SCXI™

SCXI-1540 User Manual

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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, DIO<3..0>.

»

The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **Options»Settings»General** directs you to pull down the **Options** menu, select the **Settings** item, and select **General** 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. When this symbol is marked on a product, refer to the *Read Me First: Safety and Electromagnetic Compatibility* document for information about precautions to take.

When this symbol is marked on a product, it denotes a warning advising you to take precautions to avoid electrical shock.

When this symbol is marked on a product, it denotes a component that may be hot. Touching this component may result in bodily injury.

bold

Bold text denotes items that you must select or click 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. Italic text 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.

`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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1

About the SCXI-1540

This chapter introduces the SCXI-1540 module, and explains how to install the software and hardware.

Note Descriptions in this chapter explicitly refer to the first channel (channel 0), but these descriptions also are applicable to the remaining seven channels.

This section provides an introduction to the SCXI-1540 module, and to linear variable differential transformers (LVDTs), rotary variable differential transformers (RVDTs), and resolvers.

The SCXI-1540 module is an eight-channel module for interfacing with industry-standard LVDTs, RVDTs, and resolvers. It can accommodate a 4-wire or 5-wire connection to an LVDT, and can synchronize any number of channels to a common frequency. You can set the excitation level at 1 V_{rms} or 3 V_{rms} at a frequency of 2.5 kHz, 3.3 kHz, 5 kHz, or 10 kHz. You can set the gain over the range 0.8 to 25 to handle a wide range of LVDT sensitivities. Gain, level, frequency, and wire mode are set on a per-channel basis without the use of jumpers. The SCXI-1540 is configured using Measurement & Automation Explorer (MAX) or through function calls to NI-DAQ.

What You Need to Get Started

To set up and use the SCXI-1540, you need the following:

❑ Hardware
- SCXI-1540 module
- One of the following terminal blocks:
  - SCXI-1315
  - SCXI-1310
  - TBX-96
- SCXI chassis or PXI/SCXI combination chassis

- One of the following:
  - E/M Series DAQ device
  - SCXI-1600 module
- Computer, if using an SCXI chassis
- Cabling, cable adapter, and sensors as required for your application

❑ Software

- NI-DAQ 7.0 or later
- One of the following software packages:
  - LabVIEW
  - Measurement Studio
  - LabWindows™/CVI™

❑ Documentation

- *Read Me First: Safety and Electromagnetic Compatibility*
- DAQ Getting Started guides
- *SCXI Quick Start Guide*
- *SCXI-1540 User Manual*
- Documentation for your hardware
- Documentation for your software

National Instruments Documentation

The *SCXI-1540 User Manual* is one piece of the documentation set for data acquisition (DAQ) systems. You could have any of several types of manuals depending on the hardware and software in the system. Use the manuals you have as follows:

- SCXI chassis or PXI/SCXI combination chassis manual—Read this manual for maintenance information on the chassis and for installation instructions.
- The *DAQ Getting Started* guides—This document has information on installing NI-DAQ and the E/M Series DAQ device. Install these before you install the SCXI module.

- The *SCXI Quick Start Guide*—This document contains a quick overview for setting up an SCXI chassis, installing SCXI modules and terminal blocks, and attaching sensors. It also describes setting up the SCXI system in MAX.
- The SCXI hardware user manuals—Read these manuals next for detailed information about signal connections and module configuration. They also explain, in greater detail, how the module works and contain application hints.
- Accessory installation guides or manuals—Read the terminal block and cable assembly installation guides. They explain how to physically connect the relevant pieces of the system. Consult these guides when you are making the connections.
- The E/M Series DAQ device documentation—This documentation has detailed information about the E/M Series DAQ device that plugs into or is connected to the computer. Use this documentation for hardware installation and configuration instructions, specification information about the E/M Series DAQ device, and application hints.
- Software documentation—You may have both application software and NI-DAQ software documentation. National Instruments (NI) application software includes LabVIEW, LabWindows/CVI, and Measurement Studio. After you set up the hardware system, use either your application software documentation or the NI-DAQ documentation to help you write your application. If you have a large, complex system, it is worthwhile to look through the software documentation before you configure the hardware.
- One or more of the following help files for software information:
  - **Start»Programs»National Instruments»NI-DAQ» NI-DAQmx Help**
  - **Start»Programs»National Instruments»NI-DAQ» Traditional NI-DAQ User Manual**
  - **Start»Programs»National Instruments»NI-DAQ» Traditional NI-DAQ Function Reference Help**
- NI LVDT/RVDT application notes or tutorials—NI has additional material about LVDT/RVDTs available at `ni.com/support`.

You can download NI documents from `ni.com/manuals`. To download the latest version of NI-DAQ, click **Download Software** at `ni.com`.

Electromagnetic Compatibility Guidelines

This product was tested and complies with the regulatory requirements and limits for electromagnetic compatibility (EMC) as stated in the product specifications. These requirements and limits are designed to provide reasonable protection against harmful interference when the product is operated in its intended operational electromagnetic environment.

This product is intended for use in industrial locations. There is no guarantee that harmful interference will not occur in a particular installation, when the product is connected to a test object, or if the product is used in residential areas. To minimize the potential for the product to cause interference to radio and television reception or to experience unacceptable performance degradation, install and use this product in strict accordance with the instructions in the product documentation.

Furthermore, any changes or modifications to the product not expressly approved by National Instruments could void your authority to operate it under your local regulatory rules.

Caution To ensure the specified EMC performance, operate this product only with shielded cables and accessories.

Installing Application Software, NI-DAQ, and the DAQ Device

Refer to the *DAQ Getting Started* guides packaged with the NI-DAQ software to install your application software, NI-DAQ driver software, and the E/M Series DAQ device to which you will connect the SCXI-1540. NI-DAQ 7.0 or later is required to configure and program the SCXI-1540 module. If you do not have NI-DAQ 7.0 or later, you can either contact a NI sales representative to request it on a CD or download the latest NI-DAQ version from `ni.com`.

Note Refer to the *Read Me First: Safety and Electromagnetic Compatibility* document before removing equipment covers or connecting or disconnecting any signal wires.

Installing the SCXI-1540 Module into the SCXI Chassis

Refer to the *SCXI Quick Start Guide* to install your SCXI-1540 module.

Connecting the SCXI-1540 in an SCXI Chassis to an E/M Series DAQ Device for Multiplexed Scanning

Refer to the *SCXI Quick Start Guide* to install the cable adapter and connect the SCXI modules to the E/M Series DAQ device.

If you have already installed the appropriate software, refer to Chapter 3, *Configuring and Testing*, to configure the SCXI-1540 module(s).

Connecting the SCXI-1540 in a PXI/SCXI Combination Chassis to an E/M Series DAQ Device for Multiplexed Scanning

Refer to the *SCXI Quick Start Guide* to connect the SCXI modules to the E/M Series DAQ device.

If you have already installed the appropriate software, refer to Chapter 3, *Configuring and Testing*, to configure the SCXI-1540 module(s).

Verifying the SCXI-1540 Installation in Software

Refer to the *SCXI Quick Start Guide* for information on verifying the SCXI installation.

Installing SCXI Using NI-DAQmx in Software

Refer to the *SCXI Quick Start Guide* for information on installing modules using NI-DAQmx in software.

Manually Adding Modules in NI-DAQmx

If you did not auto-detect the SCXI modules, you must manually add each of the modules. Refer to the *SCXI Quick Start Guide* to manually add modules.

Note NI recommends auto-detecting modules for the first time configuration of the chassis.

Installing SCXI Using Traditional NI-DAQ (Legacy) in Software

Refer to the *SCXI Quick Start Guide* for information on installing modules using Traditional NI-DAQ (Legacy) in software.

Manually Adding Modules in Traditional NI-DAQ (Legacy)

If you did not auto-detect the SCXI modules, you must manually add each of the modules. Refer to the *SCXI Quick Start Guide* to manually add modules.

Note NI recommends auto-detecting modules for the first time configuration of the chassis.

Verifying and Self-Testing the Installation

The verification procedure for the SCXI chassis is the same for both NI-DAQmx and Traditional NI-DAQ (Legacy). To test the successful installation for the SCXI chassis, refer to the *SCXI Quick Start Guide*. Verify that the chassis is powered on and correctly connected to an E/M Series DAQ device.

After verifying and self-testing the installation, the SCXI system should operate properly with your ADE software. If the test did not complete successfully, refer to Chapter 3, *Configuring and Testing*, for troubleshooting steps.

Troubleshooting the Self-Test Verification

If the self-test verification did not verify the chassis configuration, complete the steps in this section to troubleshoot the SCXI configuration.

Troubleshooting in NI-DAQmx

- If you get a **Verify SCXI Chassis** message box showing the SCXI chassis model number, **Chassis ID: *x***, and one or more messages stating **Slot Number: *x* Configuration has module: SCXI-*XXXX*** or **1540, hardware in chassis is: Empty**, take the following troubleshooting actions:
  - Make sure the SCXI chassis is powered on.
  - Make sure all SCXI modules are properly installed in the chassis. Refer to the *SCXI Quick Start Guide* for proper installation instructions.
  - Make sure the cable between the SCXI chassis and E/M Series DAQ device is properly connected.
  - Inspect the cable connectors for bent pins.

- Make sure you are using the correct NI cable assembly.
- Test the E/M Series DAQ device to verify it is working properly. Refer to the E/M Series DAQ device help file for more information.

- If you get a **Verify SCXI Chassis** message box showing the SCXI chassis model number, **Chassis ID:** ***x***, and the message **Slot Number:** ***x*** **Configuration has module: SCXI-*XXXX*** or **1540, hardware in chassis is: SCXI-*YYYY***, **1540**, or **Empty**, complete the following troubleshooting steps to correct the error.
    1. Expand the list of NI-DAQmx devices by clicking the **+** next to **NI-DAQmx Devices**.
    2. Right-click the SCXI chassis and click **Properties** to load the chassis configurator.
    3. Under the **Modules** tab, ensure that the cabled module is listed in the correct slot.
    4. If the cabled module is not listed in the correct slot, complete the following troubleshooting steps:
        a. If the cabled module is not listed in the correct slot and the slot is empty, click the drop-down listbox next to the correct slot and select the cabled module. Configure the cabled module following the steps listed in the *SCXI Quick Start Guide*. Click **OK**.
        b. If another module appears where the cabled module should be, click the drop-down listbox next to the correct slot and select the cabled module. A message box appears asking you to confirm the module replacement. Click **OK**. Configure the cabled module following the steps listed in the *SCXI Quick Start Guide*. Click **OK**.
- Ensure that you have the highest priority SCXI module cabled to the E/M Series DAQ device. Refer to the *SCXI Quick Start Guide* to find out which SCXI module in the chassis should be cabled to the E/M Series DAQ device.
- After checking the preceding items, return to the *Troubleshooting the Self-Test Verification* section and retest the SCXI chassis.

If these measures do not successfully configure the SCXI system, contact NI. Refer to the *Signal Conditioning Technical Support Information* document for contact information.

Troubleshooting in Traditional NI-DAQ (Legacy)

- If you get the message **`Unable to test chassis at this time`**, you have not designated at least one module as connected to a E Series DAQ device. Refer to the *Traditional NI-DAQ (Legacy)* section of Chapter 3, *Configuring and Testing*, and change the configuration of the cabled module in the system from **Connected to: None** to **Connected to: Device *x***.
- If you get the 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 is powered on.
  - Make sure the cable between the SCXI chassis and E Series DAQ device is properly connected.
  - Inspect the cable connectors for bent pins.
  - Make sure you are using the correct NI cable assembly.
  - Test the E Series DAQ device to verify it is working properly. Refer to the E Series DAQ device help file for more information.
- If you get the message **`Failed to find`**, followed by module codes and the message **`Instead found: module with ID 0Xxx`**, refer to the *Traditional NI-DAQ (Legacy)* section of Chapter 3, *Configuring and Testing*, and make sure the correct module is in the specified slot. Delete the incorrect module as described in Appendix C, *Removing the SCXI-1540*, and add the correct module as described in the *Traditional NI-DAQ (Legacy)* section of Chapter 3, *Configuring and Testing*.
- If you get the message **`Failed to find`**, followed by a module code and the message **`Slot x is empty`**, make sure the configured module is installed in the specified slot. If not, install the module by following the instructions in the *SCXI Quick Start Guide*. If the module is installed in the correct slot, power off the chassis, remove the module as specified in Appendix C, *Removing the SCXI-1540*, and verify that no connector pins are bent on the rear signal connector. Reinstall the module as described in the *SCXI Quick Start Guide*, ensuring the module is fully inserted and properly aligned in the slot.
- After checking the preceding items, return to the *Troubleshooting the Self-Test Verification* section and retest the SCXI chassis.

If these measures do not successfully configure the SCXI system, contact NI. Refer to the *Signal Conditioning Technical Support* document for contact information.

2 Connecting Signals

This chapter describes how to interface the SCXI-1540 with an LVDT, RVDT, or resolver.

Connecting to LVDTs and RVDTs

Figures 2-1 and 2-2 show the connections made to a 4-wire and 5-wire LVDT or RVDT using the SCXI-1540 with the SCXI-1315 terminal block. Figure 2-1 also shows how you can connect a device with six wires using only four wires.

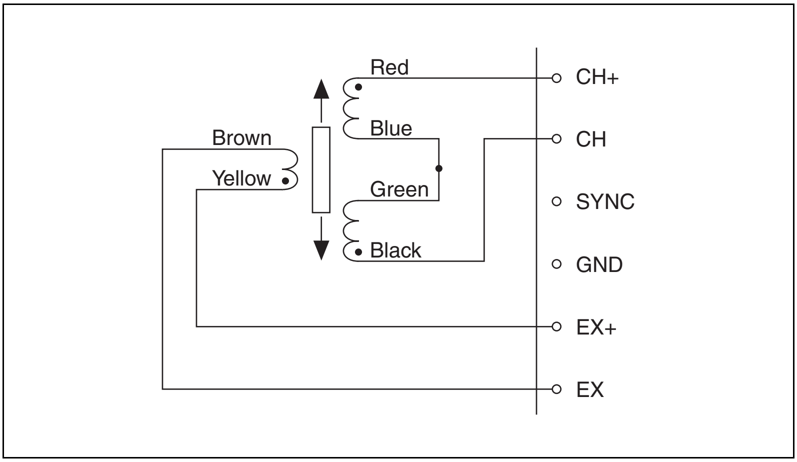


Figure 2-1. 4-Wire Connection to an LVDT or RVDT

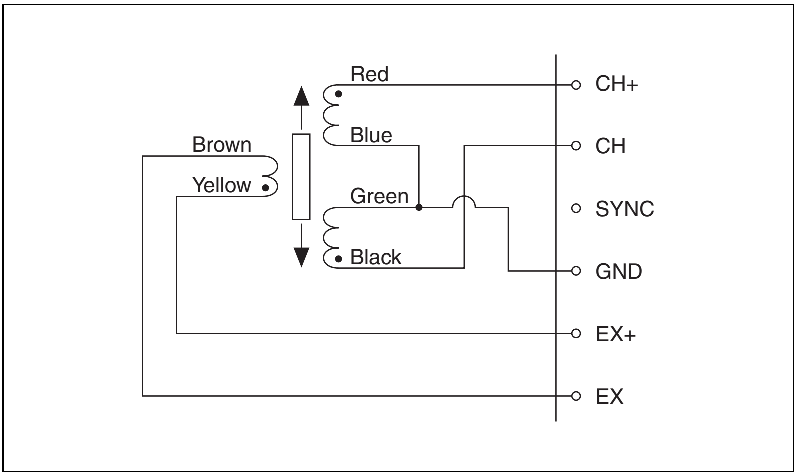


Figure 2-2. 5-Wire Connection to an LVDT or RVDT

In general, the 5-wire connection is insensitive to phase shift in the transducer and wiring, but subject to interference from common-mode voltages in the cable such as AC hum picked up from power lines, transformers, and motors. It is advisable, therefore, to use the 4-wire connection except in cases where a large phase shift in the return signal is suspected. Causes for a large phase shift might be the use of an operating frequency other than that specified by the sensor manufacturer, or a cable length greater than 100 m.

Note The default configuration setting for the SCXI-1540 is 4-wire. Refer to Chapter 5, *Using the SCXI-1540*, for more information about programming the SCXI-1540 in 5-wire mode.

Synchronizing Channels

Figure 2-3 shows how to synchronize multiple SCXI-1540 channels to the same frequency. You should do this for all channels that have wires sharing a single multi-conductor cable. Synchronization prevents beat frequencies from appearing in the data. Beat frequencies are the result of channel oscillators running at slightly different frequencies and coupling into adjacent channels through cable crosstalk.

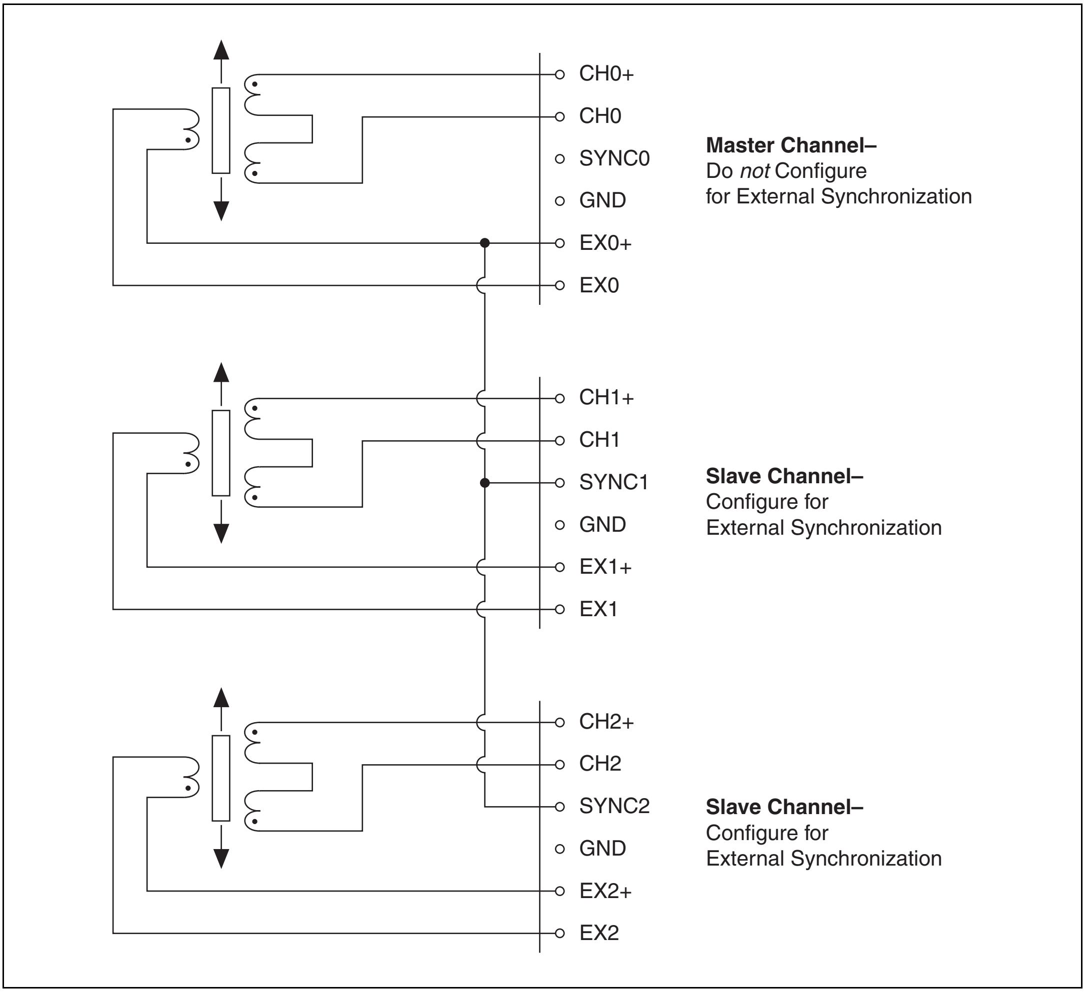


Figure 2-3. Multiple Channel Synchronization

Note To synchronize multiple channels, you must make the connections shown in Figure 2-3 *and* configure the slaved channels as externally synchronized. Refer to

Chapter 5, *Using the SCXI-1540*, for details about programming the SCXI-1540 for external synchronization. You must *not* configure the channel that originates the synchronization signal from its EX+ pin (channel 0 in the example of Figure 2-3) for external synchronization since that channel serves as master and is not slaved to any other channel.

Connecting to Resolvers

Figure 2-4 shows the connections made between a resolver and the SCXI-1540 using the SCXI-1315 terminal block. A single resolver requires the use of two channels. You must synchronize both channels using a wire connecting the EX+ on the master channel to the SYNC on the slave channel. Configure the slave channel for external synchronization as described in the *Synchronizing Channels* section. You can also synchronize more than two channels used for resolvers or combinations of resolvers, LVDTs, and RVDTs by the previously described method. Refer to Chapter 5, *Using the SCXI-1540*, Figure 5-2, for steps involved in programming resolvers.

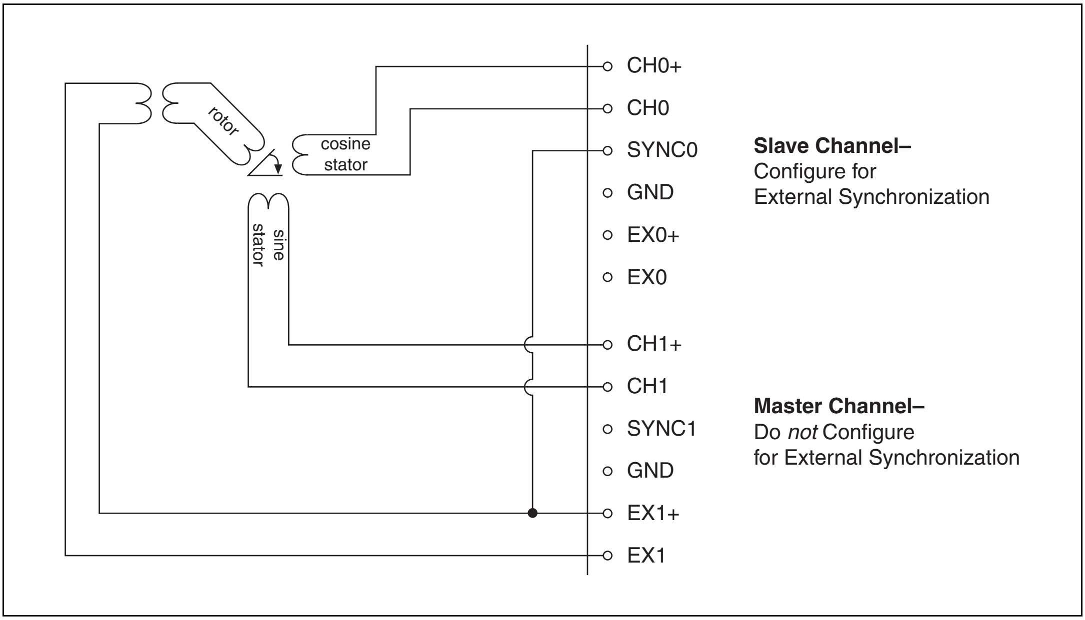


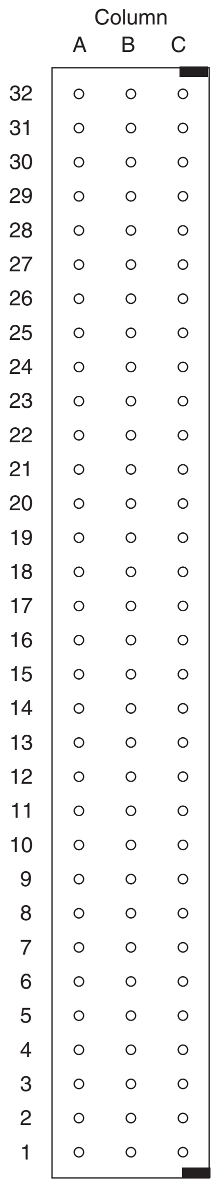
Figure 2-4. Resolver Connection

Pin Assignment

The pin assignment for the SCXI-1540 front signal connector is shown in Table 2-1. Notice that the positive input terminal for each channel is in Column C and the negative input terminal is in *Column B*. The pins labeled *RSVD* and *P0*, *P1*, ... *P7* are reserved. Do not make any connections to these pins.

Caution Do not make signal connections to pins in column A of Table 2-1.

Table 2-1. Front Signal Pin Assignments

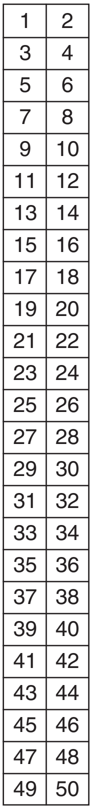
Front Connector Diagram	Pin Number	Column A	Column B	Column C
	32	RSVD	CH 0 –	CH 0 +
	31	RSVD	GND	SYNC0
	30	RSVD	EX 0 –	EX 0 +
	29	RSVD	GND	P0
	28	RSVD	CH 1 –	CH 1 +
	27	RSVD	GND	SYNC1
	26	RSVD	EX 1 –	EX 1 +
	25	RSVD	GND	P1
	24	RSVD	CH 2 –	CH 2 +
	23	RSVD	GND	SYNC2
	22	RSVD	EX 2 –	EX 2 +
	21	RSVD	GND	P2
	20	RSVD	CH 3 –	CH 3 +
	19	RSVD	GND	SYNC3
	18	RSVD	EX 3 –	EX 3 +
	17	RSVD	GND	P3
	16	RSVD	CH 4 –	CH 4 +
	15	RSVD	GND	SYNC4
	14	RSVD	EX 4 –	EX 4 +
	13	RSVD	GND	P4
	12	RSVD	CH 5 –	CH 5 +
	11	RSVD	GND	SYNC5
	10	RSVD	EX 5 –	EX 5 +
	9	RSVD	GND	P5
	8	RSVD	CH 6 –	CH 6 +
	7	RSVD	GND	SYNC6
	6	RSVD	EX 6 –	EX 6 +
	5	RSVD	GND	P6
	4	RSVD	CH 7 –	CH 7 +
	3	RSVD	GND	SYNC7
	2	RSVD	EX 7 –	EX 7 +
	1	RSVD	GND	P7

Rear Signal Connector

The rear signal connector (RSC) is a 50-pin male ribbon-cable connector used for analog signal connectivity and communication between the SCXI-1540 and the connected E/M Series DAQ device. The RSC is shown in Table 2-2. The RSC allows the E/M Series DAQ device to access all eight differential analog output signals from the SCXI-1540. For 68-pin E/M Series DAQ devices, you must connect an adapter to the RSC. The positive terminal of each analog output is named CH *X* + and the negative terminal CH *X* –. Grounding signals AO GND and OUT REF provide reference signals needed in the various analog input referencing modes on the E/M Series DAQ device. In multiplexed mode, the CH 0 signal pair is used for sending all eight channels of the SCXI-1540, and analog signals from other modules, to the connected E/M Series DAQ device. If the module is directly connected to the E/M Series DAQ device, the other analog channels of the E/M Series DAQ device are unavailable for general-purpose analog input because they are still connected to the amplifier outputs of the SCXI-1540 in multiplexed mode.

The communication signals between the E/M Series DAQ device and the SCXI system are SER DAT IN, SER DAT OUT, DAQ D*/A, SLOT 0 SEL*, SER CLK, and AI HOLD COMP,I HOLD. The digital ground, DIG GND on pins 24 and 33, provides a separate ground reference for the communication signals. SER DAT IN, SER DAT OUT, DAQ D*/A, SLOT 0 SEL*, and SER CLK are the communication lines for programming the SCXI-1540. The AI HOLD COMP, AI HOLD, and SYNC signals are the signals necessary for multiplexed mode scanning. If the E/M Series DAQ device is connected to the SCXI-1540, these digital lines are unavailable for general-purpose digital I/O.

Table 2-2. Rear Signal Pin Assignments

Rear Connector Diagram	Signal Name	Pin Number	Pin Number	Signal Name
	AI GND	1	2	AI GND
	CH 0 +	3	4	CH 0 –
	CH 1 +	5	6	CH 1 –
	CH 2 +	7	8	CH 2 –
	CH 3 +	9	10	CH 3 –
	CH 4 +	11	12	CH 4 –
	CH 5 +	13	14	CH 5 –
	CH 6 +	15	16	CH 6 –
	CH 7 +	17	18	CH 7 –
	OUT REF	19	20	—
	—	21	22	—
	—	23	24	DIG GND
	SER DAT IN	25	26	SER DAT OUT
	DAQ D*/A	27	28	—
	SLOT 0 SEL*	29	30	—
	—	31	32	—
	DIG GND	33	34	—
	—	35	36	AI HOLD COMP, AI HOLD
	SER CLK	37	38	—
	—	39	40	—
	—	41	42	—
	—	43	44	—
	—	45	46	SYNC
	—	47	48	—
	—	49	50	—

3

Configuring and Testing

This chapter describes the most frequently used software-configurable settings for the SCXI-1540.

Common Software-Configurable Settings

This section describes how to set the gain, excitation level, excitation frequency, wire mode, and external synchronization. Refer to Chapter 4, *Theory of Operation*, for a complete list of software-configurable settings.

Gain/Input Range

Gain/input range is a software-configurable setting that allows you to choose the appropriate amplification to fully utilize the range of the E/M Series DAQ device. In most applications NI-DAQ chooses and sets the gain for you as determined by the input range. This feature is described in Chapter 4, *Theory of Operation*. Otherwise, you should first determine the full-scale limits of the SCXI-1540 input signal using the following formula:

$$(V_{rms}\ \text{full-scale range}) = (\mathit{excitation\ level}) \times (\mathit{sensor\ sensitivity}) \times (\mathit{sensor\ full\text{-}scale\ travel})$$

You then set the upper channel limit to this number and set the lower channel limit to the negative of this number. For example, if you are using an LVDT designed to measure ±0.3 inches, the manufacturer specified sensitivity is 1.2 mV/V/mil, and the excitation voltage is set at 3 V_{rms}, you obtain a full-scale input voltage of:

$$\pm 1.08\ V_{rms} = (3\ V_{rms}) \times ((0.0012\ V_{rms})\ \text{per}\ V_{rms}\ \text{per mil}) \times (\pm 300\ \text{mil})$$

You then set the upper and lower channel input limits to +1.08 V and –1.08 V, respectively. A mil is equal to 0.001 in.

Refer to Chapter 5, *Using the SCXI-1540*, for more information about setting the gain programmatically.

The formula for the gain setting is:

$$(gain\ setting) = (5\ V)/(V_{rms}\ \text{full-scale range})$$

The maximum output swing of the SCXI-1540 is ±5 VDC; therefore, the gain calculation is 5 V divided by the full-scale limit. *Gain*, in the case of the SCXI-1540, is defined as the module DC output voltage divided by the module AC input voltage where the input voltage is given in units of volts rms. You should choose the setting that is closest to the calculated value, but *less than the calculated value* so that the SCXI-1540 output does not attempt to go beyond ±5 V at full scale.

Excitation Level

You may set the excitation at 1 V_{rms} or 3 V_{rms}. The higher setting is recommended in all applications except where the driven AC impedance is less than 95 Ω or where the sensor manufacturer recommends a lower excitation level. Refer to Figure 5-2 in Chapter 5, *Using the SCXI-1540*, for information about programming a resolver.

Excitation Frequency

You should select the frequency closest to that specified by the sensor manufacturer. The sensitivity of the sensor can vary considerably from the specified value if another excitation frequency is used.

Excitation Source

The excitation source may only be set to internal.

Wire Mode

Select 4-wire for 4-wire connections and 5-wire for 5-wire connections. Refer to the *Connecting to LVDTs and RVDTs* section of Chapter 2, *Connecting Signals*, for the advantages and disadvantages of each connection method.

External Synchronization

Channels that are to be synchronized to the frequency and level of another channel must have external synchronization enabled. You must also make a wire connection between the SYNC terminal of the slave channel and the EX+ terminal of the master channel. Refer to Figure 2-3, *Multiple Channel Synchronization*.

Configurable Settings in MAX

Note If you are not using an NI ADE, using an NI ADE prior to version 7.0, or are using an unlicensed copy of an NI ADE, additional dialog boxes from the NI License Manager appear allowing you to create a task or global channel in unlicensed mode. These messages continue to appear until you install version 7.0 or later of an NI ADE.

This section describes where you can access each software-configurable setting for modification in MAX. The location of the settings varies depending on the version of NI-DAQ you use. Refer to either the *NI-DAQmx* section or the *Traditional NI-DAQ (Legacy)* section. You also can refer to the *DAQ Getting Started* guides and the *SCXI Quick Start Guide* for more information on installing and configuring the hardware. You also can use the DAQ Assistant to graphically configure common measurement tasks, channels, or scales.

NI-DAQmx

In NI-DAQmx, you can configure software settings such as voltage excitation level and frequency, gain/input signal range, wire mode, and external synchronization in the following ways:

- Task or global channel in MAX
- Functions in your application

Note All software-configurable settings are not configurable both ways. This section only discusses settings in MAX. Refer to Chapter 4, *Theory of Operation*, for information on using functions in your application.

These sections describe settings that you can change in MAX and where they are located. Voltage, LVDT, or RVDT are the **NI-DAQmx Task** or **NI-DAQmx Global Channel** types you can use with the SCXI-1540.

- Voltage excitation level and frequency—configure using either **NI-DAQmx Task** or **NI-DAQmx Global Channel**. You also can set the voltage excitation level and frequency through your application. In NI-DAQmx, you can choose 1 or 3 V_{rms}. The default voltage excitation in NI-DAQmx is 3 V_{rms}. You can also set the frequency between 2.5 and 10 kHz. Refer to Appendix A, *Specifications*, for the valid frequencies
- Input signal range—configure the input signal range using either **NI-DAQmx Task** or **NI-DAQmx Global Channel**. When you set the minimum and maximum range of **NI-DAQmx Task** or **NI-DAQmx**

Global Channel, the driver selects the best gain for the measurement. You also can set it through your application. The default gain setting in NI-DAQmx is 1.0. This setting corresponds to an input range of ±5 V_{rms}.

- Wire mode—you can set the wire mode to either 4-wire or 5-wire mode as needed by your application.
- Modes of operation—configure as multiplexed or parallel mode when you configure the SCXI chassis. Refer to the *SCXI Quick Start Guide* for more information about chassis installation. parallel mode is only available for the SCXI-1540 when you use NI-DAQmx.

Note Refer to Chapter 4, *Theory of Operation*, for information on configuring the settings for your application using NI-DAQmx.

Creating an LVDT/RVDT Global Channel or Task in NI-DAQmx

To create a new NI-DAQmx LVDT/RVDT global task or channel, complete the following steps:

1. Double-click **Measurement & Automation** on the desktop.
2. Right-click **Data Neighborhood** and select **Create New**.
3. Select **NI-DAQmx Task** or **NI-DAQmx Global Channel**, and click **Next**.
4. Select **Analog Input**.
5. Select **Position**.
6. Select **LVDT** or **RVDT**.
7. If you are creating a task, you can select a range of channels by holding down the <Shift> key while selecting the channels. You can select multiple individual channels by holding down the <Ctrl> key while selecting channels. If you are creating a channel, you can only select one channel. Click **Next**.
8. Name the task or channel and click **Finish**.
9. In the **Channel List** box, select the channel(s) you want to configure. You can select a range of channels by holding down the <Shift> key while selecting the channels. You can select multiple individual channels by holding down the <Ctrl> key while selecting channels.
10. Enter the specific values for your application in the **Settings** tab. Context help information for each setting is provided on the right side of the screen.

11. Click the **Device** tab and select the autozero mode and whether or not you want synchronization enabled.
12. If you are creating a task and want to set timing or triggering controls, enter the values in the **Task Timing** and **Task Triggering** tabs.

Traditional NI-DAQ (Legacy)

In Traditional NI-DAQ (Legacy), you can configure software settings such as voltage excitation level and frequency, gain/input signal range, wire mode, and external synchronization in the following ways:

- Module property pages in MAX
- Virtual channels properties in MAX
- Functions in your ADE

Note All software-configurable settings are not configurable in all three ways. This section only discusses settings in MAX. Refer to Chapter 4, *Theory of Operation*, for information on using functions in your application.

Most of these settings are available in module properties and/or using LVDT/RVDT virtual channels:

- Wire mode—you can set the wire mode to either 4-wire or 5-wire mode as needed by your application.

Note Refer to Chapter 4, *Theory of Operation*, for information on configuring the settings for your application using Traditional NI-DAQ (Legacy).

Configuring Module Property Pages

1. Right-click the SCXI-1540 module you want to configure and select **Properties**. Click **General**.
2. If the module you are configuring is connected to an E Series DAQ device, select that device by using **Connected to**. If you want this E Series DAQ device to control the chassis, confirm there is a check in the **This device will control the chassis** checkbox. If the module you are configuring is not connected to an E Series DAQ device, select **None**.
3. Click the **Channel** tab. Select the appropriate gain, excitation voltage, sensor wire mode, excitation frequency, and whether or not you want to use external synchronization for each channel. If you want to configure all the channels at the same time, select the **Channel** drop-down menu, scroll to the bottom, and select **All Channels**. Refer

to the *Common Software-Configurable Settings* section for a detailed description of each setting. Click **Apply**.

4. Click **Accessory**. Select the accessory you connected to the module. When configuration is complete, click **OK**.

The Traditional NI-DAQ (Legacy) chassis and SCXI-1540 should now be configured properly. If you need to change the module configuration, right-click the module and repeat steps 1 through 4. Test the system following the steps in the *Troubleshooting the Self-Test Verification* section of Chapter 1, *About the SCXI-1540*.

Creating an LVDT/RVDT Virtual Channel

To create an LVDT/RVDT virtual channel, complete the following steps:

1. Right-click **Data Neighborhood** and select **Create New**.
2. Select **Traditional NI-DAQ Virtual Channel** and click **Finish**.
3. Select **Analog Input** from the drop-down menu and click **Next**.
4. Enter the **Channel Name** and **Channel Description**, and click **Next**.
5. Select **LVDT/RVDT** from the drop-down menu and click **Next**.
6. Enter the following information:
    a. Physical unit
    b. Sensitivities unit from the drop-down menu
    c. Sensitivity
    d. Measurement range min and max
7. Click **Next**.
8. Enter the following information:
    a. **What DAQ hardware will be used?** from the drop-down menu
    b. **What channel on your DAQ hardware?** from the drop-down menu
    c. **Which analog input mode will be used?** from the drop-down menu
    d. **What is the Excitation Voltage's source and value?** from the drop-down menu
    e. **Voltage** in volts rms
9. Click **Finish**.

Verifying the Signal

This section describes how to take measurements using test panels in order to verify signal, and configuring and installing a system in NI-DAQmx and Traditional NI-DAQ (Legacy).

Verifying the Signal in NI-DAQmx Using a Task or Global Channel

You can verify the signals on the SCXI-1540 using NI-DAQmx by completing the following steps:

1. Expand the list of tasks and virtual channels by clicking the **+** next to **Data Neighborhood**.
2. Click the **+** next to **NI-DAQmx Tasks** to expand the list of tasks.
3. Click the task.
4. Add or remove channels, if applicable, in the **Channel List**. Click the Add Channels button, shown at left, and select the type of channel you want to add.

   a. In the window that appears, expand the list of channels by clicking the **+** next to the module of interest.
   b. Select the channel(s) you want to verify. You can select a block of channels by holding down the <Shift> key or multiple channels by holding down the <Ctrl> key. Click **OK**.
5. Enter the appropriate information on the **Settings** tab.
6. Click the **Device** tab and enter the appropriate information on the **Device** tab.
7. Click the **Test** button to open the test panel.
8. Click the **Start** button, if necessary.
9. After you have completed verifying the channels, close the test panel window.

You have now verified the SCXI-1540 configuration and signal connection.

Note For more information on how to further configure the SCXI-1540, or how to use LabVIEW to configure the module and take measurements, refer to Chapter 4, *Theory of Operation*.

Verifying the Signal in Traditional NI-DAQ (Legacy)

This section discusses how to verify the signal in Traditional NI-DAQ (Legacy) using channel strings and virtual channels.

Verifying the Signal Using Channel Strings

The format of the channel string is as follows:

ob***x*** ! sc***y*** ! md***z*** ! *channel*

where

- ob***x*** is the onboard E Series DAQ device channel, with ***x*** representing a particular channel where the multiplexed channels are sent. This value is 0 for E Series DAQ device channel 0 in a single-chassis system. In a multichassis or remote chassis system, the E Series DAQ device channel *x* corresponds to chassis number *n* – 1, where E Series DAQ device channel *x* is used for scanning the *n*th chassis in the system.
- sc***y*** is the SCXI chassis ID, where ***y*** is the number you chose when configuring the 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.
- ***channel*** is the channel that is sampled from module *z*.

Use the format `obx ! scy ! mdz !` ***n*** to verify the signal, where ***n*** is a single input channel.

Complete the following steps to use channel strings in verifying the signal:

1. Expand the list of tasks and virtual channels by clicking the **+** next to **Devices and Interfaces**.
2. Click the **+** next to **Traditional NI-DAQ Devices** to expand the device list.
3. Right-click the appropriate E Series DAQ device.
4. Click **Test Panels**.
5. Enter the channel string.
6. Enter the input limits.
7. Select the **Data Mode**.
8. Select the **Y Scale Mode**.

Refer to the *LabVIEW Measurements Manual* for more information and for proper formatting of channel strings for different uses.

Verifying the Signal Using LVDT/RVDT Virtual Channel

If you have already created a virtual channel, complete the following steps to verify the signal:

1. Right-click the virtual channel you want to verify and select **Test**.
2. In **Channel Names**, select the channel you want to verify.
3. When you have completed verifying the channel, click **Close**.

4

Theory of Operation

This chapter discusses LVDT, RVDT, resolver concepts, and the SCXI-1540.

LVDTs, RVDTs, and Resolvers

An LVDT is a device for measuring linear position. Figure 4-1 shows a cut-away view of an LVDT.

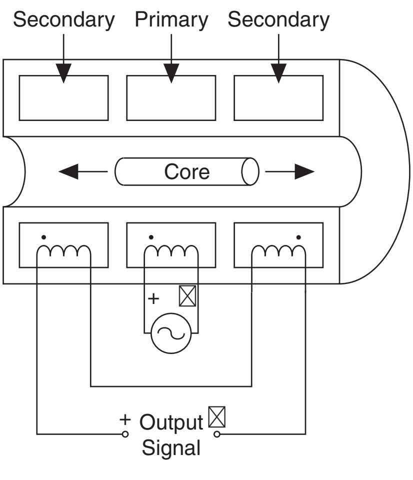


Figure 4-1. Cut-Away View of an LVDT

The primary winding, located at center, is excited with a sine-wave voltage. The resulting magnetic field is coupled through the movable core into the secondary windings located on either side of the primary. With the core at center, both secondaries have the same induced voltage. With the series connection and polarity shown, the resulting output signal is zero. If the core moves to the left, the left secondary is more strongly coupled to the primary than the right secondary, resulting in a stronger induced voltage in the left secondary and an output signal that is in phase with the primary excitation voltage. The more the core moves off center, the stronger the imbalance and the greater the output signal. Moving the core to the left of center results in the same behavior, but with the output signal out of phase with the excitation signal. Figure 4-2 shows these core locations and the resulting induced voltage and phase.

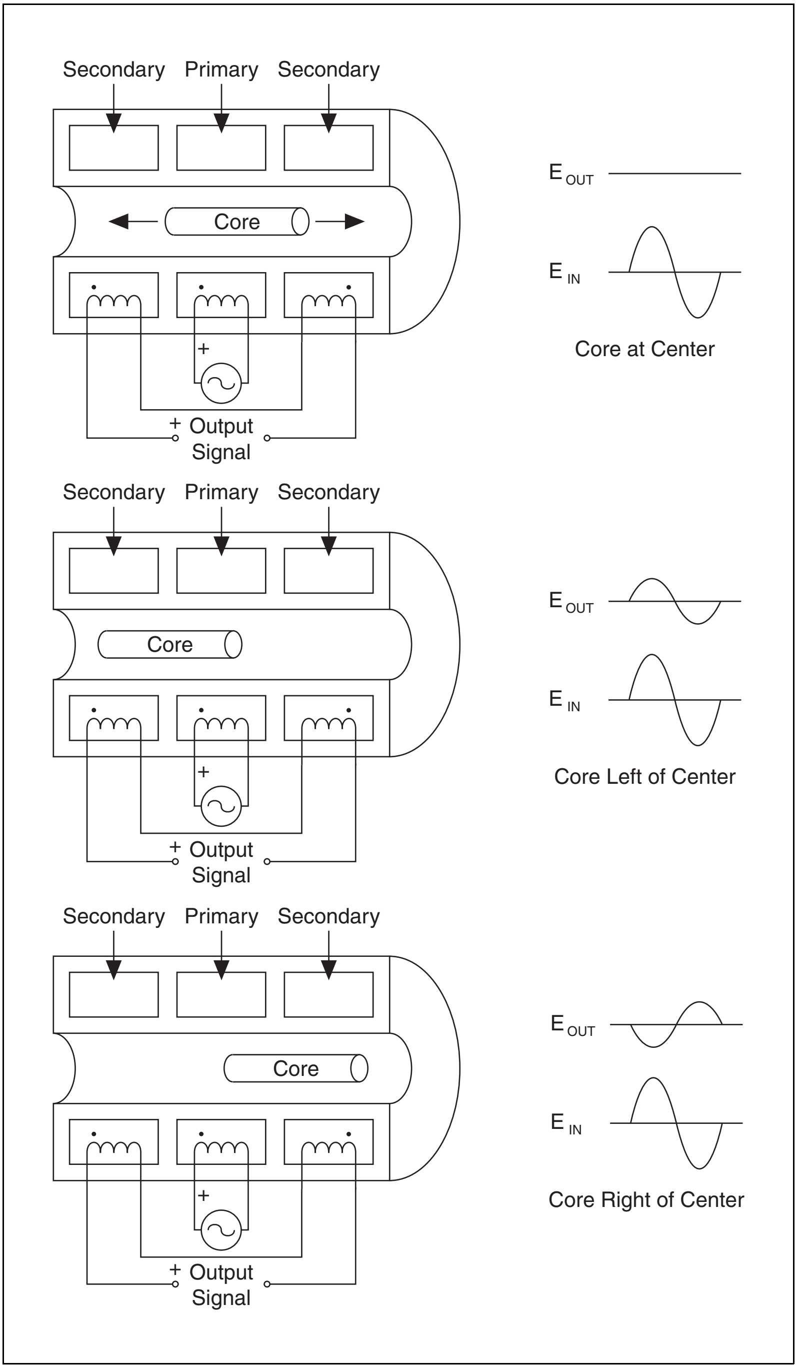


Figure 4-2. LVDT Core Locations with Resulting Induced Voltage and Phase

LVDTs are frequently used in applications where ruggedness, operation over large temperature ranges, insensitivity to contamination, or long life are important considerations. They are extremely reliable in harsh conditions.

An RVDT is simply the rotational version of an LVDT. The angular measurement range of typical RVDTs is between ±30° and ±70°.

Resolvers are similar to RVDTs, but employ secondaries at right angles that produce two simultaneous signal voltages proportional to the sine and cosine of the shaft angle. Thus, resolvers can measure over 360° of rotation and do not need to pass through 0° before making absolute position measurements, as is required by quadrature encoders.

Like LVDTs and RVDTs, resolvers are advantageous in hostile operating environments. Resolvers are often easier to use than RVDTs. You can originate the 0° position arbitrarily in software without the need to physically rotate the sensor into position. Since all that is needed to convert measured voltages to degrees is an arctangent function, there are no scaling considerations.

SCXI-1540 Theory of Operation

Figure 4-3 is a block diagram of the SCXI-1540. Each channel has an oscillator that generates a sine wave signal at a user-selected frequency between 2.5 kHz and 10 kHz. The oscillator signal passes through an amplifier with a gain of 1 or 1/3, depending upon the configuration setting of 3 V_{rms} or 1 V_{rms} respectively. If external synchronization is not enabled, the excitation signal is routed to the output buffer and then to the front signal connector pins EX+ and EX–. The output buffers are power amplifiers with a very low output impedance used for differentially driving an LVDT. EX– is 180° out of phase with EX+ so that a balanced signal is available to the LVDT secondary. If external synchronization is enabled, the buffered output signal to EX+ and EX– is obtained from the SYNC terminal on the front signal connector. This terminal connects to the EX+ terminal of a different channel that serves as master. Thus the frequency and phase of all slave channels are forced to be the same as the master. The level settings pass from the master to the slaves. Changing the level settings of the slave channels has no effect.

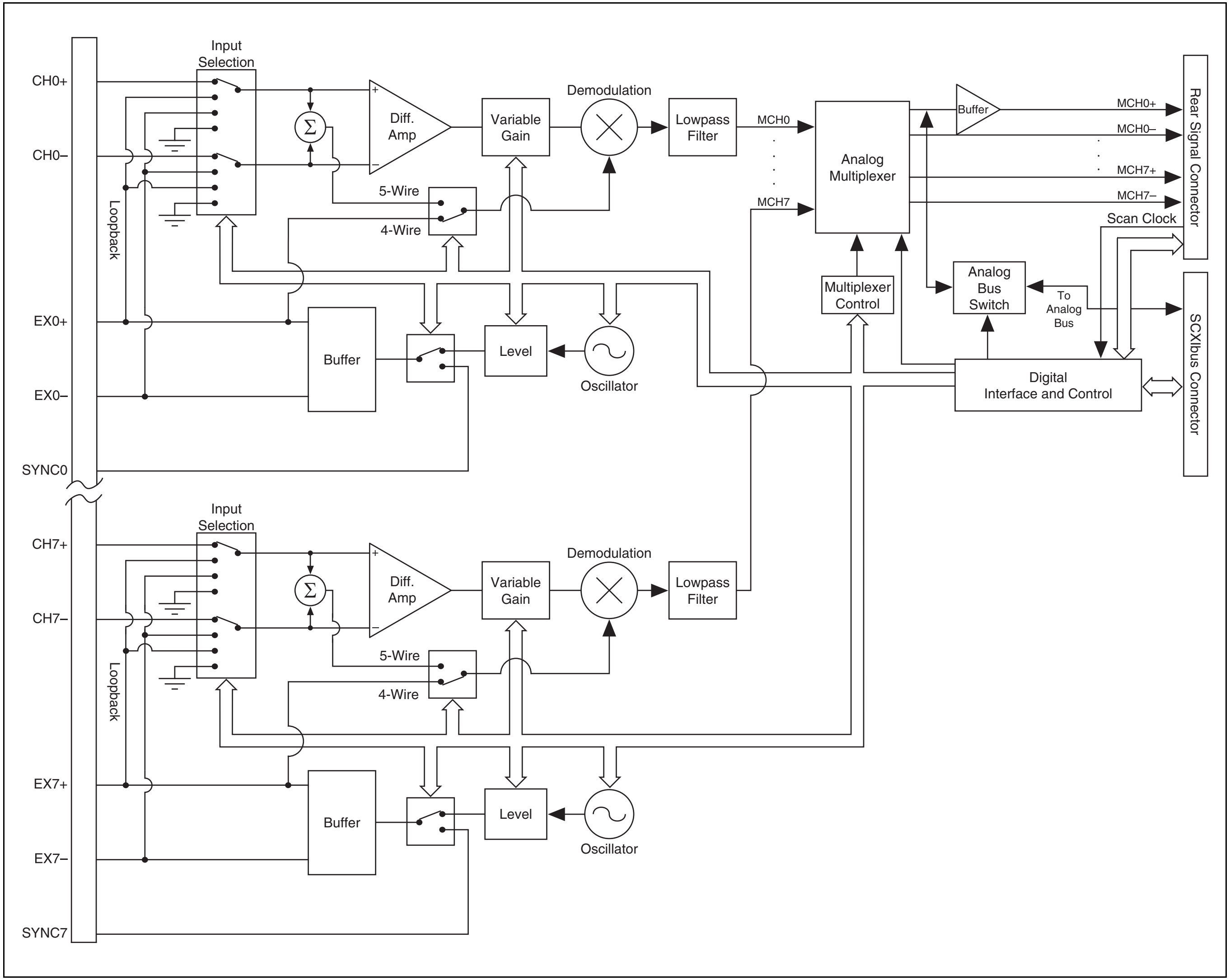


Figure 4-3. SCXI-1540 Block Diagram

The LVDT returns a signal whose phase and amplitude is related to the position of the movable core. The return signal connects across the CH + and CH – terminals on the front signal connector. In normal operation, this signal passes through the input selection switch to the differential amplifier where the common-mode signal on the input wires is rejected. The signal then passes to a variable gain stage that is set to a gain that best covers the expected signal range for the particular LVDT in use. The signal then passes to a block where it is multiplied by the excitation signal. The output of the multiplier is the product of two sine waves at the same frequency. Two signals result—a DC signal proportional to input magnitude or, equivalently, LVDT core position, and a double-frequency signal. The lowpass filter removes the double-frequency signal. Only the DC signal passes through, which is the final output signal for the particular channel. The analog multiplexer routes a particular channel output to either the SCXIbus connector or the rear signal connector. The SCXI-1540 features random scanning, meaning you can scan channels in any order.

The input selector switch allows calibration software to disconnect the differential amplifier from the front signal connector and reconnect it to the ground or excitation signal at either phase. It is therefore possible to calibrate gain and offset of the module with the module deployed in a test setup. You need not remove the field wiring. Calibration constants are stored in an onboard EEPROM and automatically used in the driver when scaling the signal.

Modes of Operation

The SCXI-1540 provides two modes of operation for passing the conditioned signals to the digitizing E/M Series DAQ device—multiplexed mode and parallel mode.

Theory of Multiplexed Mode Operation

In multiplexed mode, all input channels of an SCXI module are multiplexed into a single analog input channel of the E/M Series DAQ device. Multiplexed mode operation is ideal for high channel count systems. Multiplexed mode is typically used for performing scanning operations with the SCXI-1540. The power of SCXI multiplexed mode scanning is its ability to route many input channels to a single channel of the E/M Series DAQ device.

The multiplexing operation of the analog input signals is performed entirely by multiplexers in the SCXI modules, not inside the E/M Series DAQ device or SCXI chassis. In multiplexed mode, the SCXI-1540 scanned channels are kept by the NI-DAQ driver in a scan list. 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 through the cabled SCXI module.

The list can contain channels in any physical order and the multiplexer can sequence the channel selection from the scan list in any order. The ordering of scanned channels need not be sequential. Channels can occur multiple times in a single scan list. The scan list can contain an arbitrary number of channels for each module entry in the scan list, limited to a total of 512 channels per E/M Series DAQ device. This is referred to as flexible scanning (random scanning). Not all SCXI modules provide flexible 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 your application. You need not explicitly program the module FIFO as this is done automatically for you by the NI-DAQ driver.

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

If the scanned SCXI-1540 module is not directly cabled to the E/M Series 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 E/M Series DAQ device through the CH 0 pin on its rear signal connector.

If the E/M Series DAQ device scans the cabled module, the module routes its input signals through the CH 0 pin on its rear signal connector to the E/M Series DAQ device CH 0.

Multiplexed mode scanning acquisition rates have limitations that are determined based on the hardware in the system, and the mode of operation. The maximum multiplexing rate of SCXI is 333 kHz. If the E/M Series DAQ device can sample more quickly than 333 kHz, then the maximum multiplexing rate of SCXI is the limiting factor. If the E/M Series DAQ device cannot sample at 333 kS/s, the sample rate of the E/M Series DAQ device is the limiting factor on the maximum acquisition rate of the system in multiplexed mode operation.

Scaling LVDT and RVDT Data Using the SCXI-1540

When using an LVDT or RVDT, the fundamental measurement quantities of interest are usually linear or angular position, or some quantity derived from a position measurement. Converting the SCXI-1540 voltage output signals to these more fundamental quantities involves scaling.

The easiest way to obtain scaled data from the SCXI-1540 is to use a NI-DAQmx task or a Traditional NI-DAQ (Legacy) virtual channel. When using a task or channel in your application, the data is already scaled based on the information you entered when creating the task or channel. Your application need not perform any additional scaling.

In other cases, the analog input data read by your application has only been scaled to equal the rms voltage present at the analog input terminals of the SCXI-1540. This data is a signed quantity with the sign determined by the phase (0° or 180°), even though the units are in volts rms. If you choose to acquire the raw data in volts, you must scale the data in your application using the following formula:

$$\textit{scaled data} = \frac{\textit{SCXI-1540 data in volts rms}}{(\textit{excitation setting in volts rms}) \times (\textit{sensor sensitivity})}$$

For example, if you are working with an LVDT with a manufacturer-specified sensitivity of 1.2 mV/V/mil (or equivalently, 0.0012 V/V/mil) and the excitation level of the corresponding SCXI-1540 channel is 3 V_{rms}, the conversion formula is:

$$\textit{scaled data, in inches} = \frac{(\textit{SCXI-1540 data in volts rms})}{3\ V_{rms} \times (0.0012 \text{ volts per volt per mil}) \times (1000 \text{ mils per inch})}$$

$$= \frac{(\textit{SCXI-1540 data in volts rms})}{(3.6 \text{ volts per inch})}$$

$$= (\textit{SCXI-1540 data in volts rms}) \times (0.278 \text{ inch per volt})$$

Converting Resolver Data to Angular Position

Converting resolver data to angular position is accomplished by simply passing the data from the two channels to a four-quadrant arctangent function, such as the LabVIEW function `Inverse Tangent (2 Input)`. This function is on the **Trigonometric** subpalette. To access this function, select **Function»Numeric»Trigonometric**.

Theory of Parallel Mode Operation

Parallel mode is ideal for high speed acquisitions. In parallel mode, the eight conditioned analog output signals at the rear signal connector of the SCXI-1540, shown in Figure 4-3, are connected directly to the eight analog input channels on the E/M Series DAQ device. When the SCXI-1540 operates in parallel mode, the E/M Series DAQ device performs multiplexed scans of the SCXI-1540 parallel outputs. The SCXI-1540 module does not multiplex the channels.

Traditional NI-DAQ (Legacy) driver software can only control the SCXI-1540 module in multiplexed mode. NI-DAQmx can operate the SCXI-1540 in both multiplexed and parallel mode.

In parallel mode, SCXI-1540 channels 0 through 7 conditioned outputs are passed directly to E/M Series DAQ device channels 0 through 7. The E/M Series DAQ device channels should be configured for differential input mode.

Parallel mode operation acquisition rates have limitations that are determined based on the E/M Series DAQ device you are using. The maximum sampling rate is determined by the maximum sample rate of the E/M Series DAQ device. The 333 kHz maximum SCXI multiplexing rate is not a limitation in parallel mode operation. Therefore, if the E/M Series DAQ device can sample more quickly than 333 kHz, the SCXI-1540 configured for parallel mode operation is not the limiting factor.

5

Using the SCXI-1540

This chapter makes suggestions for developing your application and provides basic information regarding calibration.

Developing Your Application in NI-DAQmx

Note If you are not using an NI ADE, using an NI ADE prior to version 7.0, or are using an unlicensed copy of an NI ADE, additional dialog boxes from the NI License Manager appear allowing you to create a task or global channel in unlicensed mode. These messages continue to appear until you install version 7.0 or later of an NI ADE.

This section describes how to configure and use NI-DAQmx to control the SCXI-1540 in LabVIEW, LabWindows/CVI, and Measurement Studio. These ADEs provide greater flexibility and access to more settings than MAX, but you can use ADEs in conjunction with MAX to quickly create a customized application.

Typical Program Flowchart

Figure 5-1 shows a typical program LVDT/RVDT flowchart for creating a task to configure channels, take a measurement, analyze the data, present the data, stop the measurement, and clear the task. Figure 5-2 shows a similar flowchart for a resolver.

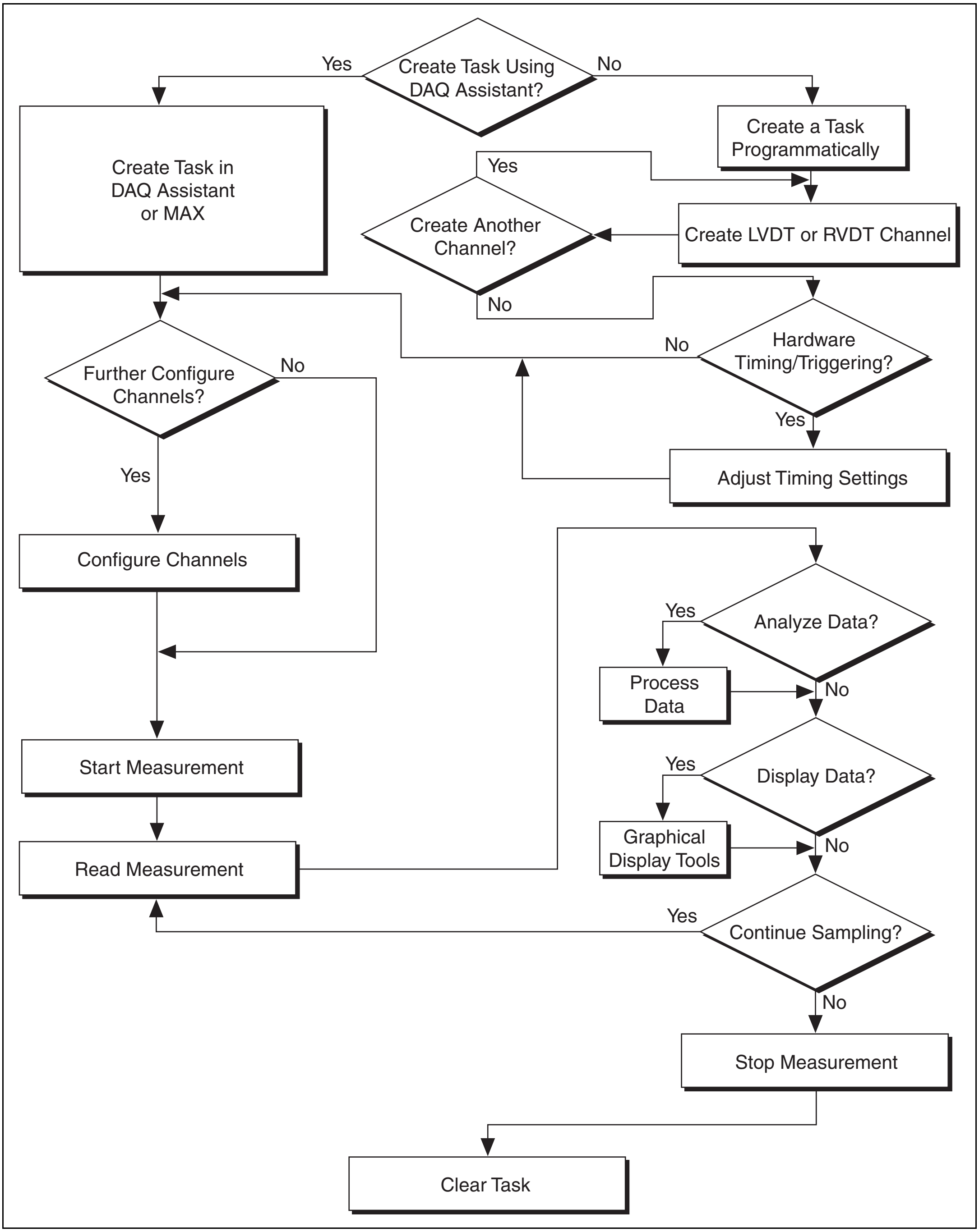


Figure 5-1. Typical Program Flowchart for LVDT or RVDT Channels

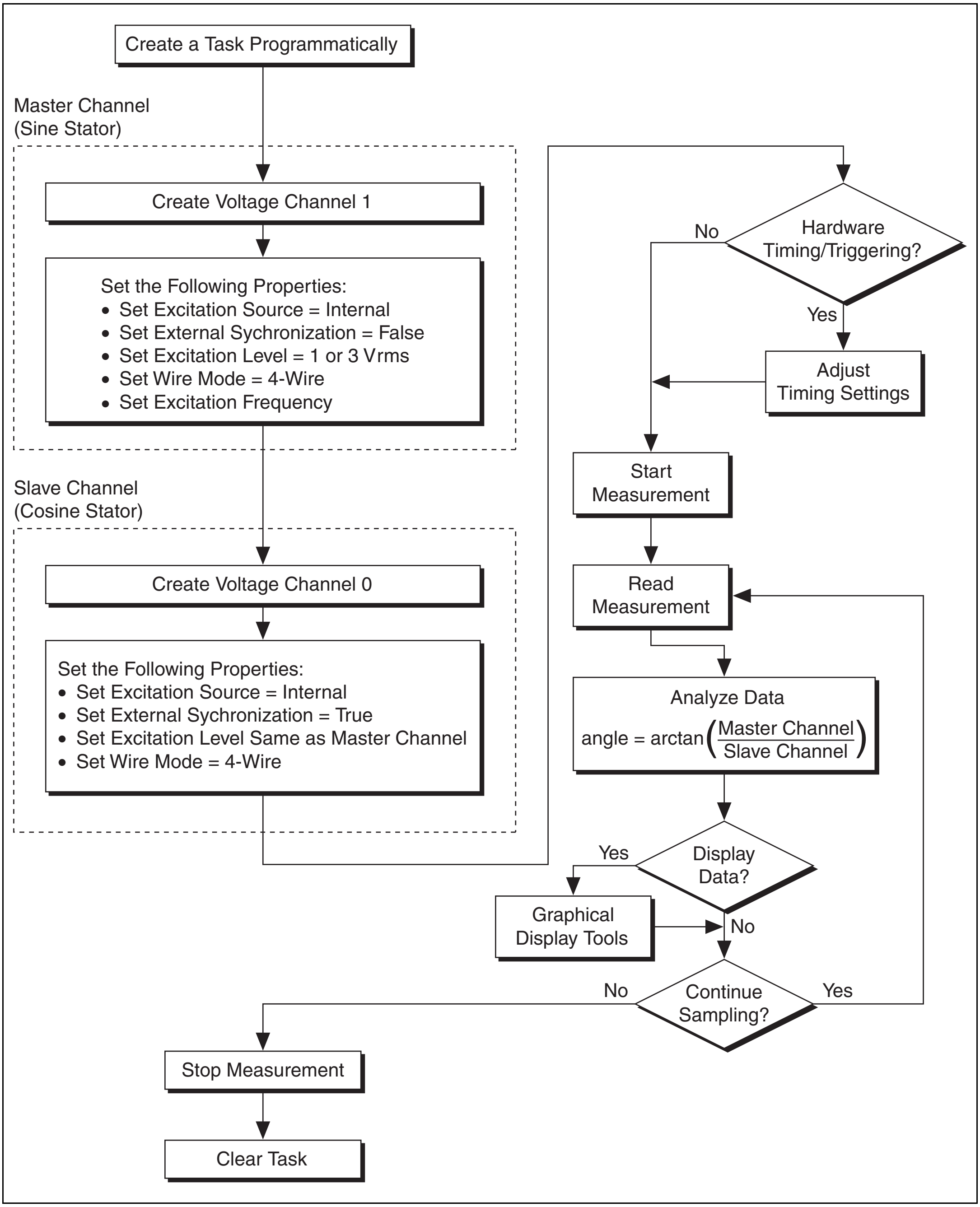


Figure 5-2. Typical Program Flowchart for Resolver Channels

Note Refer to Chapter 2, *Connecting Signals*, Figure 2-4, for physical connections.

General Discussion of Typical Flowchart

The following sections briefly discuss some considerations for a few of the steps in Figure 5-1. These sections are meant to give an overview of some of the options and features available when programming with NI-DAQmx.

Creating a Task Using DAQ Assistant or Programmatically

When creating an application, you must first decide whether to create the appropriate task using the DAQ Assistant or programmatically in the ADE.

Developing your application using DAQ Assistant gives you the ability to configure most settings such as measurement type, selection of channels, excitation voltage, signal input limits, task timing, and task triggering. You can access the DAQ Assistant through MAX or your NI ADE. Choosing to use the DAQ Assistant can simplify the development of your application. NI recommends creating tasks using the DAQ Assistant for ease of use, when using a sensor that requires complex scaling, or when many properties differ between channels in the same task.

If you are using an ADE other than an NI ADE, or if you want to explicitly create and configure a task for a certain type of acquisition, you can programmatically create the task from your ADE using functions or VIs. If you create a task using the DAQ Assistant, you can still further configure the individual properties of the task programmatically with functions or property nodes in your ADE. NI recommends creating a task programmatically if you need explicit control of programmatically adjustable properties of the DAQ system.

Programmatically adjusting properties for a task created in the DAQ Assistant overrides the original, or default, settings only for that session. The changes are not saved to the task configuration. The next time you load the task, the task uses the settings originally configured in the DAQ Assistant.

Adjusting Timing and Triggering

There are several timing properties that you can configure through the DAQ Assistant or programmatically using function calls or property nodes. If you create a task in the DAQ Assistant, you can still modify the timing properties of the task programmatically in your application.

When programmatically adjusting timing settings, you can set the task to acquire continuously, acquire a buffer of samples, or acquire one point at a time. For continuous acquisition, you must use a while loop around the acquisition components even if you configured the task for continuous acquisition using MAX or the DAQ Assistant. For continuous and buffered acquisitions, you can set the acquisition rate and the number of samples to read in the DAQ Assistant or programmatically in your application. By default, the clock settings are automatically set by an internal clock based on the requested sample rate. You also can select advanced features such as clock settings that specify an external clock source, internal routing of the clock source, or select the active edge of the clock signal.

Configuring Channel Properties

All ADEs used to configure the SCXI-1540 access an underlying set of NI-DAQmx properties. Table 5-1 shows some of these properties. You can use Table 5-1 to determine what kind of properties you need to set to configure the module for your application. For a complete list of NI-DAQmx properties, refer to your ADE help file.

Note You cannot adjust some properties while a task is running. For these properties, you must stop the task, make the adjustment, and re-start the application. Table 5-1 assumes all properties are configured before the task is started.

Table 5-1. NI-DAQmx Properties

Property	Short Name	Description
Analog Input»General Properties» Advanced»Range»High	AI.Rng.High	Specifies the upper limit of the input range on the digitizer device.
Analog Input»General Properties» Advanced»Range»Low	AI.Rng.Low	Specifies the lower limit of the input range on the digitizer device.
Analog Input»General Properties» Signal Conditioning»Excitation» Value	AI.Excit.Val	Specifies the amount of excitation in RMS volts.
Analog Input»General Properties» Signal Conditioning»Excitation» AC Excitation»Frequency	AI.ACExcit.Freq	Specifies the frequency of AC excitation.

Table 5-1. NI-DAQmx Properties (Continued)

Property	Short Name	Description
Analog Input»General Properties» Signal Conditioning»Excitation» AC Excitation»Synchronization Enable	AI.ACExcit.SyncEnable	Specifies whether to synchronize the AC excitation source of the channel to that of another channel.
Analog Input»General Properties» Signal Conditioning»Excitation» AC Excitation»Wire Mode	AI.ACExcit.WireMode	Specifies the number of leads on the LVDT or RVDT.
Analog Input»General Properties» Advanced»Gain and Offset»Gain Value	AI.Gain	Specifies a gain factor to apply to the signal conditioning portion of the channel.
Analog Input»General Properties» Advanced»High Accuracy Settings» Auto Zero Mode	AI.AutoZeroMode	Specifies when to measure ground. NI-DAQmx then subtracts the voltage either on every sample or only once, depending on the setting.
Analog Input»Measurement Type (read only)	AI.MeasType	Indicates the measurement to take with the analog input channel.

Note This is *not* a complete list of NI-DAQmx properties and does not include every property you may need to configure your application. It is a representative sample of important properties to configure for LVDT/RVDT measurements. For a complete list of NI-DAQmx properties and more information about NI-DAQmx properties, refer to your ADE help file.

Acquiring, Analyzing, and Presenting

After configuring the task and channels, you can start the acquisition, read measurements, analyze the data returned, and display it according to the needs of your application. Typical methods of analysis include digital filtering, averaging data, performing harmonic analysis, applying a custom scale, or adjusting measurements mathematically.

NI provides powerful analysis toolsets for each NI ADE to help you perform advanced analysis on the data without requiring you to have a programming background. After you acquire the data and perform any required analysis, it is useful to display the data in a graphical form or log it to a file. NI ADEs provide easy-to-use tools for graphical display, such as charts, graphs, slide controls, and gauge indicators. NI ADEs have tools that allow you to easily save the data to files such as spread sheets for easy viewing, ASCII files for universality, or binary files for smaller file sizes.

Completing the Application

After you have completed the measurement, analysis, and presentation of the data, it is important to stop and clear the task. This releases any memory used by the task and frees up the DAQ hardware for use in another task.

Note In LabVIEW, tasks are automatically cleared when the program is stopped.

Developing an Application Using LabVIEW

This section describes in more detail the steps shown in the typical program flowchart in Figure 5-1, such as how to create a task in LabVIEW and configure the channels of the SCXI-1540. If you need more information or for further instructions, select **Help»VI, Function, & How-To Help** from the LabVIEW menu bar.

Note Except where otherwise stated, the VIs in Table 5-2 are located on the **Functions» All Functions»NI Measurements»DAQmx - Data Acquisition** subpalette and accompanying subpalettes in LabVIEW.

Table 5-2. Programming a Task in LabVIEW

Flowchart Step	VI or Program Step
Create Task in DAQ Assistant	Create a `DAQmx Task Name Control` located on the **Controls»All Controls»I/O»DAQmx Name Controls** subpalette, right-click it, and select `New Task (DAQ Assistant)`.
Create a Task Programmatically (optional)	`DAQmx Create Task.vi` located on the **Functions» All Functions»NI Measurements»DAQmx - Data Acquisition»DAQmx Advanced Task Options** subpalette—This VI is optional if you created and configured your task using the DAQ Assistant. However, if you use it in LabVIEW, any changes you make to the task will not be saved to a task in MAX.
Create LVDT or RVDT Channels	`DAQmx Create Virtual Channel.vi` (AI Voltage by default, to change, click **AI Voltage** and select **Analog Input» Position»LVDT** or **Analog Input»Position»RVDT**.)—This VI is optional if you created and configured your task and channels using the DAQ Assistant. Any channels created with this VI are not saved in the DAQ Assistant. They are only available for the present session of the task in LabVIEW.
Adjust Timing Settings (optional)	`DAQmx Timing.vi` (Sample Clock by default)—This VI is optional if you created and configured your task using the DAQ Assistant. Any timing settings modified with this VI are not saved in the DAQ Assistant. They are only available for the present session of the task in LabVIEW.
Configure Channels (optional)	DAQmx Channel Property Node, refer to the *Using a DAQmx Channel Property Node in LabVIEW* section for more information. This step is optional if you created and fully configured the channels using the DAQ Assistant. Any channel modifications made with a channel property node are not saved in the task in the DAQ Assistant. They are only available for the present session of the task in LabVIEW.
Start Measurement	`DAQmx Start Task.vi`
Read Measurement	`DAQmx Read.vi`
Analyze Data	Some examples of data analysis include filtering, scaling, harmonic analysis, or level checking. Some data analysis tools are located on the **Functions»Signal Analysis** subpalette and on the **Functions»All Functions»Analyze** subpalette.

Table 5-2. Programming a Task in LabVIEW (Continued)

Flowchart Step	VI or Program Step
Display Data	You can use graphical tools such as charts, gauges, and graphs to display your data. Some display tools are located on the **Controls»All Controls»Numeric»Numeric Indicators** subpalette and **Controls»All Controls»Graph** subpalette.
Continue Sampling	For continuous sampling, use a While Loop. If you are using hardware timing, you also need to set the `DAQmx Timing.vi` sample mode to Continuous Samples. To do this, right-click the terminal of the `DAQmx Timing.vi` labeled **sample mode** and click **Create»Constant**. Click the box that appears and select **Continuous Samples**.
Stop Measurement	`DAQmx Stop Task.vi` (This VI is optional, clearing the task automatically stops the task.)
Clear Task	`DAQmx Clear Task.vi`

Using a DAQmx Channel Property Node in LabVIEW

You can use property nodes in LabVIEW to manually configure the channels. To create a LabVIEW property node, complete the following steps:

1. Launch LabVIEW.
2. Create the property node in a new VI or in an existing VI.
3. Open the block diagram view.
4. From the **Functions** toolbox, select **All Functions» NI Measurements»DAQmx - Data Acquisition**, and select `DAQmx Channel Property Node`.
5. The **ActiveChans** property is displayed by default. This allows you to specify exactly what channel(s) you want to configure. If you want to configure several channels with different properties, separate the lists of properties with another **Active Channels** box and assign the appropriate channel to each list of properties.

Note If you do not use Active Channels, the properties are set on all of the channels in the task.

6. Right-click **ActiveChans**, and select **Add Element**. Left-click the new **ActiveChans** box. Navigate through the menus, and select the property you wish to define.

7. Change the property to read or write to either get the property or write a new value. Right-click the property, go to **Change To**, and select **Write**, **Read**, or **Default Value**.
8. After you have added the property to the property node, right-click the terminal to change the attributes of the property, add a control, constant, or indicator.

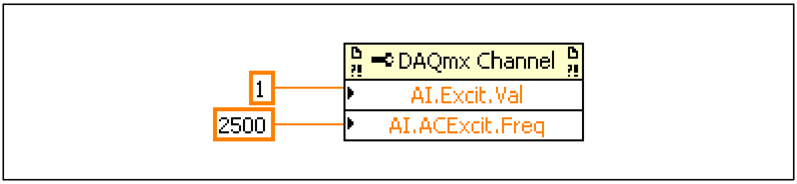


Figure 5-3. LabVIEW Channel Property Node with AC Excitation at 1 Volt RMS and AC Excit Frequency at 2500 Hz

9. To add another property to the property node, right-click an existing property and left-click **Add Element**. To change the new property, left-click it and select the property you wish to define.

Note Refer to the *LabVIEW Help* for information about property nodes and specific NI-DAQmx properties.

Specifying Channel Strings in NI-DAQmx

Use the channel input of **DAQmx Create Channel** to specify the SCXI-1540 channels. The input control/constant has a pull-down menu showing all available external channels. The strings take one of the following forms:

- single device identifier/channel number—for example `SC1Mod1/ch0`
- multiple, noncontinuous channels—for example `SC1Mod1/ch0`, `SC1Mod1/ch4`
- multiple continuous channels—for example `SC1Mod1/ch0:4` (channels 0 through 4)

When you have a task containing SCXI-1540 channels, you can set the properties of the channels programmatically using the **DAQmx Channel Property Node**.

Follow the general programming flowchart or open an example to build a basic LVDT/RVDT virtual channel. You can use property nodes in LabVIEW to control, configure, and customize the NI-DAQmx task and SCXI-1540. To create a LabVIEW property node, complete the following steps:

1. Launch LabVIEW.
2. Create the property node in a new Virtual Instrument (VI) or in an existing VI.
3. Open the block diagram view.
4. From the **Functions** tool bar, select **NI Measurements**, **DAQmx - Data Acquisition**, and select the type of property node you wish to configure.
5. Left-click inside the property box and select **ActiveChans**. This allows you to specify what channel(s) you want to configure. If you want to configure several channels with different properties, separate the lists of properties with another **ActiveChans** box, and assign the appropriate channel to each list of properties.
6. Right-click **ActiveChan**s and select **Add Element**. Left-click the new **ActiveChan**s box. Navigate through the menus and select the property you wish to define.
7. You must change the property to read or write to either get the property or write a new value. Right-click the property, go to **Change To**, and select **Write**, **Read**, or **Default Value**.
8. After you have added the property to the property node, right-click the terminal to change the attributes of the property, add a control, constant, or indicator.
9. To add another property to the property node, right-click an existing property and left-click **Add Element**. To change the new property, left-click it and select the property you wish to define.

Note Refer to the *LabVIEW Help* for information about property nodes and specific NI-DAQmx properties.

Text Based ADEs

You can use text based ADEs such as LabWindows/CVI, Measurement Studio, Visual Basic 6, .NET, and C# to create code for using the SCXI-1540.

LabWindows/CVI

LabWindows/CVI works with the **DAQ Assistant** in MAX to generate code for an LVDT/RVDT task. You can then use the appropriate function call to modify the task. To create a configurable channel or task in LabWindows/CVI, complete the following steps:

1. Launch LabWindows/CVI.
2. Open a new or existing project.
3. From the menu bar, select **Tools»Create/Edit DAQmx Tasks**.
4. Choose **Create New Task In MAX** or **Create New Task In Project** to load the DAQ Assistant.
5. The DAQ Assistant creates the code for the task based on the parameters you define in MAX and the device defaults. To change a property of the channel programmatically, use the `DAQmxSetChanAttribute` function.

Note Refer to the *NI LabWindows/CVI Help* for more information on creating NI-DAQmx tasks in LabWindows/CVI and NI-DAQmx property information.

Measurement Studio (Visual Basic 6, .NET, and C#)

When creating an LVDT/RVDT task in Visual Basic 6, .NET and C#, follow the general programming flow in Figure 5-1. You can then use the appropriate function calls to modify the task. This example creates a new task and configures an NI-DAQmx LVDT/RVDT channel on the SCXI-1540. You can use the same functions for Visual Basic 6, .NET and C#.

In this example, an analog input channel object is used since reading the voltage from an LVDT is an analog input operation. The following text is a function prototype example:

```
void AIChannelCollection.CreateLVDTChannel(
    System.String physicalChannelName,
    System.String nameToAssignChannel,
    System.Double minVal,
    System.Double maxVal,
    AILVDTUnits lvdtUnits,
    System.Double sensitivity,
    AISensitivityUnits sensitivityUnits,
    AIExcitationSource voltExcitSource,
    System.Double voltExcitVal,
    System.Double voltExcitFreq,
    AIACExcitWireMode acExcitWireMode);
```

To actually create and configure the channel, you would enter something resembling the following example code:

```
Task myTask = new
NationalInstruments.DAQmx.Task("myTaskName");
MyTask.DAQmxCreateAIPosLVDTChan (
    "SC1Mod1/ai0", // System.String physicalChannelName
    "lvdt0", // System.String nameToAssignChannel
    -0.001, // System.Double minVal
    0.001, // System.Double maxVal
    AILVDTUnits.Inches, // AIRVDTUnits lvdtUnits
    1.0, // System.Double
    AISensitivityUnits.MVolts/Volt/0.001inch, //
    AISensitivityUnits sensitivityUnits
    AIExcitationSourceInternal, // AIExcitationSource
    voltExcitSource
    1.0, // System.Double voltExcitUnit
    2500, // System.Double voltExcitFreq
    AIACExcitWireMode.4Wire, // AIACExcitWireMode
    acExcitWireMode);
// setting attributes after the channel is created
AIChannel myChannel = myTask.AIChannels["LVDT0"];
myChannel.AutoZeroMode = AIAutoZeroMode.Once;
```

You can change any of the properties at a later time. For example, to change the excitation value of `myChannel`, enter the following lines:

```
AIChannel myChannel = myTask.AIChannels["LVDT 0"];
myChannel.Excitationvalue = 3.0;
```

Modify the example code above or the code from one of the shipping examples as needed to suit your application. Refer to the *Other Application Documentation and Material* section for the location of program examples.

Notes You can create and configure the LVDT/RVDT task in MAX and load it into your application with the function call `NationalInstruments.DAQmx.DaqSystem.Local.LoadTask`.

Refer to the *NI Measurement Studio Help* for more information on creating NI-DAQmx tasks in LabWindows/CVI and NI-DAQmx property information.

Programmable NI-DAQmx Properties

All of the different ADEs that configure the SCXI-1540 access an underlying set of NI-DAQmx properties. Table 5-1 provides a list of some of the properties that configure the SCXI-1540. You can use this list to determine what kind of properties you need to set to configure the device for your application. For a complete list of NI-DAQmx properties, refer to your ADE help file.

Note Table 5-1 is *not* a complete list of NI-DAQmx properties and does not include every property you may need to configure LVDTs, RVDTs, and resolvers. It is a representative sample of important properties to configure LVDTs, RVDTs, and resolvers. For a complete list of NI-DAQmx properties and more information on NI-DAQmx properties, refer to your ADE help file.

Developing Your Application in Traditional NI-DAQ (Legacy)

Note If you are not using an NI ADE, using an NI ADE prior to version 7.0, or are using an unlicensed copy of an NI ADE, additional dialog boxes from the NI License Manager appear allowing you to create a task or global channel in unlicensed mode. These messages continue to appear until you install version 7.0 or later of an NI ADE.

This section describes how to configure and use Traditional NI-DAQ (Legacy) to control the SCXI-1540 in LabVIEW, LabWindows/CVI, Measurement Studio, and other text-based ADEs. These NI ADEs provide greater flexibility and access to more settings than MAX, but you can use ADEs in conjunction with MAX to quickly create a customized application.

Traditional NI-DAQ (Legacy) in LabVIEW

LabVIEW is a graphical programming environment for test and measurement application development with built-in easy to use tools for data acquisition, analysis, and display. Traditional NI-DAQ (Legacy) provides several standard data acquisition subVIs as well as subVIs specifically for use with the SCXI-1540.

For applications using Traditional NI-DAQ (Legacy) in LabVIEW, there are two typical methods of addressing SCXI-1540 channels—virtual channels (specifically LVDT/RVDT virtual channels) and SCXI channel strings. Depending on the needs of your application, you choose one of these channel addressing methods to use in your LabVIEW application.

The LVDT/RVDT virtual channel provides scaling for LVDT/RVDTs and allows you to select any name for the SCXI-1540 LVDT/RVDT channel that you choose without additional code. When you use virtual channels, the maximum number of channels per E Series DAQ device is 512 in multichassis systems. NI recommends using the LVDT/RVDT virtual channel for ease of use. Refer to Appendix B, *Using SCXI Channel Strings with Traditional NI-DAQ (Legacy) 7.0 or Later*, for more information on how to create a LVDT/RVDT virtual channel.

The SCXI channel string allows you to combine large numbers of channels into fewer scan list entries and to measure the signal voltage level directly for custom scaling in your application. NI recommends using SCXI channel strings for more advanced applications. In LabVIEW, an array of these channel strings configures multiple modules for scanning. When using SCXI channel strings, you can scan up to 3,072 channels in a multichassis system using a single E Series DAQ device. Refer to Appendix B, *Using SCXI Channel Strings with Traditional NI-DAQ (Legacy) 7.0 or Later*, for more information about using SCXI channel strings.

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

To use virtual channels, enter the name of a virtual channel into the analog input channel string. If using multiple virtual channels, enter them in a different index in the channel string array, or separate them using a comma.

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

Typical Program Flow

After you have determined how you want to address the channels and whether you want to configure the SCXI-1540 in MAX or LabVIEW, you can design your application using a typical program flow such as the one shown in Figure 5-4.

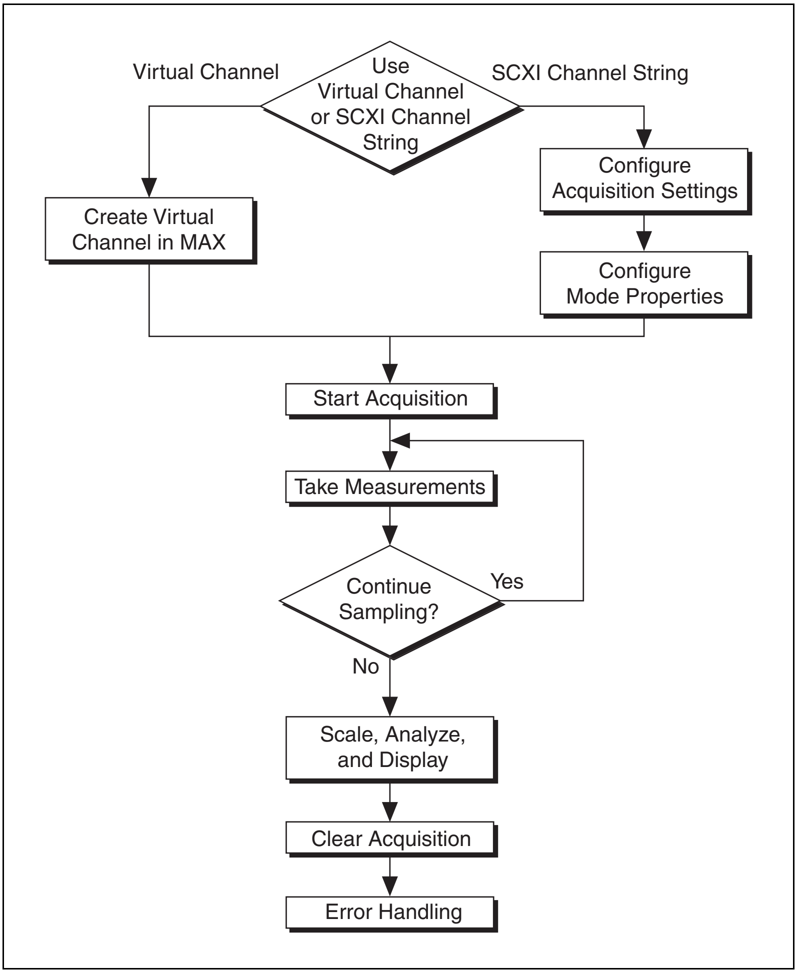


Figure 5-4. Typical SCXI-1540 Program Flow with Traditional NI-DAQ (Legacy)

Configure the SCXI-1540 Settings Using Traditional NI-DAQ (Legacy) in LabVIEW

To configure and control the SCXI-1540 from LabVIEW, use the AI Parameter VI. You can find AI Parameter VI in the function subpalette **Data Acquisition»Analog Input»Advanced Analog Input**.

A parameter changed by the AI Parameter VI takes effect in hardware when AI Start VI is called, not when AI Parameter VI is called. The AI parameter VI merely changes the configuration in the driver memory. When called, the AI Start VI reads the configuration settings in the driver memory and then sends the actual control information to the SCXI-1540 module. A setting established through AI Parameter VI is only valid for the LabVIEW session and does not change the setting in MAX.

You can use the AI Parameter VI to configure the SCXI-1540 settings shown in Table 5-3.

Table 5-3. Settings for Configuring the SCXI-1540 Through the AI Parameter

Software-Configurable Setting	AI Parameter VI Parameter Name	Allowable Settings (Float In, Boolean In, or Value In)	
		Data Type	Values
Excitation Level	SCXI AC Voltage Excitation	Float In (dbl)	1.0, 3.0
Excitation Frequency	SCXI AC Frequency Excitation	Float In (dbl)	2500, 3300, 5000, 10000
Connection Type	SCXI Connection Type	Value In	4-Wire LVDT, 5-Wire LVDT
Synchronization Type	SCXI Synchronization Type	Value In	Internal Synchronization, External Synchronization

An example of using the AI Parameter VI to control an SCXI-1540 is shown in Figure 5-5.

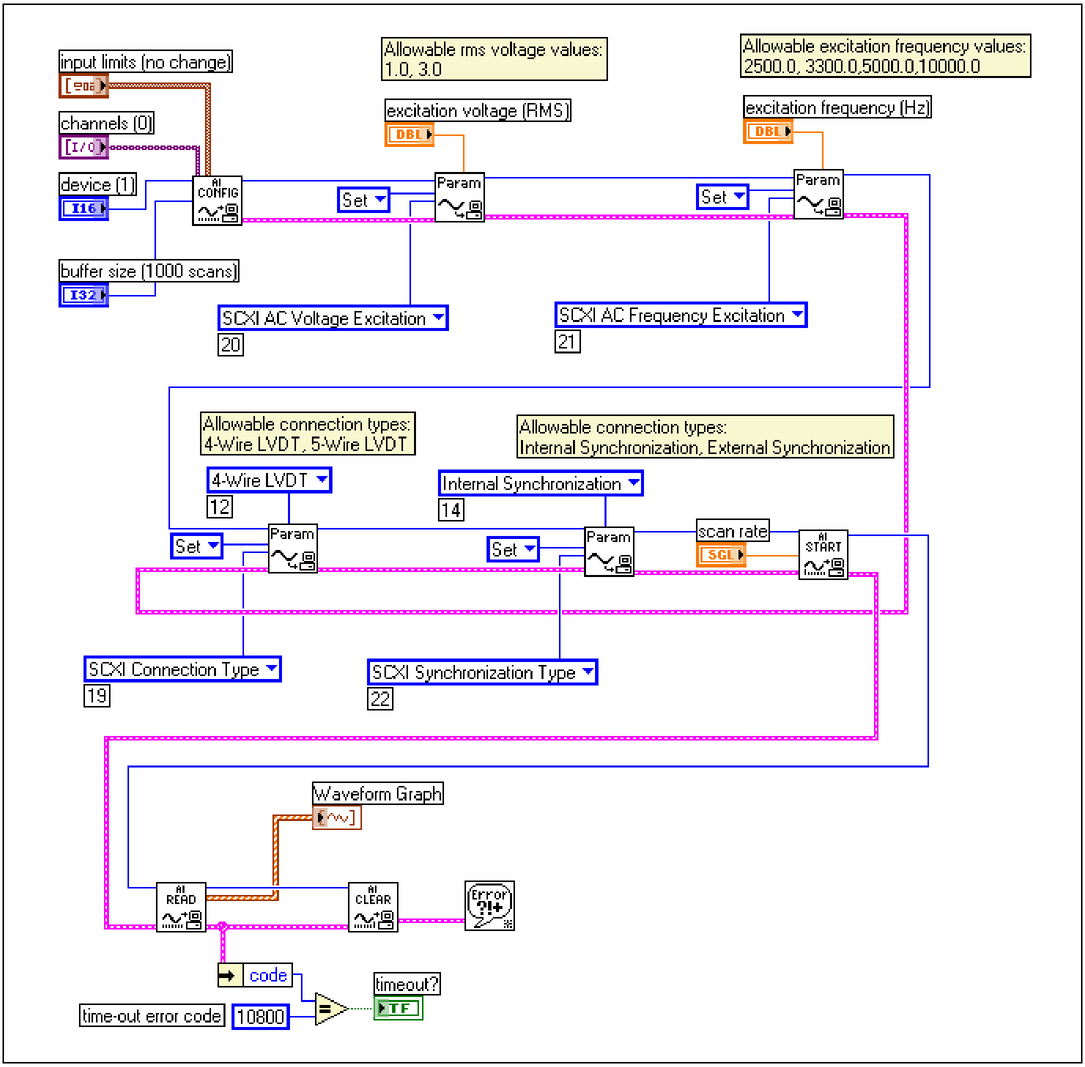


Figure 5-5. Using the AI Parameter VI to Set Up the SCXI-1540

Configure, Start Acquisition, and Take Readings Using Traditional NI-DAQ (Legacy) in LabVIEW

After you have configured the SCXI-1540 settings for your application, you can use the intermediate analog input functions AI Config VI, AI Start VI, AI Read VI, and AI Clear VI to create your data acquisition application. You can find the intermediate data acquisition Traditional NI-DAQ (Legacy) functions in the function subpalettes **Data Acquisition» Analog Input**. NI recommends using the intermediate analog input functions for most SCXI-1540 applications. For more information about using the intermediate data acquisition Traditional NI-DAQ (Legacy) functions, refer to the *LabVIEW Measurements Manual*. You also can use the *LabVIEW Help* for more detailed information about the various inputs and outputs of these functions.

Analyze and Display Using Traditional NI-DAQ (Legacy) in LabVIEW

In LabVIEW, you can easily analyze SCXI-1540 measurements with a variety of powerful analysis functions that you can find in the function subpalettes **Analyze»Waveform Conditioning** and **Analyze» Signal Processing**. You can perform post acquisition processing such as waveform comparisons, harmonic analysis, and digital filtering. For more information about these VIs, refer to the *LabVIEW Analysis Concepts* manual. You also can use the *LabVIEW Help* for more detailed information about how to use the analysis VIs.

In LabVIEW, you also can easily display SCXI-1540 measurements with a variety of graphical waveform graphs, numeric slides, gauges, and other indicators. You can find useful graphical controls and indicators for user interaction with your application in the controls subpalettes. For more information about these VIs, refer to the *LabVIEW User Manual*. You also can use the *LabVIEW Help* for more detailed information about how to use graphical controls and indicators in your application.

Traditional NI-DAQ (Legacy) in Text-Based ADEs

NI text-based ADEs, such as LabWindows/CVI, Measurement Studio for Microsoft Visual Basic, and Measurement Studio for Microsoft Visual C++, offer help in the development of test and measurement applications. These ADEs provide easy data acquisition, data analysis, graphical display, and data logging tools. Refer to the ADE user manual for more information about how to use these features.

The high-level data acquisition tools provided in LabWindows/CVI and Measurement Studio allow you to easily use virtual channels configured in

MAX providing easy configuration and programming of the data acquisition systems. However, some of the more advanced features of the SCXI-1540 are not accessible through this easy-to-use API. For more advanced features or for more explicit control of the programmatic attributes, use the low-level DAQ functions provided in the Traditional NI-DAQ (Legacy) C API. Refer to the ADE user documentation for more information about how to use the high-level data acquisition tools that are provided in your NI ADE.

For more advanced SCXI-1540 applications, or if you are using an ADE other than an NI ADE, you can use the Traditional NI-DAQ (Legacy) C API to call functions from the DAQ driver dynamically linked library (dll). The *C and Low-Level DAQ Functions* section outlines the steps for programming with the low-level DAQ function calls. If you are using LabWindows/CVI or Measurement Studio, you also can write advanced applications using the same low-level DAQ functions guidelines.

Configuring System Settings Using Traditional NI-DAQ (Legacy) C API

Start the configuration of the acquisition by ensuring that the SCXI-1540 module and SCXI chassis are in their default states, and that the driver software configuration matches the states the actual physical hardware configuration. After setting the hardware and software to the defaults of the module(s), you can configure any module settings that vary from the default configuration settings. You also should configure the acquisition parameters using the functions in Table 5-4. For additional information such as the function prototypes, parameters, and usage instructions for each function, refer to the *Traditional NI-DAQ (Legacy) C Function Reference Help* installed by default in **Start»Programs»National Instruments» NI-DAQ**.

Table 5-4. Configuration Functions

Function	Description
SCXI_Reset	Resets the hardware such as the specified module to its default state. You also can use SCXI_Reset to reset the SCXI chassis Slot 0 scanning circuitry or reset the entire chassis. The SCXI-1540 default conditions are: • Gain set at 0.8 • 3 V_{rms} excitation level • 10 kHz excitation frequency • External synchronization off • 4-wire mode
SCXI_Load_Config	Loads the SCXI chassis configuration information you established in MAX. Sets the software states of the chassis and the modules present to their default states. This function makes no changes to the hardware state of the SCXI chassis or modules. It is possible to programmatically change the configuration you established in MAX using the SCXI_Set_Config function.
SCXI_SCAN_Setup	Initializes multiplexing circuitry for a scanned data acquisition operation. Initialization includes storing a table of the channel sequence and gain setting for each channel to be digitized (MIO and AI devices only). You *cannot* repeat channels or use nonsequential channels when using the SCXI_SCAN_Setup function.
SCXI_MuxCtr_Setup	Programs the E Series DAQ device with the correct number of channels multiplexed per scan. This number must match the total number of channels programmed in SCXI_SCAN_Setup.

Note NI strongly recommends monitoring the built-in error status of each NI-DAQ function. The NI-DAQ C API provides the NIDAQErrorHandler function, which ensures that a specified NI-DAQ function executed properly, and assists in handling error messages and reporting.

Configure Module Settings Using Traditional NI-DAQ (Legacy) C API

After configuring the hardware for acquisition, you must load the various channel attributes such as filter, gain, and excitation appropriate for your application explicitly using the NI-DAQ function calls shown in Table 5-5. For more information regarding each setting, refer to the *Traditional NI-DAQ (Legacy) C Function Reference Help* installed by default in **Start»Programs»National Instruments»NI-DAQ**.

Table 5-5. NI-DAQ Functions Used to Configure SCXI-1540

Channel Setting	NI-DAQ Function to Use	Significant Parameters	Possible Parameters Values
Connection Type	`SCXI_Configure_Connection`	i16 `connectionType`	0—Four-wire connection 1—Five-wire connection 2—Disable external synchronization 3—Enable external synchronization
Excitation Voltage	`SCXI_Set_Excitation`	i16 `excitationType` (type of excitation to set) f32 `excitationValue` (new value for the specified excitation parameter)	0—AC voltage specified in units of V_{rms} 1.0, 3.0
Excitation Voltage	`SCXI_Set_Excitation`	i16 `excitationType` (type of excitation to set) f32 `excitationValue` (new value for the specified excitation parameter)	1—AC frequency specified in units of Hz 2500, 3300, 5000, 10000

Perform Acquisition Using Traditional NI-DAQ (Legacy) C API

There are several NI-DAQ functions you can use to take measurements. Usually in SCXI the preference is to take multiple samples from multiple channels using the `SCAN_Op` function. `SCAN_Op` performs a synchronous, multiple-channel scanned data acquisition operation. `SCAN_Op` does not return until Traditional NI-DAQ (Legacy) acquires all the data or an acquisition error occurs. For this reason, it is sometimes useful to use `SCAN_Op` in conjunction with the function `Timeout_Config`, which establishes a timeout limit synchronous functions to ensure that these functions eventually return control to your application. After acquiring data using `SCAN_Op`, the resultant data is not organized by channel, so you should demultiplex the data using `SCAN_Demux`. `SCAN_Demux` rearranges, or demultiplexes, data acquired by a `SCAN_Op` into row-major order, meaning each row of the array holding the data corresponds to a scanned channel for easier access by C applications. BASIC applications need not call `SCAN_Demux` to rearrange two-dimensional arrays since these arrays are accessed in column-major order. For more information regarding each acquisition function, refer to the *Traditional NI-DAQ (Legacy) Function Reference Help* installed by default in **Start»Programs»National Instruments»NI-DAQ**.

Note To synchronize multiple channels, you must make the connections shown in Figure 2-4 *and* configure the slaved channels as externally synchronized. Do this through MAX or by using the NI-DAQ function `SCXI_Configure_Connection`. You must *not* configure the channel that originates the synchronization signal from its EX+ pin for external synchronization since that channel serves as master and is not slaved to any other channel.

Perform Scaling, Analysis, and Display

After acquiring raw voltage data from the acquisition functions, most applications require adjustment by device calibration constants for accuracy, scaling measured voltage, analysis, and graphical display.

The SCXI-1540 has stored software calibration constants loaded on the module EEPROM that are used to achieve the absolute accuracy specifications. `SCXI_Scale` scales an array of binary data acquired from an SCXI channel to voltage using the stored software calibration constants when it scales the data. You must call `SCAN_Demux` before `SCXI_Scale` if you have multiple channels in the scan. For more information regarding `SCXI_Scale`, refer to the *Traditional NI-DAQ (Legacy) Function Reference Help* installed by default in **Start»Programs»National Instruments»NI-DAQ**. NI-ADEs provide many powerful analysis functions to perform digital filtering, harmonic analysis, averaging, and complex mathematics on measurements.

After performing scaling and analysis on the acquired data, you can display the measurements in several ways. You can use any built in GUI tools in your ADE. NI ADEs provide many graphical controls and indicators such as charts, graphs, gauges, slides, and plots that you can use to display the data. There is also a built in function, found in `nidaqex.h`, called `NIDAQPlotWaveform` that you can use to generate a simple plot of the data.

Other Application Documentation and Material

This section provides information about multiplexed scanning and the Traditional NI-DAQ (Legacy) examples for Measurement Studio and LabWindows/CVI. Refer to the ADE manual and the DAQ analog input examples that come with your application software for more detailed information on programming the SCXI modules for scanning in multiplexed mode.

Using Software for Multiplexed Scanning

Performing scanning operations in software depends on the ADE you are using. While using LabVIEW or Visual Basic 6, 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 E Series DAQ device controlling the scan.

A discussion describing how to implement multiplexed scanning in the different ADEs follows. Refer to the 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.

LabVIEW and the SCXI Channel String

For LabVIEW and Visual Basic 6, the channel string determines the sequence in which SCXI channels are scanned. Refer to Appendix B, *Using SCXI Channel Strings with Traditional NI-DAQ (Legacy) 7.0 or Later*, for more information about using SCXI channels strings in

Traditional NI-DAQ (Legacy). In LabVIEW, an array of these channel strings configures multiple modules in the scan list. 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:

`obx ! scy ! mdz ! ` **`channels`**

where

ob***x*** is the onboard E Series DAQ device channel, with *x* representing a particular channel where the multiplexed channels are sent. This value is 0 for DAQ channel 0 in a single-chassis system. In a multichassis or remote chassis system, however, the E Series DAQ device channel *x* corresponds to chassis number *n* – 1, where E Series DAQ device channel *x* is used for scanning the *n*th 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 The obx ! specifier is optional and causes the gains on the module and E Series DAQ device to be automatically set to fit the input limits parameter. When this specifier is omitted, the default gain on the E Series DAQ device, usually the lowest gain, is used, but the SCXI-1540 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 a 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 a 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.

LabVIEW and the Virtual Channel String

For LabVIEW and Visual Basic 6, the channel string can also contain virtual channels. For the SCXI-1540, these virtual channels are analog input channels you create that have custom names, that perform all error correction and scaling without additional code. Virtual channels are particularly useful when sensors requiring different scaling factors are used on the same SCXI-1540 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-1540, no changes are needed in the application. All that is required is creating a different 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.

To create a virtual channel for the SCXI-1540, insert a new analog input channel in the **Data Neighborhood** path in MAX, name it, and then follow the software prompts to create virtual position channels, voltage channels, or customized analog input channels. For more information on virtual channels, consult the MAX online 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.

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

Performing a Multiplexed Scan

To perform a multiplexed scan in your application, complete 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 default input limits configured in the virtual channel configurator are used.

You have completed a multiplexed scan using your SCXI-1540.

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

C and Low-Level DAQ Functions

When using a C-based environment, you need to take several steps to configure the SCXI-1540 for multiplexed scanning. The following procedure outlines the steps for programming with the low-level NI-DAQ function calls:

1. Prepare your SCXI-1540 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 5-6.

Table 5-6. NI-DAQ Functions Used to Configure SCXI-1540

Channel Setting	NI-DAQ Function to Use
Gain	`SCXI_Set_Gain`
Excitation Frequency	`SCXI_Set_Excitation`
Excitation Level	`SCXI_Set_Excitation`
Wire Mode (4-Wire or 5-Wire)	`SCXI_Configure_Connection`
Enable External Synchronization	`SCXI_Configure_Connection`

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. Therefore, it is not possible to repeat channels or use nonsequential channels using this function.
3. Use `SCXI_MuxCtr_Setup` to program the E Series 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 E Series DAQ device. If you are using a multifunction E Series 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 *Traditional NI-DAQ (Legacy) User Manual* for additional information on scanning with E Series DAQ devices.

Traditional NI-DAQ (Legacy) CVI Examples

Many example programs ship with NI-DAQ. For more example information on how to create tasks and channels, refer to the example programs. By default, the example programs are installed in `C:\Program Files\NationalInstruments\CVI 8.x\Samples`. More examples are installed by default in `C:\Program Files\National Instruments\NI-DAQ\Examples`.

Traditional NI-DAQ (Legacy) Measurement Studio Examples

Many example programs ship with NI-DAQ. For more example information on how to create tasks and channels, refer to the example programs. By default, the example programs are installed in `C:\Program Files\NationalInstruments\Measurement Studio 7.0`. More examples are installed by default in `C:\Program Files\National Instruments\NI-DAQ\Examples`.

Calibration

The SCXI-1540 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 both offset and gain errors in the module.

You may want to periodically calibrate the module for offset and gain drift using the procedures described in the *Calibration Procedures* section.

Calibration Procedures

You can calibrate the offset and gain on the SCXI-1540 using National Instruments software. The SCXI-1540 provides input switching that automatically connects the input terminals to the excitation terminals when you perform a calibration. There is generally no need to change the input wiring since this connection is made internally and the front panel input signal terminals are disconnected. The excitation terminals remain connected to the front panel. This causes no problems during calibration provided there is no wiring error that might short-circuit the excitation signal.

Caution Ensure the calibration on the DAQ device or DMM you are using is current and traceable. If you modify the gain and offset software-correction values using an uncalibrated device, your calibration is *not* valid, or your calibration is *not* traceable.

Calibration Using LabVIEW or a C-Based ADE

You can use the LabVIEW SCXI Calibrate VI or the NI-DAQ function `SCXI_Calibrate` to calibrate your SCXI-1540. These functions calibrate all channels for all gains and excitation levels when called.

If you are using external synchronization, National Instruments recommends that you perform a calibration with the synchronization wiring and synchronization configuration settings in place. Excitation levels and frequencies are affected slightly by synchronization which, in turn, slightly effects the calibration.

If you are using LabVIEW, use the following procedure:

1. Make sure the E/M Series DAQ device or DMM you are using has a valid calibration.
2. Use the LabVIEW function SCXI Calibrate VI to calibrate your module.
    a. Enter the E/M Series DAQ device and the SCXI channel string for all eight channels. For example, your channel string might be `ob0 ! sc1 ! md3 ! 0:7`.
    b. Select **internal calibration** as the calibration operation you are going to perform.
    c. Select the **Default EEPROM load area** as the area you want to update.

If you are using a C-based ADE, use the following procedure:

1. Make sure the E/M Series DAQ device or DMM you are using has a valid calibration and meets the accuracy specifications for your application.
2. Use the NI-DAQ function, `SCXI_Calibrate`.
    a. Enter the E/M Series DAQ device, DAQ channel, and module slot. You need not enter a channel number since `SCXI_Calibrate` automatically calibrates all channels of the SCXI-1540.
    b. Select **internal calibration (0)** as the operation you are going to perform.
    c. Select the **load area (1)** as the EEPROM area you want to update.

The SCXI-1540 takes a few seconds to perform the calibration. After completion, your module has new calibration constants stored for all channels, gains, and excitation settings.

A
Specifications

This appendix lists the specifications for the SCXI-1540 modules. These specifications are typical at 25 °C unless otherwise noted.

General Specifications

Table A-1. Input Range, Gain, and Required E/M Series DAQ Device Input Limits

Input Range (V_{rms})	Full-Scale Voltage (used in calculating Accuracy, refer to the *Absolute Accuracy* section)	Gain Setting (VDC out/V_{rms} in)	E/M Series DAQ Device Input Limits (V)
6.0	6.0	0.8	±5.0
5.5	5.5	0.9	±5.0
5.0	5.0	1.0	±5.0
4.5	4.5	1.1	±5.0
4.0	4.0	1.25	±5.0
3.5	3.5	1.4	±5.0
3.0	3.0	1.6	±5.0
2.7	2.7	1.8	±5.0
2.5	2.5	2.0	±5.0
2.2	2.2	2.2	±5.0
2.0	2.0	2.5	±5.0
1.7	1.7	2.8	±5.0
1.5	1.5	3.2	±5.0
1.35	1.35	3.6	±5.0
1.25	1.25	4.0	±5.0
1.10	1.10	4.5	±5.0
1.00	1.00	5.0	±5.0
0.85	0.85	5.6	±5.0

Table A-1. Input Range, Gain, and Required E/M Series DAQ Device Input Limits (Continued)

Input Range (V_{rms})	Full-Scale Voltage (used in calculating Accuracy, refer to the *Absolute Accuracy* section)	Gain Setting (VDC out/V_{rms} in)	E/M Series DAQ Device Input Limits (V)
0.75	0.75	6.3	±5.0
0.70	0.70	7.0	±5.0
0.62	0.62	8.0	±5.0
0.55	0.55	9.0	±5.0
0.50	0.50	10.0	±5.0
0.45	0.45	11.0	±5.0
0.40	0.40	12.5	±5.0
0.35	0.35	14.0	±5.0
0.31	0.31	16.0	±5.0
0.27	0.27	18.0	±5.0
0.25	0.25	20.0	±5.0
0.22	0.22	22.0	±5.0
0.20	0.20	25.0	±5.0
0.10	0.20	25.0	±2.5
0.05	0.20	25.0	±1.0

Input impedance ....100 kΩ ±2%

Frequency response ....250 Hz LPF, 4-pole Butterworth

Input connections...................................4-wire or 5-wire

Synchronization ....Internal or external[1]

Residual ripple and noise........................<0.1% peak of full scale

Nonlinearity ....<0.1% of full scale max
0.05% of full scale typ

Output range ....±5.0 V

[1] When using external synchronization, the SCXI-1540 only supports input excitation sources that are supplied by the SCXI-1540.

Output offset drift.................................. ±70 µV/°C max

Input gain .... Refer to Table A-1

Input gain accuracy[1] .... ±2%

Gain drift .... ±300 ppm/°C max

Input damage level,
power on or off...................................... 32 V_{rms}

Excitation

Frequency....................................... 2.5 kHz ±10%
3.3 kHz ±10%
5.0 kHz ±10%
10.0 kHz ±10%

Level

Low setting[1] .... 1 V_{rms} ±5%

High setting[1] .... 3 V_{rms} ±5%

Minimum load impedance .... 32 Ω for 1 V_{rms} setting
95 Ω for 3 V_{rms} setting

[1] This is the error before correction in software. Input gain error, excitation level error, and output offset error are accounted for in the software correction coefficients stored in the onboard EEPROM. These constants are applied automatically when using NI-DAQmx tasks or Traditional DAQ (Legacy) virtual channels. The specifications in the *Absolute Accuracy* section indicate overall accuracy of the SCXI-1540, including the application of the software correction coefficients.

Absolute Accuracy

Absolute accuracy includes the cumulative error of both excitation and input gain after the application of software correction coefficients. The software correction coefficients reside in the onboard EEPROM and are applied automatically to acquired data when using NI-DAQmx tasks or Traditional NI-DAQ (Legacy) virtual channels.

Table A-2. Absolute System Accuracy

Exc. Freq (kHz)	% of Reading		Max Offset (% of Full Scale)	System Noise (Peak, % of Full Scale)		Temperature Drift	
	Typical	Max		Single Pt.	100 Pt. Avg.	Gain Drift (°C)	Offset Drift (°C)
2.5	±0.2%	±0.5%	±0.05%	±0.03%	±0.01%	±0.03%	±0.003%
3.3	±0.2%	±0.5%	±0.05%	±0.03%	±0.01%	±0.03%	±0.003%
5	±0.2%	±0.5%	±0.05%	±0.03%	±0.01%	±0.03%	±0.003%
10	±0.5%	±1.0%	±0.05%	±0.03%	±0.01%	±0.03%	±0.003%

Absolute accuracy is (voltage reading) × % of reading + (Full-Scale Voltage from Table A-1) × (max offset) + (system noise × full-scale voltage). To include the effects of temperature drift away from the temperature at which the module was calibrated, add the term

$$(\textit{voltage reading}) \times (\textit{gain drift}) \times \Delta T + (\textit{full-scale voltage} \times \textit{offset drift}) \times \Delta T$$

where ΔT is temperature change. Scan rate for 100-point averages is 200 scans per second.

Power Requirements

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

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

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

Physical

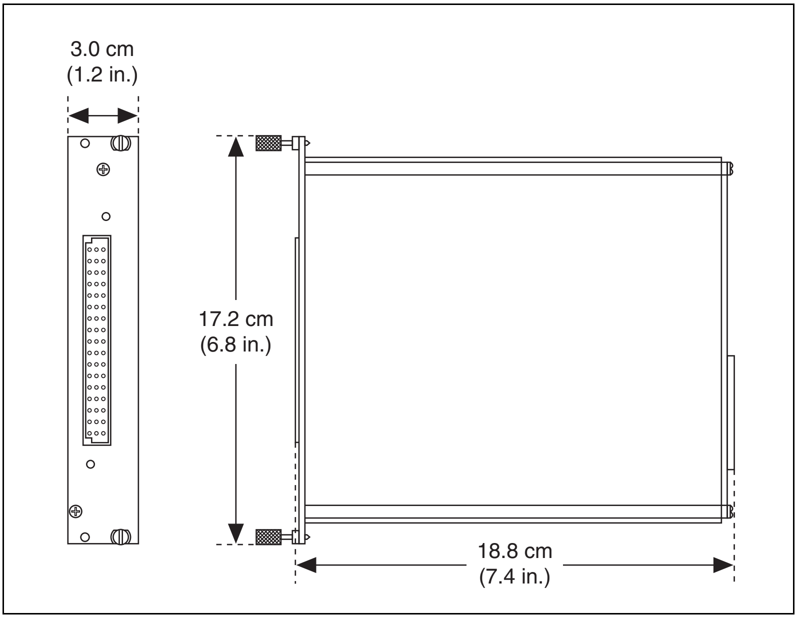


Figure A-1. SCXI-1540 Dimensions

Weight .... 727 g (25.6 oz)

Maximum Working Voltage

Maximum working voltage refers to the signal voltage plus the common-mode voltage.

Channel-to-earth..................................... 6 V_{rms}, Measurement Category I

Channel-to-channel .... 6 V_{rms}, Measurement Category I

Caution Do *not* use for measurements within Measurement Categories II, III, or IV.

Caution The protection provided by the SCXI-1540 can be impaired if it is used in a manner not described in this document.

Environmental

Operating temperature ....0 °C to 50 °C

Storage temperature ....–20 °C to 70 °C

Humidity ....10% to 90% RH, noncondensing

Maximum altitude..................................2,000 m

Pollution Degree 2
Indoor use only

Safety

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN-61010-1
- UL 61010-1, 61010-1

Note For UL and other safety certifications, refer to the product label or visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- EN 61326-1 (IEC 61326-1): Class A emissions; Basic immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions

Note In the United States (per FCC 47 CFR), Class A equipment is intended for use in commercial, light-industrial, and heavy-industrial locations. In Europe, Canada, Australia and New Zealand (per CISPR 11) Class A equipment is intended for use only in heavy-industrial locations.

Note Group 1 equipment (per CISPR 11) is any industrial, scientific, or medical equipment that does not intentionally generates radio frequency energy for the treatment of material or inspection/analysis purposes.

Note For EMC declarations and certifications, and additional information, refer to the *Online Product Certification* section.

CE Compliance CE

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 73/23/EEC; Low-Voltage Directive (safety)
- 89/336/EEC; Electromagnetic Compatibility Directive (EMC)

Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

Environmental Management

NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at `ni.com/environment`. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers At the end of the product life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers, National Instruments WEEE initiatives, and compliance with WEEE Directive 2002/96/EC on Waste and Electronic Equipment, visit `ni.com/environment/weee`.

电子信息产品污染控制管理办法 （中国 RoHS）

中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请登录 `ni.com/environment/rohs_china`。(For information about China RoHS compliance, go to `ni.com/environment/rohs_china`.)

B

Using SCXI Channel Strings with Traditional NI-DAQ (Legacy) 7.0 or Later

Note This appendix is not applicable if you use the virtual channels to configure and measure the SCXI channels. Virtual channels are configured using MAX. If you use virtual channels, you address the SCXI channels by specifying the channel name(s) in the channel string input.

When using LabVIEW and Visual Basic 6, the SCXI channel string determines which SCXI channels are scanned and the scanning sequence. The SCXI channel string allows you to take measurements from several channels on one module with only one channel string entry. An array of these channel string entries 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:

`obx ! scy ! mdz ! channels`

where

`obx` is the onboard E Series DAQ device channel, with *x* representing a particular channel where the multiplexed channels are sent. This value is 0 for E Series DAQ device channel 0 in a single-chassis system. In a multichassis or remote chassis system, the E Series DAQ device channel *x* corresponds to chassis number *n* – 1, where E Series DAQ device channel *x* is used for scanning the *n*th chassis in the system.

`scy` is the SCXI chassis ID, where *y* is the number you chose when configuring the chassis.

`mdz` 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.

`channels` is the list of channels that are scanned for module *z*. It can have several formats:

- `obx ! scy ! mdz ! nx`, where *nx* is a single input channel.
- `obx ! scy ! mdz ! (n0, n2)`, where *n0, n2* are individual input channel that are not necessarily sequential.
- `obx ! scy ! mdz ! n0:n3`, where *n0* and *n3* represent an ascending sequential list of input channels, inclusive.
- `obx ! scy ! mdz ! (n0, n2, n3:n4, n1, n5, n2)`, where *n0*, *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* are explicitly repeated in the channel list.

Note Using parenthesis surrounding multiple channels in a channel string is important for correct scanning operation of the SCXI channels.

In a single-chassis system, the `obx !` specifier is optional and causes the gains on the module and E Series DAQ device to be automatically set to fit the input limits parameter. When this specifier is omitted, the default gain on the E Series DAQ device, usually the lowest gain, is used, but the SCXI-1540 gain is adjusted to fit the input limits. NI recommends using the `obx !` specifier.

Repeating channels or having channels out of sequence in a scan list is not supported on all SCXI modules. Refer to the manual of each module for information on this feature, which is referred to as flexible scanning or random scanning.

For more information about using SCXI channel string, refer to the *LabVIEW Measurements Manual* and SCXI-1540 shipping examples.

Special SCXI-1540 Channel Strings

You can use the calibration ground channel string with the SCXI-1540 to acquire signals from alternative locations rather than the signal inputs on the channels. This section describes the use of these channels.

Calibration Ground Channel String

The SCXI-1540 has a special calibration feature that enables LabVIEW to ground the module amplifier inputs so that you can read the amplifier offset. For the other SCXI analog input modules, you must physically wire the terminals to ground. The measured amplifier offset is for the entire signal path including the SCXI module and the E Series DAQ device.

To read the grounded amplifier on the SCXI-1540 use the standard SCXI string syntax in the channels array with `calgnd`*`z`* substituted for the channel number, where *`z`* is the appropriate SCXI channel needing grounding.

For example, use the SCXI channel string `ob0 ! sc1 ! md1 ! calgnd0` to read the grounded channel 0 signal of the module in slot 1 of SCXI chassis 1. The resulting measurement should be very close to 0 V. The AI Start VI grounds the amplifier before starting the acquisition. The AI Clear VI removes the grounds from the amplifier after the acquisition completes.

You can specify a range of channels also. The string `calgnd0:7` grounds the amplifier inputs for channels 0 through 7 and reads the offset for each amplifier.

Use the SCXI Calibrate VI, available on the **Functions»Data Acquisition» Calibration and Configuration** palette, to automatically perform a self calibration and modify the scaling constants on the module to adjust for any amplifier offset. Refer to the *Calibration Using LabVIEW or a C-Based ADE* section of Chapter 5, *Using the SCXI-1540*, for more information about how to use SCXI Calibrate VI with the SCXI-1540.

C

Removing the SCXI-1540

This appendix explains how to remove the SCXI-1540 from MAX and an SCXI chassis or PXI/SCXI combination chassis.

Removing the SCXI-1540 from MAX

To remove a module from MAX, complete the following steps after launching MAX:

1. Expand **Devices and Interfaces**.
2. Click the **+** next to **NI-DAQmx** and/or **Traditional NI-DAQ Devices** to expand the list of installed chassis.
3. Click the **+** next to the appropriate chassis to expand the list of installed modules.
4. Right-click the module or chassis you want to delete and click **Delete**.
5. A confirmation window opens. 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.

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

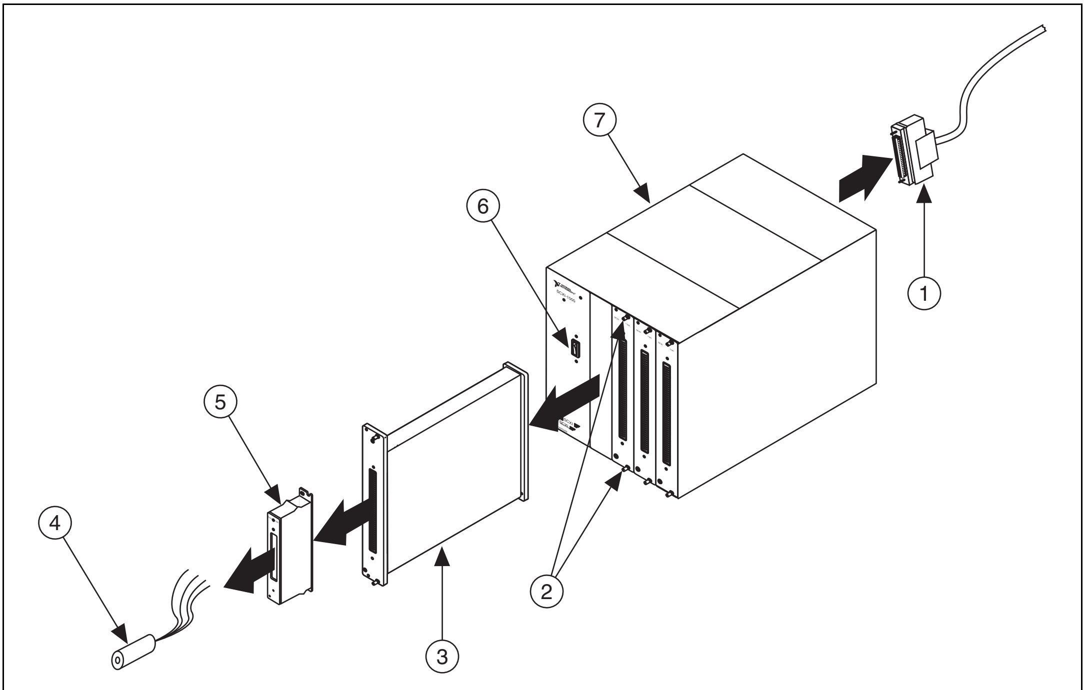
Removing the SCXI-1540 from a Chassis

Consult the documentation for the chassis and accessories for additional instructions and precautions. To remove the SCXI-1540 module from a chassis, complete the following steps while referring to Figure C-1:

Note Figure C-1 shows an SCXI chassis, but the same steps are applicable to a PXI/SCXI combination chassis.

1. Power off the chassis. Do *not* remove the SCXI-1540 module from a chassis that is powered on.
2. If the SCXI-1540 is the module cabled to the E/M Series DAQ device, disconnect the cable.
3. Remove any terminal block that connects to the SCXI-1540.
4. Rotate the thumbscrews that secure the SCXI-1540 to the chassis counterclockwise until they are loose, but do not completely remove the thumbscrews.

Remove the SCXI-1540 by pulling steadily on both thumbscrews until the module slides completely out.



1	Cable	4	LVDT Sensor	6	SCXI Chassis Power Switch
2	SCXI Module Thumbscrews	5	Terminal Block	7	SCXI Chassis
3	SCXI-1540				

Figure C-1. Removing the SCXI-1540

D

Common Questions

This appendix lists common questions related to the use of the SCXI-1540.

Which version of NI-DAQ works with the SCXI-1540 and how do I get the most current version of NI-DAQ?

You must have NI-DAQ 7.0 or later. NI recommends using the latest version of NI-DAQmx. Visit `ni.com` and follow the link, **Drivers and Updates»Current Software Versions»Multifunction DAQ** to find the latest version of NI-DAQ for your operating system.

I have gone over the *Verifying and Self-Testing the Installation* in Chapter 1, *About the SCXI-1540*, yet I still cannot correctly test and verify that my SCXI-1540 is working. What should I do now?

Unfortunately, there always exists 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.

Can I use the unused analog input channels of the E/M Series DAQ device if I am directly cabled to the SCXI-1540?

No. E/M Series DAQ device channels 1 through 7 connect to the conditioned analog outputs of SCXI-1540 channels 1 through 7.

Which digital lines are unavailable on the E/M Series DAQ device if I am cabled to an SCXI-1540 module?

Table D-1 shows the digital lines that are used by the SCXI-1540 for communication and scanning. These lines are unavailable for general-purpose digital I/O if the SCXI-1540 is connected to the E/M Series DAQ device.

Table D-1. Digital Signals on the SCXI-1540

DAQ Signal Name	SCXI Signal Name	50-Pin Connector	68-Pin Connector	Direction (with respect to the E/M Series DAQ device)
P0.0	SERDATIN	25	52	Output
P0.4	SERDATOUT	26	19	Input
P0.1	DAQD*/A	27	17	Output
P0.2	SLOT0SEL*	29	49	Output
AI HOLD COMP, AI HOLD	SCANCLK	36	46	Output
EXT SROBE*	SERCLK	37	45	Output
AI SAMP CLK, AI SAMP	SYNC*	46	38	Output

In LabVIEW, can I use different input limits for the same SCXI-1540 channel if I repeat the channel in the SCXI channel string array?

No. The SCXI-1540 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 NI-DAQmx, can I use a VI to change my SCXI-1540 configuration settings?

Yes. You can use the DAQmx Property Node to change all the SCXI-1540 configuration settings.

Are there any cabling restrictions when using an SCXI-1540 module with a plug-in E/M Series DAQ device?

Refer to the *SCXI Quick Start Guide* to determine which module to use as the cabled module. A cabled module is the module connected directly to the E/M Series DAQ device. This ensures that a timing signal (from GPCTR0 on the E/M Series DAQ device) is available for use by all simultaneous-sampling SCXI modules in the chassis.

Can I use the SCXI-1540 with a version of NI-DAQ that works under the Macintosh Operating System (MacOS)?

No.

Some SCXI modules permit *random scanning*. Does the SCXI-1540 module permit random scanning?

Yes. Random scanning is described in Chapter 2, *Connecting Signals*.

What is the power-up state of the SCXI-1540 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.

Which accessories can I use to connect signals to the front of the SCXI-1540 module?

Refer to Chapter 1, *About the SCXI-1540*, for more information.

How do I calculate the maximum permitted scan rate when using one or more SCXI-1540 modules in multiplexed mode?

For the SCXI-1540 and most other SCXI modules, the maximum scan rate is limited to a 333 kS/s/(number of scanned channels) if the controlling E/M Series DAQ device is not the limiting factor.

How do I control the gain, frequency, excitation level, wire mode, and synchronization in LabVIEW?

You can create and save a DAQmx task in Max or programmatically in LabVIEW using DAQmx API VIs.

The gain of each SCXI-1540 channel is automatically set based on the channel limits used in setting up the task.

Frequency, excitation level, wire mode, and synchronization mode are also properties of the task that you can set or edit using DAQmx Property Nodes.

How do I control the gain, frequency, excitation level, wire mode, and synchronization in C-based application environments?

You must use the NI-DAQ functions listed in Table 5-5, *NI-DAQ Functions Used to Configure SCXI-1540*.

Glossary

Symbol	Prefix	Value
p	pico	10^{-12}
n	nano	10^{-9}
μ	micro	10^{-6}
m	milli	10^{-3}
k	kilo	10^{3}

Numbers/Symbols

%	percent
/	per
°	degrees
Ω	ohms
+5 V (signal)	+5 VDC source signal

A

A	amperes
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
ADE	application development environment such as LabVIEW, LabWindows/CVI, Visual Basic 6, C, and C++
AI HOLD COMP, AI HOLD	scan clock signal used to increment to the next channel after each E/M Series DAQ device analog-to-digital conversion

C

C	Celsius
CE	European emissions control standard
CH *x* –	negative input terminal for channel *x*
CH *x* +	positive input terminal for channel *x*
crosstalk	an unwanted signal on one channel due to an input signal on a different channel

D

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 and E/M Series MIO data acquisition devices.
DC	direct current
DIGGND	digital ground signal
DIN	Deutsche Industrie Norme (German Industrial Standard)
DIO	digital input/output
DMM	digital multimeter

E

EEPROM	electrically erasable programmable read-only memory—ROM that can be erased with an electrical signal and reprogrammed. Some SCXI modules contain an EEPROM to store measurement-correction coefficients.
EMC	electromagnetic compliance

EMI	electromagnetic interference
EX–	a negative excitation output terminal
EX+	a positive excitation output terminal

G

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

H

Hz	hertz—cycles per second of a periodic signal; the unit of measure for frequency

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
in.	inch or inches
input impedance	the measured resistance and capacitance between the input terminals of a circuit

L

LPF	lowpass filter
LVDT	linear variable differential transformer—a transformer-based sensor for measuring linear displacement

M

m	meters
mil	a unit of measure equal to 0.001 inch
MIO	multifunction I/O
multiplexed mode	an SCXI operating mode in which analog input channels are multiplexed into one module output so that your cabled E/M Series DAQ device has access to the module's multiplexed output as well as the outputs of all other multiplexed modules in the chassis that are coupled to the SCXIbus

N

NI-DAQ	National Instruments driver software for DAQ hardware
NI-DAQmx	The latest NI-DAQ driver with new VIs, functions, and development tools for controlling measurement devices.
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; 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 (NRSE) measurement system reference, but the voltage at this reference can vary with respect to the measurement system ground

O

offset error	the output of a system with a zero-volt input

P

ppm — parts per million

PXI — PCI eXtensions for Instrumentation—an open specification that builds on the CompactPCI specification by adding instrumentation-specific features

Q

quadrature encoder — A device that converts linear or rotary movement into electrical pulses on two channels. The pulse stream of one channel either leads or lags the pulse stream of the other channel depending on the direction of movement.

R

resolver — A transformer-based sensor for measuring absolute angular displacement over 360°. Measurement is continuous for any number of revolutions. The simultaneous conditioning of a sine and a cosine signal is required.

rms — root mean square—the square root of the average value of the square of the instantaneous signal amplitude; a measure of signal amplitude

RSC — rear signal connector

RSVD — reserved bit, pin, or signal

RVDT — rotary variable differential transformer—a transformer-based sensor for measuring absolute angular displacement whose measurement range is typically between ±30° and ±70° of rotation

S

s — seconds

S/s — samples per second—used to express the rate at which a E/M Series DAQ device samples an analog signal

scan — one or more analog samples taken at the same time, or nearly the same time. Typically, the number of input samples in a scan is equal to the number of channels in the input group. For example, one scan, acquires one new sample from every analog input channel in the group.

scan rate	the number of scans a system takes during a given time period, usually expressed in scans per second. For example, a scan rate of 10 Hz means sampling each channel 10 times per second.
SCANCLK	scan clock signal used to increment to the next channel after each E/M Series DAQ device analog-to-digital conversion
SCXI	Signal Conditioning eXtensions for Instrumentation—the National Instruments product line for conditioning low-level signals within an external chassis near sensors so only high-level signals are sent to E/M Series DAQ devices in the noisy PC environment
SCXIbus	located in the rear of an SCXI chassis, the SCXIbus is the backplane that connects modules in the same chassis to each other
sensitivity	for an LVDT or RVDT, the ratio of output voltage change to input position change for a primary excitation level of one volt rms
SERDATOUT	serial data output signal
signal conditioning	the manipulation of signals to prepare them for digitizing
SYNC	synchronization pulse for scanning
system noise	a measure of the amount of noise seen by an analog circuit or an ADC when the analog inputs are grounded

T

Traditional NI-DAQ (Legacy)	An upgrade to the earlier version of NI-DAQ. Traditional NI-DAQ (Legacy) has the same VIs and functions and works the same way as NI-DAQ 6.9.x. You can use both Traditional NI-DAQ (Legacy) and NI-DAQmx on the same computer, which is not possible with NI-DAQ 6.9.x.

U

UL	Underwriters Laboratory

V

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

W

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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