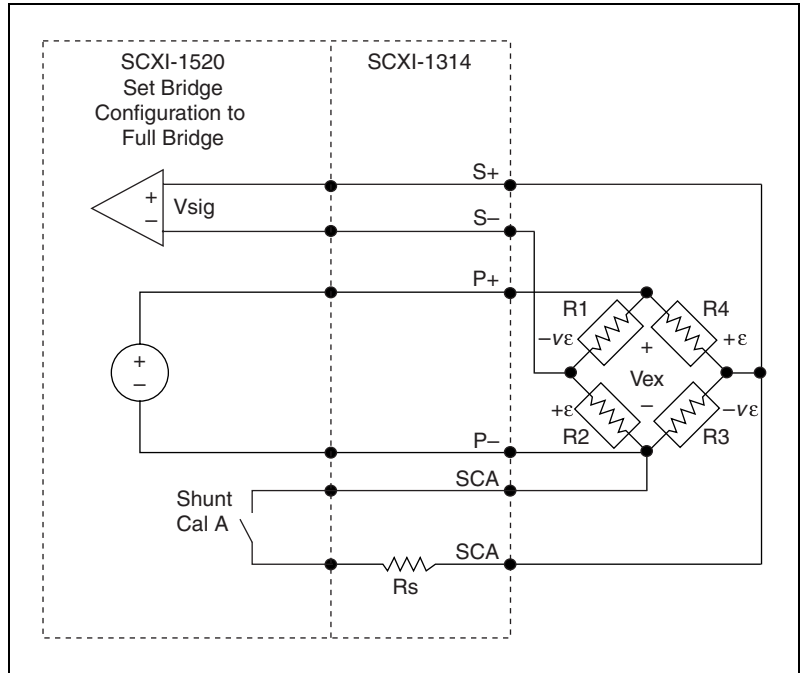
$$\varepsilon_s = \frac{-4U}{GF[(v+1) - U(v-1)]}$$

Figure 2-7. Full-Bridge Configuration III

✏️ **Notes**   Full-bridge configuration III is sometimes used for axial strain measurement. R2 and R4 are positioned along the beam axis and on opposite sides of the beam, and R1 and R3 are positioned transverse to the beam axis and on opposite sides of the beam.

Strain gauges need not have a particular self-temperature-compensation number.

As shown in Figure 2-7, for greatest calibration accuracy, use separate wires between the bridge and the SCA terminals. Do not directly connect S+ or P– to the SCA terminals inside the SCXI-1314 terminal block unless the strain-gauge cable length is very short.

V_{EX} in the equations above is understood to be the excitation voltage at the bridge. The equations apply if remote-sense leads connect RS+ and RS– to the top and bottom corners of the bridge, as shown in Figure 2-8. If V_{EX} is assumed to be the excitation voltage at the SCXI-1520 module, multiply the expression for measured strain by $(1 + 2R_L / R_g)$ to account for the voltage drop in the excitation leads.

The nominal values of R_1, R_2, R_3, and R_4 equal R_g.

Shunt Calibration

In Figures 2-1 through 2-7, energizing the SCA switch simulates a predetermined value of tensile strain. The predetermined value, ε_s, is given for each configuration.

You can perform shunt calibration using a virtual channel in MAX. To create a virtual channel, refer to the section below entitled *LabVIEW and the Virtual Channel String*. In creating the virtual channel, you indicate to MAX that the channel is an SCXI-1520 channel. At that point, you can choose to perform a calibration. Selecting the shunt calibration option automatically shunt calibrates the channel you are creating.

You can also perform shunt calibration programmatically in your LabVIEW application. With the system unstrained, you energize shunt calibration switch SCA. Multiply the measured strain reading obtained in your software by a correction factor to obtain a corrected reading equal to the simulated value, ε_S. The correction factor is simply the calculated value ε_S divided by the measured value ε when the shunt calibration switch is on and the strain gauges are unstrained. Once you determine this value, turn off the shunt calibration switch and apply the correction factor to all strain data taken thereafter.

You programmatically turn the shunt calibration switches on and off by using the LabVIEW function AI Parameter VI that is located in the function subpalette **Data Acquisition»Analog Input»Advanced Analog Input**.

✎ **Note**   As with all settings that are controlled by AI Parameter VI, the switch settings take effect when the next AI Start VI is encountered in your software, not at the time AI Parameter VI is called. You should discard the first 500 ms of data after the switches are closed since the filters in the SCXI-1520 are not fully stabilized until 500 ms have elapsed.

Remote Sense

The SCXI-1520 excitation output circuits set the output voltage by monitoring the remote sense terminals. Hence, the SCXI-1520 corrects for a voltage $(I \times R)$ drop in the excitation leads between the module and the bridge, even if lead resistance changes with temperature.

Wire the SCXI-1520 for remote sense as shown in Figure 2-8. There are no configuration settings you need to change in the software.
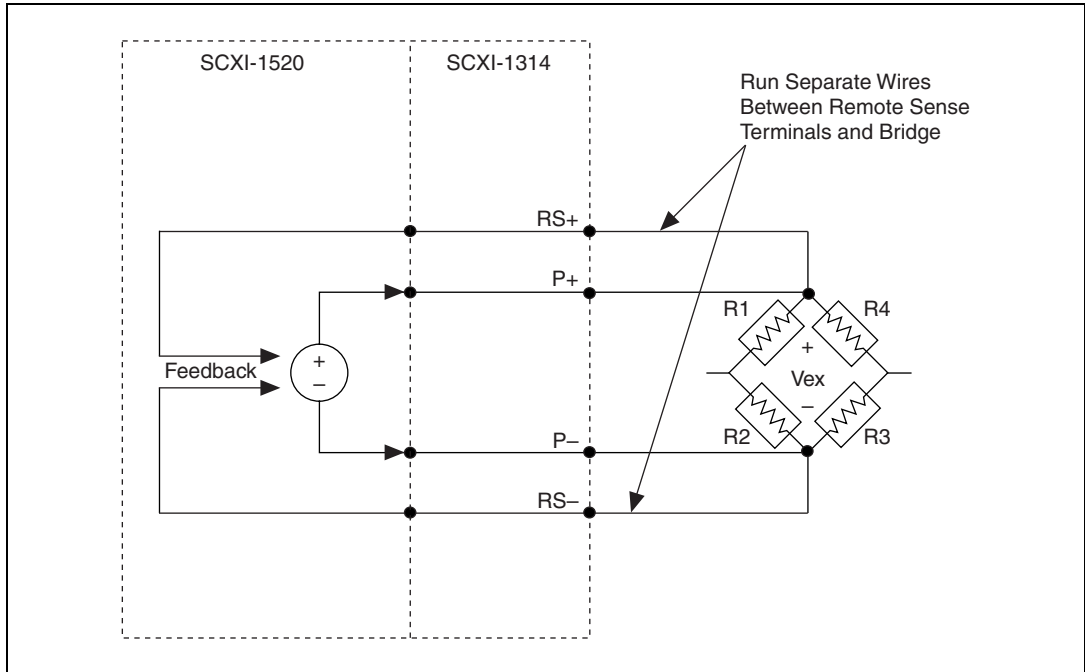
Figure 2-8. Remote Sense

The SCXI-1520 provides the additional capability of allowing you to monitor the voltages on RS+ and RS– from software. Refer to *Scanning the SCXI-1520 Analog Input Channels with SCXI Channel Strings* for more information.

✎ **Notes**   If you choose not to use remote sense, you need not connect RS+ to P+ or RS– to P– since 1 kΩ resistors inside the module that make these connections for you as shown in Figure 1-1, *Block Diagram of SCXI-1314/SCXI-1520 Combination*.

If you use remote sense, set R_L to zero in the equations for measured strain (ε).

Bridge Nulling

Most strain-gauge signal conditioners provide a means of nulling bridge offset voltage. Usually the null adjustment takes the form of a multi-turn potentiometer. In the SCXI-1520, hardware nulling is accomplished electronically under software control.

You can automatically null a channel by creating a virtual channel in MAX. To create a virtual channel, refer to *LabVIEW and the Virtual Channel*

String. In creating the virtual channel, you indicate to MAX that the channel is an SCXI-1520 channel. At that point, you are given the option of performing a calibration. An option under calibration is strain null. Selecting this option automatically nulls the channel you are creating.

From LabVIEW, you can automatically null a specified SCXI-1520 channel using SCXI Strain Null VI. You can find this VI on the function subpalette **Data Acquisition»Calibration and Configuration**.

You can also write your own nulling routine in LabVIEW by directly reading and writing the value of the electronic potentiometers using the AI Parameter VI.

✏️ **Note**   The hardware nulling circuits have finite resolution, so there is usually a small residual offset voltage after performing a hardware nulling operation. Your application software should include a measurement of the residual offset voltage immediately after a hardware nulling operation. You then subtract the measured residual offset voltage from subsequent voltage measurements in your application software.

Multiplexed and Parallel Modes

In multiplexed mode, all input channels of an SCXI module are multiplexed into a single analog input channel of the National Instruments DAQ device. The multiplexing operation is performed entirely by multiplexers in the SCXI modules, not inside the DAQ device.

In parallel mode, the eight conditioned analog output signals at the rear signal connector of the SCXI-1520, as shown in Figure 2-9, are connected directly to the eight analog input channels on the DAQ device. Multiplexing between channels is performed inside the DAQ device, not inside SCXI module.

Driver software for the SCXI-1520 only recognizes the multiplexed mode. However, you can still directly digitize the conditioned analog signals for all eight channels. Refer to *Using the SCXI-1520 Parallel Outputs* for more information.

Theory of Multiplexed Hardware Operation

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

If the module being scanned 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 pin on its rear signal connector.

If the DAQ device scans the cabled module, the module routes its input signals through the MCH0 pin 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.

Multiplexed mode is typically used for performing scanning operations with the SCXI-1520. 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.

You can specify this list to scan the modules in the chassis in any order, with an arbitrary number of channels for each module entry in the list, limited to a total of 512 channels per chassis. You can randomly scan the channels on the SCXI-1520, meaning you can scan channels in any order and channels can occur multiple times in a single scan.

AIGND	1	2	AIGND
MCH0+	3	4	MCH0–
MCH1+	5	6	MCH1–
MCH2+	7	8	MCH2–
MCH3+	9	10	MCH3–
MCH4+	11	12	MCH4–
MCH5+	13	14	MCH5–
MCH6+	15	16	MCH6–
MCH7+	17	18	MCH7–
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 2-9. Rear Signal Connector Pin Assignments

Using Software for Multiplexed Scanning

Performing scanning operations in software depends on the ADE
you are using. While using LabVIEW, Measure, or Visual Basic
(ComponentWorks), all scanning operations are prepared in software
by using an SCXI *channel string* as the input to the channel parameter in
the analog input VI or function. These ADEs also support virtual channels
using Data Neighborhood (DAQ Channel Wizard) in MAX.

In LabWindows/CVI, C, or C++ development environments, you need
to make several NI-DAQ function calls to set up each module involved
in the scan, the chassis, and the DAQ device controlling the scan. In
VirtualBench, the instruments that support SCXI scanning configure the

channels of the module in a menu item in the graphical user interface. In BridgeVIEW, you must configure SCXI channels as virtual channels (tags) in MAX.

A discussion describing how to implement multiplexed scanning in the different ADEs follows. See your ADE manual and the DAQ analog input examples that come with your application software for more detailed information on programming your SCXI modules for scanning in multiplexed mode.

Using LabVIEW to Sequence the Scanning of SCXI Channels

For LabVIEW, Measure, and Visual Basic, the channel string determines the sequence in which SCXI channels are scanned. In LabVIEW, an array of these channel strings configures multiple modules for scanning. When the application program runs, the channel string is used for programming the channel information into the SCXI system. The format of the channel string is as follows:

ob$x$! sc$y$! md$z$! *channels*

where

ob$x$ is the onboard DAQ device channel, with x representing a particular channel where the multiplexed channels are sent. This value is 0 for DAQ device channel 0 in a single-chassis system. In a multichassis or remote chassis system, however, the DAQ device channel x corresponds to chassis number $n–1$, where DAQ device channel x is used for scanning the nth chassis in the system.

sc$y$ is the SCXI chassis ID, where y is the number you chose when configuring your chassis.

md$z$ is the slot position where the module is located, with z being the particular slot number. The slots in a chassis are numbered from left to right, starting with 1.

Note   In a single-chassis system, the ob$x$! specifier is optional and causes the gains on the module and DAQ device to be automatically set to fit the input limits parameter. When this specifier is omitted, the default gain on the DAQ device, usually the lowest gain, is used, but the SCXI-1520 gain is adjusted to fit the input limits.

The last parameter, *channels*, is the list of channels that are scanned for module *z*. It can have several formats:

- obx ! scy ! mdz ! *n*, where *n* is a single input channel.

- **obx ! scy ! mdz ! *n1:n2***, where *n1* and *n2* represent an ascending sequential list of input channels, inclusive.

- obx ! scy ! mdz ! (*n1, n2, n3:n4, n1, n5, n2*), where *n1*, *n2*, and *n5* represent single channels, not necessarily sequential, and *n3* and *n4* represent the endpoints of an ascending sequential list of channels, inclusive. In this case, channels *n1* and *n2* have explicitly been repeated in the channel list.

Note   Repeating channels or having channels out of sequence in a scan list is not supported on all SCXI modules. Please refer to the manual of each module for information on this feature.

Scanning the SCXI-1520 Analog Input Channels with SCXI Channel Strings

To scan SCXI-1520 analog input channels, you use SCXI channel strings as described in *Using LabVIEW to Sequence the Scanning of SCXI Channels*.

You can also scan the remote sense terminals to monitor the excitation voltage while simultaneously acquiring data from analog input channels. To scan the positive remote sense terminal of the *n*th channel, you use the following channel string:

```
obx ! scy ! mdz ! p_pos(n)
```

To scan the negative remote sense terminal of the *n*th channel, you use the following channel string:

```
obx ! scy ! mdz ! p_neg(n)
```

Note   To measure the total excitation voltage across the bridge, you must take the difference between p_pos(n) and p_neg(n):

(*n*th channel bridge excitation voltage) =
(reading from p_pos(n)) – (reading from p_neg(n))

Note   If no wires are connected to the remote sense terminals RS+ and RS–, the voltages measured are the voltages on excitation output terminals P+ and P–. Internal 1 kΩ resistors connect RS+ to P+ and RS– to P–.

LabVIEW and the Virtual Channel String

For LabVIEW, Measure, and Visual Basic, the channel string can also contain virtual channels. For the SCXI-1520, these virtual channels are analog input channels you create that have custom names that perform error correction and scaling without additional code. Virtual channels are particularly useful when sensors requiring different scaling factors are used on the same SCXI-1520 channel. Using virtual channels, you can use sensors needing special scaling in a generic analog input application without performing hard-coded scaling. If you change the scaling or want to connect a different sensor to your SCXI-1520, no changes are needed in the application. All that is required is creating a different virtual channel or modifying an existing virtual channel, and using its name in the channel string.

Note You cannot mix virtual channels with the SCXI channel strings shown in the previous section within the same channel string array.

To create a virtual channel for the SCXI-1520, insert a new analog input channel in the **Data Neighborhood** path in MAX, name it, and then follow the software prompts to create virtual strain channels, voltage channels, or customized analog input channels. For more information on virtual channels, consult the *Measurement & Automation Explorer Help* file.

To use virtual channels, enter the name of a virtual channel into the analog input channel string. If using multiple virtual channels, separate them using a comma, or enter them in a different index in the channel string array. All scaling is done automatically by the application.

Since you can randomly scan virtual analog input channels, you can enter virtual channels in any order or repeatedly in a channel string array.

Calculating the Maximum Scan Rate

To calculate the maximum permitted scan rate when using one or more SCXI-1520 modules in multiplexed mode, use the formula (maximum permitted scan rate) = $1 \div ((3 \, \mu s) \times$ (number of scanned channels) $+ 7 \, \mu s)$ if the controlling DAQ device sampling rate can be set at $1 \div (3 \, \mu s) = 333 \, kS/s$ or higher. In this equation, the term (number of scanned channels) is the number of all the channels scanned in a chassis; this includes channels other than SCXI-1520 channels.

If the DAQ device is slower than 333 kS/s, replace (3 μs) with $1 \div$ (maximum sampling rate) for the particular DAQ device. For example, a PCI-MIO-16XE-10 with a maximum sampling rate of 100 kS/s has a

maximum permitted scan rate of $1 \div ((10 \mu s) \times ($number of scanned channels$) + 7 \mu s)$ when used with the SCXI-1520.

Performing a Multiplexed Scan

To perform a multiplexed scan in your application, perform the following steps:

1. Open an analog input example in your ADE.

2. Enter the appropriate SCXI channel string or virtual channel string into the **channels** parameter.

3. Either enter the **input limits** for signals connected to your module to adjust the gain settings in your system or use the default gain settings from the configuration utility, and then run the application. When using virtual channels, the input limits configured in the virtual channel configurator are used.

You have completed a multiplexed scan using your SCXI-1520.

This is not a comprehensive discussion of SCXI scanning using LabVIEW, BridgeVIEW, Measure, or ComponentWorks, but this should give you enough information to help you get started with the examples shipped with these software packages.

Using the SCXI-1520 Parallel Outputs

The SCXI-1520 parallel outputs are the eight conditioned analog signals provided at the rear signal connector. Although NI-DAQ does not support using the SCXI-1520 in parallel mode, you can directly measure the parallel outputs with a DAQ device. SCXI-1520 channels 0 through 7 correspond directly to DAQ device channels 0 through 7 when the DAQ device channels are configured for differential input mode. When using these parallel outputs, you must be aware of the following:

- To configure or control the module, you must still execute at least one multiplexed scan of all SCXI-1520 channels you intend to use. Control information for the SCXI-1520 is sent to the SCXI-1520 coincident with the first AI Start VI encountered in LabVIEW.

- SCXI-1520 hardware settings are indeterminate until the first multiplexed scan has occurred.

- You must perform all scaling of the parallel output voltages in your application software.

- You cannot apply calibration data from the EEPROMs of the SCXI-1520 to data taken directly from the parallel outputs. Therefore, National Instruments recommends you perform your own system calibration if accuracy is important.

- The parallel output signals are *frozen* when a module is scanned during a multiplexed scan. The track-and-hold circuit of each channel is in hold mode during this time. Also, glitches occur on the parallel outputs as the SCXI-1520 multiplexer changes from channel to channel. Because of these unwanted artifacts of scanning, National Instruments recommends that you do not perform multiplexed scans of modules while simultaneously measuring their parallel outputs.

- You should configure the DAQ device inputs for differential mode.

- You cannot access the RS*X*+ or RS*X*– terminals at the RSC.

Controlling the SCXI-1520 Programmatically from LabVIEW

If you prefer to configure and control the SCXI-1520 from LabVIEW rather than through MAX, use AI Parameter VI. You can find AI Parameter VI in the function subpalette **Data Acquisition» Analog Input»Advanced Analog Input**. Figure 2-10 illustrates the use of AI Parameter VI. A parameter changed by AI Parameter VI takes effect in hardware when AI Start VI is called, not when AI Parameter VI is called. AI parameter VI merely changes the configuration in driver memory. When called, AI Start VI reads the configuration settings in driver memory and then sends the actual control information to the SCXI-1520 module.
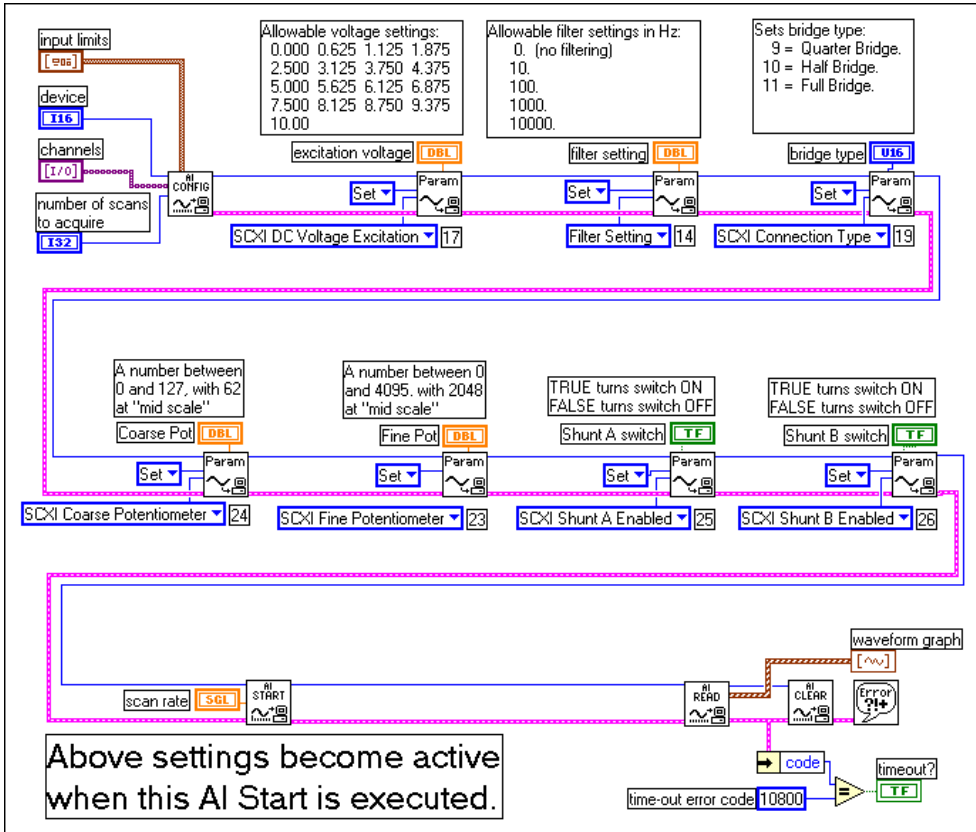
Figure 2-10. Using the AI Parameter VI to Set Up the SCXI-1520

For more information, use the *LabVIEW Help* file for the AI Parameter VI, and refer to the example VI for the SCXI-1520.

C and Low-Level DAQ Functions

When using a C-based environment, you need to take several steps to configure the SCXI-1520 for multiplexed scanning. The following procedure outlines the steps for programming with the low-level NI-DAQ function calls:

1. Prepare your SCXI-1520 settings either by loading the original SCXI configuration settings using SCXI_Load_Config or by specifying all configuration settings using the NI-DAQ function calls in Table 2-2. For more information regarding each setting, refer to *SCXI-1520 Configuration Settings* in Chapter 1, *Installing and Configuring the SCXI-1520*.

Table 2-2. NI-DAQ Functions Used to Configure SCXI-1520

Channel Setting	NI-DAQ Function to Use
Gain	`SCXI_Set_Gain`
Bandwidth	`SCXI_Set_Filter`
Excitation Voltage	`SCXI_Set_Excitation`
Bridge Configuration	`SCXI_Configure_Connection`
Shunt Calibration	`SCXI_Calibrate_Setup`

2. Specify the module scan list, the start channel of each module, and the number of channels to scan on each module with the function `SCXI_SCAN_Setup`. This function accepts an array of start channels and an array of the number of channels to scan in each module.

Note It is not possible to repeat channels or use nonsequential channels using the `SCXI_SCAN_Setup` function.

3. Use `SCXI_MuxCtr_Setup` to program the DAQ device with the correct number of channels multiplexed per scan. This number must match the total number of channels programmed in step 2.

You are now ready to acquire the channel data with the DAQ device. If you are using a multifunction DAQ device, you can use `SCAN_OP` to perform the scanning operation. After scanning, convert the binary data to voltage data using `SCXI_Scale`. Refer to the NI-DAQ documentation for additional information on scanning with DAQ devices.

Calibrating the SCXI-1520

The SCXI-1520 is shipped with a calibration certificate and is calibrated at the factory to the specifications described in Appendix A, *Specifications*. Calibration constants are stored inside the calibration EEPROM and provide software correction values your application development software uses to correct your measurements for offset errors in the module.

To obtain the highest level of accuracy, you should periodically perform an internal calibration. You can initiate an internal calibration using National Instruments software.

Internal Calibration Procedure

The SCXI-1520 incorporates internal calibration paths that allow routing channel inputs to ground or to an onboard reference voltage. National Instruments software disconnects the channel inputs from the front signal connector and reconnects the inputs to ground or to an onboard reference when performing an internal calibration. You need not change any input connections for an internal calibration.

Internal Calibration Using LabVIEW

For internal calibration using LabVIEW, perform the following steps using the LabVIEW SCXI Calibrate VI:

1. Enter the DAQ device and the SCXI channel string for the channel to be calibrated.

2. Select **internal calibration** as the calibration operation you are going to perform.

The driver software takes a few seconds to perform the calibration. After completion, your module has new calibration constants stored for all gain settings. You must repeat the procedure to calibrate other channels in the module.

Internal Calibration Using a C-Based ADE

For internal calibration using a C-based ADE, perform the following steps using the NI-DAQ function, SCXI_Calibrate:

1. Enter the DAQ device, DAQ channel, module slot, and module channel.

2. Select **internal calibration (0)** as the operation you are going to perform.

The SCXI-1520 takes a few seconds to perform the calibration. After completion, your module has new calibration constants stored for all gain settings. You must repeat the procedure to calibrate other channels in the module.

A

Specifications

This appendix lists the specifications for the SCXI-1520 modules. These specifications are typical at 25 °C unless otherwise noted.

Analog Input

Number of channels 8

Voltage gain settings .... X1 to X1000 with the following gain settings: 1; 1.15; 1.3; 1.5; 1.8; 2; 2.2; 2.4; 2.7; 3.1; 3.6; 4.2; 5.6; 6.5; 7.5; 8.7; 10; 11.5; 13; 15; 18; 20; 22; 24; 27; 31; 36; 42; 56; 65; 75; 87; 100; 115; 130; 150; 180; 200; 220; 240; 270; 310; 360; 420; 560; 650; 750; 870; 1000

Input coupling .... DC

Maximum working voltage .... Either the SX+ or SX– input should remain within ±10 V of ground. Both inputs should be within ±10 V of one another.

Overvoltage protection .... ±35 V powered on, ±25 V powered off

Inputs protected .... <0...7>

Transfer

Nonlinearity ....Better than 0.02% of FSR

Gain error...±0.35% of setting at RSC,
±0.1% of the value returned by
driver software

Offset error
    Gain ≥20 ....150 µV max
    Gain <20 ....3 mV max

Amplifier

Input impedance (DC) .... >1 GΩ

Input bias current ....±20 nA max

Input offset current ....±20 nA max

CMRR (DC to 60 Hz, full-bridge setting)
    Gain ≥20 ....>85 dB
    Gain <20 ....>60 dB

Dynamic

Minimum scan interval (per channel, any gain in multiplexed mode)
    ±0.0125 accuracy.............................3 µs
    ±0.006 accuracy...............................10 µs
    ±0.0015 accuracy.............................20 µs

Noise RTI, gain=200, 0.1 to 10 Hz.........2.0 μV_{pp}

Spot noise RTI, gain=200, 1000 Hz ....16 nV/$\sqrt{\text{Hz}}$

Filter

Lowpass filter type ....4-pole Butterworth
(24 dB/octave rolloff)

Lowpass filter settings ....10 Hz, 100 Hz, 1 kHz,
10 kHz, or bypass

Bandwidth, filter bypassed ....–3 dB at 20 kHz

Track and Hold

Acquisition time

    Settle to 0.012% .... 7 µs

    Settle to 0.003% .... 10 µs

    Settle to 0.0015% .... 50 µs

Hold mode settling time .... 1 µs typ

Interchannel skew .... ±50 ns max

Intermodule skew .... ±100 ns max

Droop rate .... 30 mV/s typ, 100 mV/s max

Stability

Recommended warm-up time .... 15 min

Gain drift .... ±40 ppm of reading/°C max

Offset drift

    Gain ≥20 .... ±2 µV/°C typ, ±5 µV/°C max

    Gain <20 .... ±10 µV/°C typ, ±25 µV/ °C max

Null Compensation

Range .... ±4% of excitation voltage, 20,000
counts of resolution (±80,000 µε
null compensation range, 4 µε
resolution for quarter-bridge,
GF = 2.0)

Excitation

Type .... Constant voltage

Settings .... 0.0 to 10.0 V in 0.625 V
increments

Error .... ±20 mV ±0.3% of nominal setting
±0.1% of value returned by driver
software

Maximum operating current
in all ranges..29 mA

Short-circuit protection...........................Yes

Regulation...No load to 120 Ω load
    With remote sense ....±0.003%
    Without remote sense ....±0.08%

Temperature drift....................................±0.005%/°C, ±30 µV/°C max

Noise, DC to 10 kHz...............................200 μV_{pp}

Remote sense ....Error less than ±0.02% per ohm
                               of lead resistance, both leads

Protection...Surge arrestors in parallel with
                               excitation terminals, shunt to
                               ground

Bridge Completion[1]

Half-bridge...Two precision resistors,
                               5 kΩ each

Quarter-bridge ....Socketed resistor inside the
                               SCXI-1314 terminal block

Shunt Calibration[2]

Type...Two independent points

Resistor ....Socketed inside the SCXI-1314
                               terminal block

Switch resistance ....32 Ω

Switch off leakage ....<1 nA

Switch break-down voltage ....±60 VDC

---

[1] Half-bridge completion is performed inside the module and configured under software control. The quarter-bridge completion resistor is in the SCXI-1314 terminal block and is socketed. Resistors shipped with the SCXI-1314 are 120 Ω and 350 Ω RN-55 style (standard 1/4 W size). The tolerance is ±0.1% and the temperature coefficient is 10 ppm/°C max.

[2] Shunt calibration resistors are in the SCXI-1314 terminal block and are socketed. Resistors shipped with the SCXI-1314 are 100 kΩ RN-55 style (standard 1/4 W size). The tolerance is ±0.1% and the temperature coefficient is 10 ppm/°C max.

Power Requirements (from SCXI Backplane)

V+.. 18.5 to 25 VDC, +170 mA min

V−.. −18.5 to −25 VDC, −170 mA min

+5 V... +4.75 to 5.25 VDC, 50 mA min

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, UL 3111-1, and CAN/CSA C22.2 No. 1010.1 for electrical measuring and test equipment

Approved at altitudes up to 2,000 m

Installation Category II

Pollution Degree 2

Regulatory Compliance

📝 **Note**   For full regulatory compliance, you must use shielded cables. In addition, consult the *Declaration of Conformity* of this product for any other installation requirements that you may need.

European

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

Safety .... EN 61010-1

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-1520.

Table B-1. Accessories Available for the SCXI-1520

Accessory	Description
SCXI-1314	Screw terminal block—mounts on the front of the SCXI-1520 module. It includes connections and sockets for two shunt calibration resistors and a quarter-bridge completion resistor per channel.
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

C

Connectors

This appendix describes the front and rear signal connectors on the SCXI-1520.

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. You must not connect sensor signals to reserved pins, marked RSVD in Table 2-1, *Front Signal Connector Pin Assignments*.

⚠ **Caution** Do *not* make signal connections to pins marked RSVD in Table 2-1.

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-1520 and the connected DAQ device. The rear signal connector is shown in Figure 2-9, *Rear Signal Connector Pin Assignments*. The rear signal connector allows the DAQ device to access all eight differential analog output signals from the SCXI-1520. The positive terminal of each analog output is named MCH*X*+ and the negative terminal MCH*X*–. 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 all eight channels of the SCXI-1520, and 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 unavailable for general-purpose analog input because they are still connected to the amplifier outputs of the SCXI-1520 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-1520. The SCANCLK and SYNC signals are the signals necessary for multiplexed mode scanning. If the DAQ device is connected to the SCXI-1520, these digital lines are unavailable for general-purpose digital I/O.

D

Common Questions

This appendix lists common questions related to the use of the SCXI-1520.

Which version of NI-DAQ works with the SCXI-1520 and how do I get the most current version of NI-DAQ?

You must have NI-DAQ 6.9 or later. 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.

I have gone over the *Verifying and Self-Testing the Configuration* in Chapter 2, *Installing and Configuring the SCXI-1520*, yet I still cannot correctly test and verify that my SCXI-1520 is working. What should I do now?

Unfortunately, there is always the chance that one or more components in your system are not operating correctly. You may have to call or e-mail a technical support representative. The technical support representative will often suggest additional troubleshooting measures. If requesting technical support by phone, have your system nearby so you can try these measures immediately. National Instruments contact information is listed in Appendix E, *Technical Support Resources*.

How do I configure an SCXI-1200 DAQ device for use with the SCXI-1520?

You cannot use the SCXI-1520 with the SCXI-1200.

Can I use the unused analog input channels of the DAQ device if I am directly cabled to the SCXI-1520?

No. DAQ device channels 1 through 7 connect to the conditioned analog outputs of SCXI-1520 channels 1 through 7.

Can I configure the SCXI-1520 for use in parallel mode?

No. See *Using the SCXI-1520 Parallel Outputs* in Chapter 2, *Taking Measurements Using the SCXI-1520* for more information.

Which digital lines are unavailable on the DAQ device if I am cabled to an SCXI-1520 module?

Table D-1 shows the digital lines that are used by the SCXI-1520 for communication and scanning. These lines are unavailable for general-purpose digital I/O if the SCXI-1520 is connected to the DAQ device.

Table D-1. Digital Signals on the SCXI-1520

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.				

Some SCXI modules permit random scanning. Does the SCXI-1520 module permit random scanning?

Yes. Random scanning is described in Chapter 2, *Taking Measurements Using the SCXI-1520*.

In LabVIEW, can I use different input limits for the same SCXI-1520 channel if I repeat the channel in the SCXI channel string array?

No. The SCXI-1520 cannot dynamically change the gain settings during scanning. Therefore, group channels with similar input ranges together in the channel string array. Make sure that repeated channels in different indices of the channel string array have the same input limits in the corresponding input limits array.

In LabVIEW, can I use a VI to change my SCXI-1520 configuration settings?

Yes. You can use the AI Parameter VI to change all the SCXI-1520 configuration settings. Refer to *Controlling the SCXI-1520 Programmatically from LabVIEW* in Chapter 2, *Taking Measurements Using the SCXI-1520*.

In C, can I randomly scan the SCXI-1520 using low-level NI-DAQ function calls?

No. When using C, you can scan only consecutive channels using traditional SCXI channel programming. Please refer to the *NI-DAQ Function Reference Online Help* for more details on SCXI scanning.

Are there any cabling restrictions when using an SCXI-1520 module with a plug-in E Series DAQ device?

Yes. If a chassis contains an SCXI-1520, an SCXI-1530/1531, or SCXI-1140 module, at least one of these modules must be the cabled module. A cabled module is the module connected directly to the DAQ device. This ensures that a timing signal is available for use by all simultaneous-sampling SCXI modules in the chassis.

Can I use the SCXI-1520 with a version of NI-DAQ that works under the Macintosh Operating System (MacOS)?

No, as of NI-DAQ 6.9. Check the release notes of later versions of NI-DAQ at ni.com for updates.

Is a register-level programming manual available for the SCXI-1520?

No.

What is the power-up state of the SCXI-1520 multiplexer, analog bus switches, and configuration settings?

The multiplexer, analog bus switches, and configuration settings are not in a known state immediately after power on. All hardware settings are programmed automatically when beginning an acquisition in LabVIEW or a test panel in MAX.

Which accessories can I use to connect signals to the front of the SCXI-1520 module?

Refer to Appendix B, *Accessories*, for more information.

How do I control the gain, excitation voltage, filter setting, bridge configuration, potentiometer settings, and shunt calibration switches from LabVIEW?

The gain of each SCXI-1520 channel is automatically set based on the channel limits used in setting up the acquisition. You usually use the LabVIEW AI Config VI to set the channel limits. If the channel limits are

not explicitly set, the SCXI-1520 defaults to the gain setting entered when the module was configured using MAX. Refer to Chapter 1, *Installing and Configuring the SCXI-1520*, for more information.

Although excitation voltage, filter setting, and bridge configuration are usually set using MAX, you can also control or change these settings programmatically using AI Parameter VI in LabVIEW.

Although you usually use the SCXI Strain Null VI to adjust the electronic potentiometers for nulling the analog inputs to zero, you can also manually set or retrieve the potentiometer settings using the AI Parameter VI.

The shunt calibration switches are exclusively controlled using the AI Parameter VI.

How do I control the gain, excitation voltage, filter setting, bridge configuration, potentiometer settings, and shunt calibration switches in C-based application environments?

You must use the NI-DAQ functions listed in Table 2-2, *NI-DAQ Functions Used to Configure SCXI-1520*.

For an SCXI-1520 channel *not* connected to a strain-gauge bridge, are there any special considerations?

You should set the excitation voltage to zero. This is because the SCXI-1520 input offset correction constants stored in EEPROM are obtained with the excitation voltage set to zero. With the excitation voltage not at zero, error voltages from the auto-nulling circuits can increase offset error beyond the limits given in the specifications.

Does the SCXI-1314 terminal block contain a CJC temperature sensor?

No.

Are there any user-serviceable parts inside the SCXI-1520?

No. There are no fuses, multiturn potentiometers, DIP switches, slide switches, socketed resistors, or jumpers inside the module. Disassembly of the module for any reason may void its warranty and nullify its calibration.

E

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
ε	strain
ε_s	simulated strain

υ	Poisson's ratio
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
ACH	analog input channel signal
acquisition time	the time required by a sample-and-hold system to switch from hold mode back to tracking a signal
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
bridge completion resistors	fixed-valued resistors used to complete a Wheatstone bridge when fewer than four of the bridge elements are working strain gauges
Butterworth response filter	a lowpass filter response whose characteristics are optimized for maximum flatness in the passband

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
compressive strain	strain that results from an object being compressed. Compressive strain has a negative value ($\varepsilon < 0$).
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 boards plugged into a computer, and possibly generating control signals with D/A and/or DIO boards 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 board 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 board, 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
DOUT	digital output signal
drivers/driver software	software that controls a specific hardware device such as a DAQ device
droop rate	the rate that a sample-and-hold circuit in hold mode deviates from the true hold value, expressed in millivolts per second

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
excitation	using a voltage or current source to energize an active 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
full bridge	a Wheatstone bridge in which all four elements are active strain gauges

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
gauge factor	For a given strain gauge, gauge factor is the fractional resistance change relative to the strain that caused the resistance change. Thus, gauge factor is a measure of strain-gauge sensitivity.
GF	*see* gauge factor

H

half bridge	a Wheatstone bridge consisting of two active strain gauges and two passive fixed-valued resistors
hold mode settling time	the time it takes for a sample-and-hold circuit to switch from sampling mode to hold mode and settle within a given percentage at the true hold value

hold step	the difference in the true hold value and the measured hold value in a sample-and-hold circuit
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
input offset current	the difference between the bias current flowing out of the input terminals SX+ and SX–. Ideally, this difference is zero so that no error voltage is generated across the input due to differences in bias current.
inst.	instrumentation
instrumentation amplifier	a very accurate differential amplifier with a high input impedance
interchannel skew	the largest difference in hold mode settling time between two sample-and-hold circuits on the same module
intermodule skew	the largest difference in hold mode settling time between two sample-and-hold circuits on different modules

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

line 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
microstrain	the unit of strain measurement usually denoted by $\mu\varepsilon$. One $\mu\varepsilon$ represents a deformation of 10^{-6}, or 0.0001%.
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
null compensation	the provision in strain-gauge signal conditioning hardware to remove the unwanted offset voltage present at the output of a strain-gauge bridge when no strain is applied

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
OUTREF	output reference signal
overvoltage protection	maximum voltage that will not cause hardware damage

P

P	pull-up
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
phase shift	the angular difference between identical reference points in two periodic signals
Poisson's ratio	the negative ratio of transverse strain to longitudinal (axial) strain
pole	a term used to describe the quality of a lowpass filter. In general, the more poles a lowpass filter has, the better it attenuates frequencies beyond the cutoff frequency.
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

psi	pounds per square inch
PX–	a negative excitation output terminal
PX+	a positive excitation output terminal
PXI	PCI eXtensions for Instrumentation—an open specification that builds on the CompactPCI specification by adding instrumentation-specific features

Q

QTR	terminal for connection to a quarter-bridge completion resistor
quarter bridge	a Wheatstone bridge consisting of one active strain gauge and three passive fixed-valued resistors
quarter-bridge completion resistor	the bridge completion resistor in series with the active strain gauge in a quarter-bridge configuration. The quarter-bridge completion resistor must have the same nominal resistance value as the strain gauge.

R

random scanning	the hardware capability to sequence through channels in a scan list in any order
remote sense	the method of compensating for voltage drops in bridge excitation leads by remotely measuring the voltage applied to the bridge
R_g	gauge resistance
R_L	line 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
R_S	shunt-calibration resistance
RS–	remote sense terminal, negative input

RS+	remote sense terminal, positive input
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
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-and-hold	a circuit with a sample mode where the output tracks the input signal and a hold mode where the output remains at the last known input voltage before switching modes
sample rate	the number of samples a system takes over a given time period, usually expressed in samples per second
SCA	shunt calibration terminal, circuit A
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 interval accuracy	the minimum interchannel delay needed to achieve a given accuracy
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
SCB	shunt calibration terminal, circuit B
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 device 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
shunt calibration	the method of calibrating the gain of a strain-gauge data acquisition channel by placing a resistor of known value in parallel with a bridge element
signal conditioning	the manipulation of signals to prepare them for digitizing
simulated strain	a strain measurement where the change in bridge output voltage is not caused by deformation of the specimen being measured. Rather, it is caused by temporarily connecting a known resistance in parallel with one of the bridge elements while all the strain gauges in the bridge remain unstrained.
simultaneous sample-and-hold	a series of sample-and-hold circuits that are connected so as to switch modes in unison
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
spot noise	the rms noise voltage or rms noise current in a frequency band 1 Hz wide at the specified frequency
STC strain gauge	self-temperature compensating strain gauge. An STC strain gauge is designed to have a resistive temperature coefficient that counteracts the thermal expansion coefficient of the material to which the gauge is bonded. Thus, the system is made insensitive to changes in temperature.
strain	the fractional deformation of a body ($\Delta L/L$ where L is length) subjected to an applied force. Strain is usually given in units of microstrain. One microstrain represents a deformation of 10^{-6}, or 0.0001%.
S*X*–	negative signal input terminal for channel *X*
S*X*+	positive signal input terminal for channel *X*
SYNC	synchronization pulse for scanning (only used with modules featuring simultaneous sample and hold)
system noise	a measure of the amount of noise seen by an analog circuit or an ADC when the analog inputs are grounded

T

tensile strain	strain that results from an object being stretched. Tensile strain has a positive value ($\varepsilon > 0$).
track and hold	*see* sample-and-hold
TRIG0	trigger 0
TTL	transistor-transistor logic
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
voltage excitation	a source that supplies the voltage needed by a sensor for its proper operation
V_r	(V_{IN}/V_{EX}) strained – (V_{IN}/V_{EX}) unstrained
V_{rms}	volts, root mean square

W

W	watts
Wheatstone bridge	A circuit arrangement consisting of four resistive elements in a diamond pattern. With excitation voltage applied across two opposing terminals, small resistance changes in the elements are easily detected by measuring voltage changes across the remaining two terminals.
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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