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SCXI™

SCXI-1600 User Manual

USB 16-Bit Digitizer Module

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Conventions

The following conventions are used in this manual:

<> Angle brackets contain values associated with a bit or signal name.

» The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.

 This icon denotes a note, which alerts you to important information.

 This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash. When this icon is marked on the product, refer to the *Read Me First: Safety and Radio-Frequency Interference* document, shipped with the product, for precautions to take.

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

 When 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, hardware labels, or an introduction to a key concept. This font also denotes text that is a placeholder for a word or value that you must supply.

`monospace` Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.

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1

About the SCXI-1600

This chapter introduces the SCXI-1600 USB digitizer module. The SCXI-1600 module is a high-performance plug-and-play USB device used for direct connection between USB-compatible computers and SCXI systems.

The SCXI-1600 module is a USB data acquisition (DAQ) device that features a 16-bit ADC. The SCXI-1600 receives analog signals from other SCXI modules and amplifies, digitizes, and sends data through a USB port. The SCXI-1600 can also control digital input, digital output, and analog output SCXI modules. The SCXI-1600 has no DIP switches, jumpers, or potentiometers. It is easily configured and calibrated using software.

The SCXI-1600 connects to other SCXI modules to acquire up to 352 analog signals from thermocouples, RTDs, strain gauges, voltage sources, and current sources. It is USB compatible, which supports hot or powered insertion into the USB port. You need not power down the computer to connect to an SCXI system.

Caution SCXI modules are *not* hot swappable. Refer to the *Installing the SCXI-1600* section for proper installation instructions.

The SCXI-1600 module is based on E Series DAQ devices and uses the National Instruments DAQ-STC system timing controller for time-related functions. The DAQ-STC makes possible such applications as equivalent time sampling, and seamlessly changing the sampling rate. The DAQ-STC consists of three timing groups that control analog input.

Detailed specifications of the SCXI-1600 module are in Appendix A, *Specifications*.

What You Need to Get Started

To set up and use the SCXI-1600 module, you need the following:

- ❑ Hardware
  - SCXI-1600 module (supplied with a USB cable)
  - Analog-input, analog-output, or digital I/O SCXI module
  - SCXI chassis
  - Personal computer or a PXI controller with a USB port
  - Cabling, cable adapter, and sensors as required for your application

Note The SCXI-1600 is not compatible with the PXI/SCXI combination chassis.

- ❑ Software
  - NI-DAQ 7.3 or later
  - One of the following:
    - LabVIEW
    - LabWindows™/CVI™
- ❑ Documentation
  - *SCXI-1600 User Manual*
  - *DAQ Quick Start Guide*
  - *SCXI Quick Start Guide*
  - *Read Me First: Safety and Radio-Frequency Interference*
  - Documentation for your software

National Instruments Documentation

The *SCXI-1600 User Manual* is one piece of the documentation set for DAQ systems. You could have any of several types of documents, depending on the hardware and software in the system. Use the documents you have as follows:

- The *DAQ Quick Start Guide*—This document describes how to install NI-DAQ devices and NI-DAQ. You must install NI-DAQ before you install the SCXI module.
- The *SCXI Quick Start Guide*—This document describes how to set up an SCXI chassis, install SCXI modules and terminal blocks, and configure the SCXI system in Measurement & Automation Explorer (MAX).
- *Getting Started with SCXI*—Read this manual first. It gives an overview of the SCXI system and contains the most commonly needed information for the modules, chassis, and software.
- SCXI chassis manual—This manual contains installation instructions and maintenance information about the chassis.
- 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—If you are using accessory products, 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.
- Software documentation—You may have both application software and NI-DAQ software documentation. 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. Refer to **Start»Programs»National Instruments»NI-DAQ»NI-DAQmx Help** for software information.

You can download NI documents from `ni.com/manuals`.

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

Refer to the *DAQ Quick Start Guide*, packaged with the NI-DAQ software, to install your application software and NI-DAQmx driver software.

NI-DAQmx 7.3 or later is required to configure and program the SCXI-1600 module. If you do not have NI-DAQmx 7.3 or later, you can either contact an NI sales representative to request it on a CD or download the latest NI-DAQmx version from `ni.com/downloads`.

Installing the SCXI-1600

Note Refer to the *Read Me First: Radio-Frequency Interference* document before removing equipment covers or connecting or disconnecting any signal wires.

Refer to the *SCXI Quick Start Guide* to unpack, install, and configure the SCXI-1600 in an SCXI chassis. After installing the SCXI-1600, power on the SCXI chassis. The computer should detect the SCXI chassis and all its modules. If the SCXI-1600 does not initialize properly, you *must* restart the SCXI chassis with the power on switch.

LED Pattern Descriptions

There are four LEDs on the front of the SCXI-1600 that confirm the signal conditioning system is functioning properly as follows:

- The top two green LEDs, which monitor the V+ and V– rails of the SCXI chassis backplane, must be bright green for the signal conditioning system to function properly. If either or both the *V+* or *V–* green LEDs is off, check the SCXI chassis backplane fuses and replace any bad fuses as described in the *SCXI Chassis User Manual*.
- The bottom two LEDs, the yellow *ACTIVE* LED and green *READY* LED, indicate the state of the SCXI-1600 USB. If the *READY* LED is bright green, the SCXI-1600 is powered, connected to the host, and is configured properly. Refer to Table 1-1 for LED pattern descriptions.

Table 1-1. LED Patterns for SCXI-1600 USB States

ACTIVE Yellow LED	READY Green LED	Description
Off	Off	The SCXI-1600 is not powered.
Off	On	The SCXI-1600 is configured, but there is no activity over the bus.
On	On	The SCXI-1600 is configured and there is activity over the bus.
Blinking	On	
Off	Blinking	The SCXI-1600 is being configured, but there is no activity over the bus.
On	Blinking	The SCXI-1600 is being configured and there is activity over the bus.
Blinking	Blinking	
Blinking continuously		This indicates a recoverable error state in the SCXI-1600. You can power off the module, or detach and reattach the USB cable to reset the module.
Blinking alternately		This indicates an unrecoverable error in the SCXI-1600. Refer to the *Signal Conditioning Technical Support Information* document to contact NI for support.

2

Connecting Signals

This chapter describes how to make input and output signal connections to the SCXI-1600 module using the device I/O connectors. The following connector types are located on the front panel:

- Three BNC connectors—These connectors are used to access PFI 0/AI START TRIG and PFI 7/AI SAMP CLK, and to perform external calibration. For calibration information refer to Chapter 4, *Using the SCXI-1600*.
- USB connector—This connector is used to communicate and transfer data between the computer and SCXI-1600 module. Figure 2-1 illustrates the connection requirements.

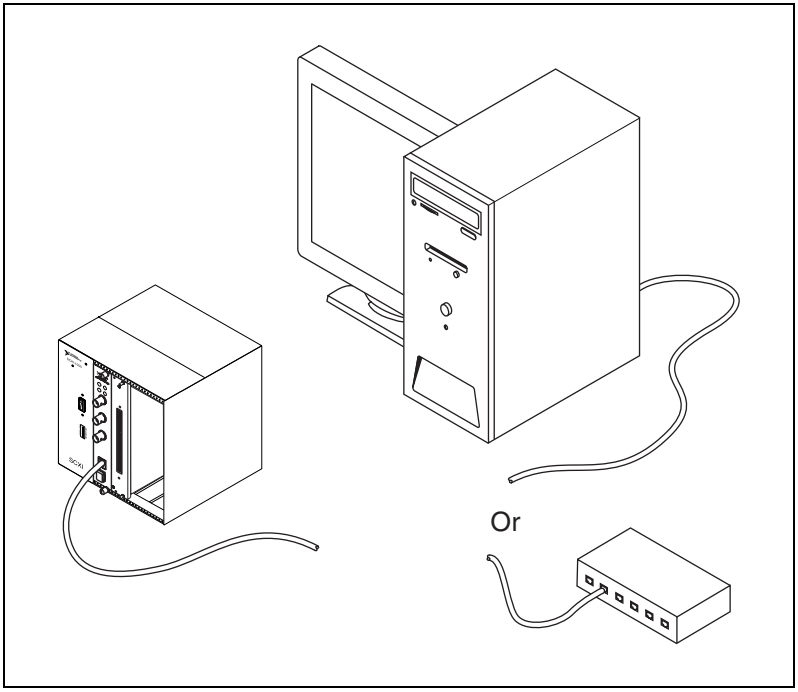
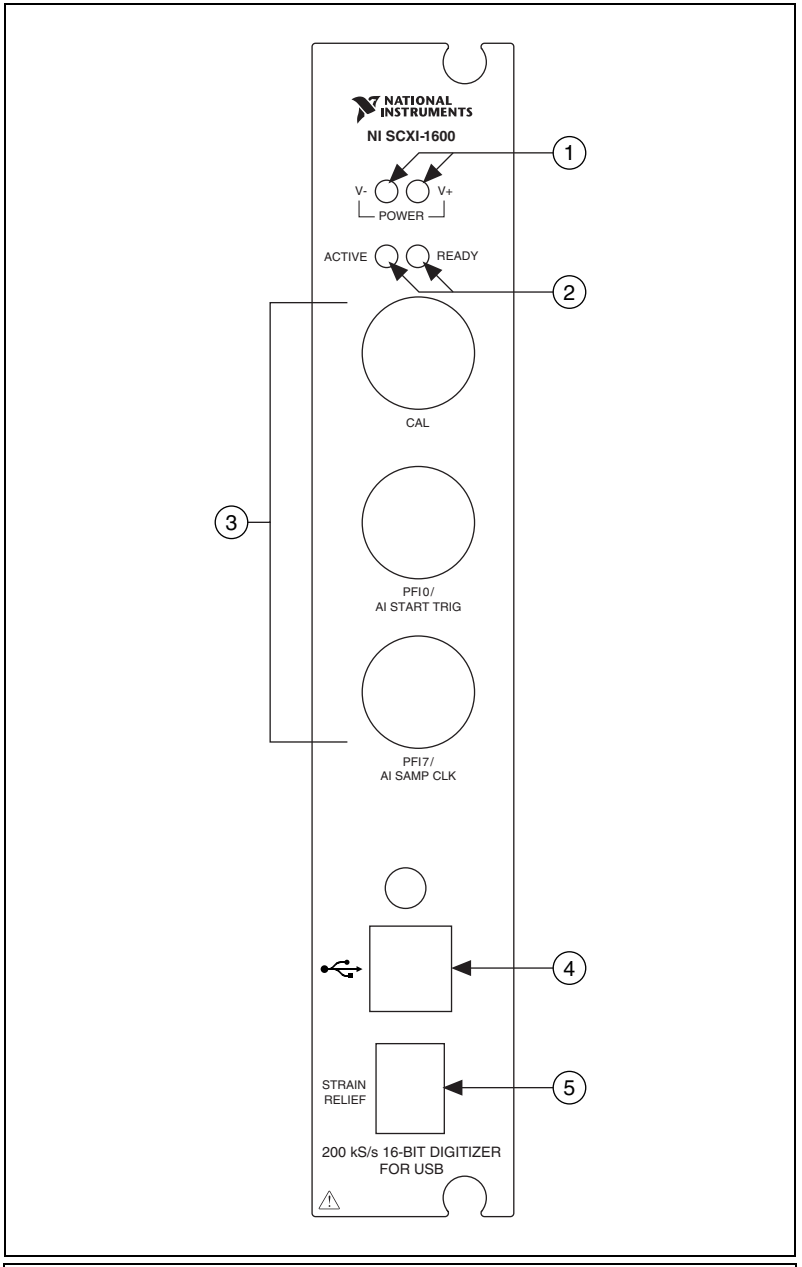


Figure 2-1. Cable between the SCXI-1600 and the Computer USB Port or USB Hub

Figure 2-2 shows the SCXI-1600 connectors.



1 Power Monitor LEDs
2 USB ACTIVE and READY LEDs
3 BNC Connectors
4 USB Connector
5 Strain Relief

Figure 2-2. SCXI-1600 Module Front Panel Connectors

Connecting Signals

This section describes the SCXI-1600 I/O signals.

I/O Connector Signal Descriptions

Table 2-1. I/O Connector Signal Descriptions

Signal Name	Reference	Direction	Description
PFI 0/AI START TRIG	D GND	Input	PFI 0/Trigger 1—As an input, this is either one of the PFIs or the source for the hardware digital trigger. PFI signals are explained in Appendix B, *Timing Signal Information*.
		Output	As an output, this is the AI START TRIG signal. In posttrigger data acquisition sequences, a low-to-high transition indicates the initiation of the acquisition sequence. In pretrigger applications, a low-to-high transition indicates the initiation of the pretrigger conversions.
PFI 7/SAMP CLK	D GND	Input	PFI 7/Start of scan—As an input, this is one of the PFIs.
		Output	As an output, this is the SAMP CLK signal. This pin pulses once at the start of each analog input scan in the interval scan. A low-to-high transition indicates the start of the scan.
EXT CAL	AI GND	Input	External calibration—This input is used for external calibration of the SCXI-1600. The DC source must be more accurate than 10 ppm.

Table 2-2 shows the I/O signal summary for the SCXI-1600 module.

Caution Exceeding the maximum input voltage ratings, which are listed in Table 2-2, can damage the SCXI-1600 module and the computer. NI is *not* liable for any damages resulting from such signal connections.

Table 2-2. I/O Signal Summary

Signal Name	Drive	Protection (Volts) On/Off	Source (mA at V)	Sink (mA at V)	Rise Time (ns)	Bias
PFI 0/ AI START TRIG	DIO	24 V	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 7/ AI SAMP CLK	DIO	24 V	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
EXT CAL	AI	24 V	—	—	—	—

AI = analog input
DIO = digital input/output
pu = pullup

Note: The tolerance on the 50 kΩ pullup and pulldown resistors is very large. Actual values can range between 17 kΩ and 100 kΩ.

The SCXI-1600 controls the SCXI system and digitizes analog signals from the other modules in the system and has no configurable settings. For information about configuring other modules in the system, refer to the module user manuals and the *SCXI Quick Start Guide*.

Notes The SCXI-1600 operates in multiplexed mode only.

The SCXI-1600 has no Test Panels in MAX and is grayed out. You can perform Test Chassis to verify the presence of the SCXI-1600.

Field Wiring Considerations

Environmental noise can seriously affect the accuracy of measurements made with the SCXI system if you do not take proper precautions when running signal wires between signal sources and the module. The following recommendations apply mainly to analog input signal routing, but they also apply to signal routing in general.

Take the following precautions to minimize noise pickup and maximize measurement accuracy:

- For the external calibration signals, make connections using individually shielded, twisted-pair wires. With this type of wire, the signals attached to the CH+ and CH– inputs are twisted together and then covered with a shield. You then connect this shield only at one point to the signal source ground. This kind of connection is required for signals traveling through areas with large magnetic fields or high electromagnetic interference.
- Route signals to the device carefully. Keep cabling away from noise sources. The most common noise source in a computer DAQ system is the video monitor. Separate the monitor from the analog signals as much as possible.

The following recommendations apply to all signal connections to the SCXI-1600 module:

- Separate SCXI-1600 module signal lines from high-current or high-voltage lines. These lines are capable of inducing currents in or voltages on the SCXI-1600 module signal lines if they run in parallel paths at a close distance. To reduce the magnetic coupling between lines that run in parallel, separate them as much as possible or run the lines perpendicular to each other.
- Do not run signal lines through conduits that also contain power lines.
- Protect signal lines from magnetic fields caused by electric motors, welding equipment, breakers, or transformers by running them through special metal conduits.

For more information, refer to the *Field Wiring and Noise Consideration for Analog Signals* application note, available at `ni.com`.

3

Theory of Operation

This chapter discusses the theory of operational measurement concepts.

Figure 3-1 shows the block diagram for the SCXI-1600 module.

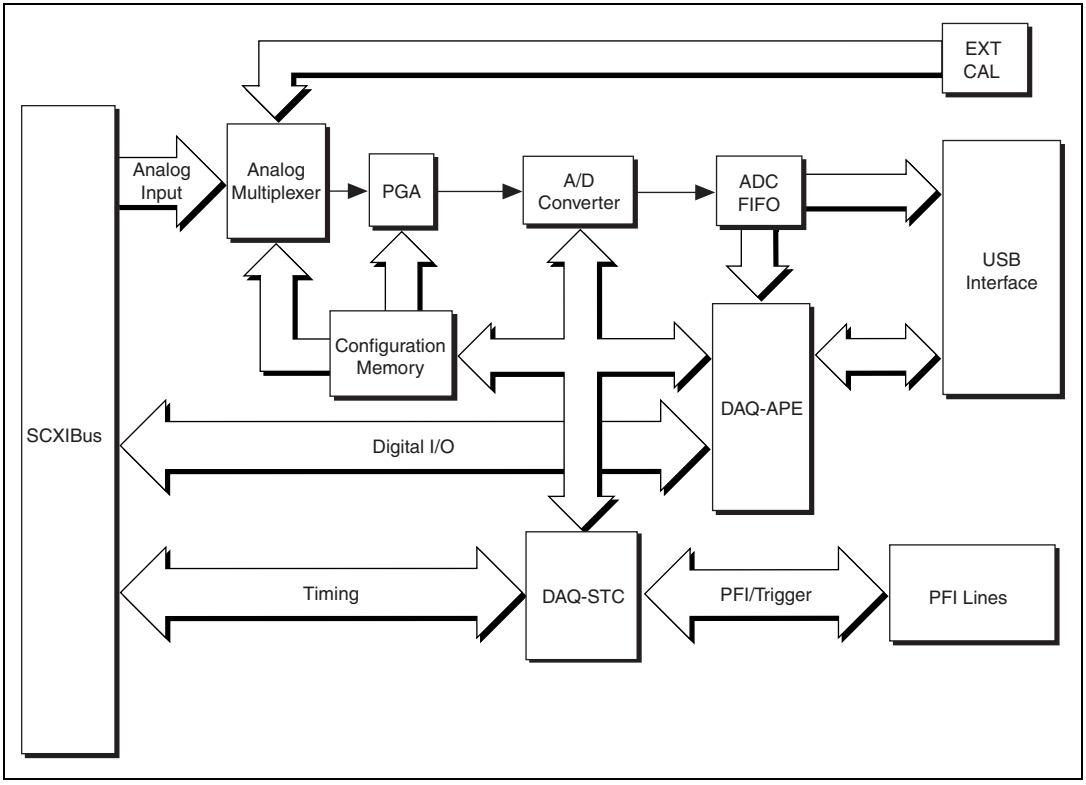


Figure 3-1. SCXI-1600 Module Block Diagram

Analog Input

When setting up an SCXI system using the SCXI-1600 module, follow the analog input setup instructions of the input SCXI modules. The input mode on the SCXI-1600 does not affect the input used on the analog input

modules. The detailed analog input descriptions of the digitizer provide information regarding the functionality of the SCXI-1600.

The analog input portion of the board acquires analog signals from the SCXI chassis backplane and prepares the signal for digital conversion. The type of input, the input range, and the software configurable gain of the SCXI-1600 are described in detail in the following sections.

Input Mode

The SCXI-1600 module input mode is differential (DIFF). A channel configured in DIFF mode connects the positive analog input line to the positive input of the PGIA and the negative analog input line to the negative input of the PGIA. Specifically, all the analog input channels coming from the input SCXI modules are multiplexed to analog channel 0 on the SCXI backplane. The signals are then accepted into the SCXI-1600.

Input Polarity, Input Range, and Gain

The SCXI-1600 module has a software-programmable gain to obtain the highest level of precision. It matches the input signal range to a range the ADC can accommodate using the gains available. Specifically, the SCXI-1600 has a bipolar input range of 10 V (±5 V) and gains of 0.5, 1, 10, and 100. With the proper gain, which is set by the driver software, the full resolution of the ADC is used to measure the input signal. The gain on the signals are set using the gain on the SCXI analog input module multiplied with the gain on the SCXI-1600. Table 3-1 shows the overall input range and precision of the SCXI-1600 according to the input range configuration and gain used.

Table 3-1. Actual Range and Measurement Precision

Range Configuration	Gain	Actual Input Range	Precision[1]
–5 to +5 V	0.5	–10 to +10 V	305.2 µV
	1.0	–5 to +5 V	152.6 µV
	10.0	–500 to +500 mV	15.26 µV
	100.00	–50 to +50 mV	1.53 µV

[1] The value of 1 LSB of the 16-bit ADC; that is, the voltage increment corresponding to a change of one count in the ADC 16-bit count.

Note: Refer to Appendix A, *Specifications*, for absolute maximum ratings.

Considerations for Selecting Input Ranges of an SCXI System

The range that you select depends on the expected range of the incoming signal. A large input range can accommodate a large signal variation, but reduces the voltage resolution. Choosing a smaller input range improves the voltage resolution, but can result in the input signal going out of range. For best results, match the input range as closely as possible to the expected range of the input signal. For example, if you are certain the input signal is between ±50 mV, specify this range. If the signal is less than –50 mV or greater than 50 mV, inaccurate readings occur.

Calculating the Maximum Scan Rate

The SCXI-1600 module can scan multiple channels at a high rate. To calculate the maximum permitted scan rate when using one or more SCXI modules in multiplexed mode, use the following:

$$\textit{maximum permitted scan rate} = \frac{1}{(5\ \mu s \times \textit{number of channels scanned})}$$

In this equation, the term (*number of channels scanned*) is the number of all the channels scanned in a chassis.

Scanning Considerations

The settling time for the SCXI-1600 module is independent of the selected gain. With the SCXI-1600, the gain is constant and the source impedance is low. Refer to Appendix A, *Specifications*, for a complete listing of settling times for the SCXI-1600 module.

The low source impedance of the SCXI-1600 module keeps the settling time low. Settling times can increase when scanning high-impedance signals due to a phenomenon called *charge injection*, where the analog input multiplexer injects a small amount of charge into each signal source when that source is selected. If the source impedance is not low enough, the effect of the charge—a voltage error—does not decay by the time the ADC samples the signal.

Timing Signal Routing

The DAQ-STC provides a very flexible interface for connecting timing signals to other devices or external circuitry. The SCXI-1600 module uses two programmable function input (PFI) pins on the I/O connector for connecting to external circuitry. These connections enable the SCXI-1600 to control and be controlled by other devices and circuits.

You can control a total of 13 timing signals internal to the DAQ-STC by an external source. You also can control these timing signals by signals generated internally to the DAQ-STC. These selections are fully software configurable. The signal routing multiplexer for controlling the AI CONV CLK signal on the SCXI-1600 is shown in Figure 3-2.

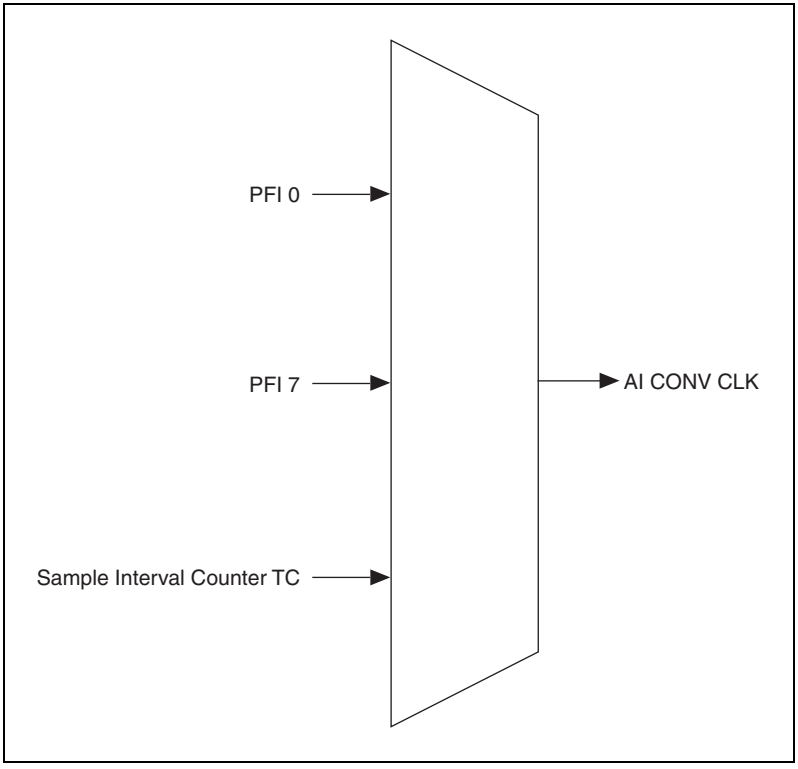


Figure 3-2. AI CONV CLK Signal Routing

Figure 3-2 shows that the AI CONV CLK signal is generated from sources including the external signals PFI <0, 7> and the internal signal sample interval counter TC.

Programmable Function Inputs

The two PFIs connect to the signal routing multiplexer for each timing signal, and software can select one of the PFIs as the external source for a given timing signal. You can use the two PFIs as an input by any of the timing signals, and multiple timing signals can use the same PFI simultaneously. This flexible routing scheme reduces the need to change physical connections to the I/O connector for different applications.

You also can enable each of the PFI pins individually to output a specific internal timing signal. For example, if you need the AI SAMP CLK signal as an output on the I/O connector, software can power on the output driver for the PFI 7/AI SAMP CLK pin.

Multiplexed Operation

The SCXI-1600 operates in multiplexed mode, digitizing the conditioned signals from other SCXI modules and communicating with the host through the USB port.

In multiplexed mode, all input channels of an SCXI module are multiplexed into a single analog input channel of the DAQ device. Multiplexed mode operation is ideal for high channel count systems. The power of SCXI multiplexed mode scanning is its ability to route many input channels to a single channel of the SCXI-1600.

The multiplexing operation of the analog input signals is performed entirely by multiplexers in the SCXI modules, not inside the SCXI-1600 or SCXI chassis. In multiplexed mode, the SCXI module channels you are scanning 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 to the SCXI-1600.

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 352 channels per SCXI-1600. This is referred to as *flexible scanning* (random scanning). Not all SCXI modules provide flexible scanning.

The analog input modules include 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.

4

Using the SCXI-1600

This chapter describes how to develop your application and provides basic information about calibration.

Developing Your Application in NI-DAQmx

This section describes how to configure and use NI-DAQmx to control the SCXI-1600 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. Refer to the *SCXI Quick Start Guide* for general SCXI configuration information.

Note If you are not using an NI ADE, using an NI ADE prior to version 7.0, or 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.

Typical Program Flowchart

Figure 4-1 shows a typical program flowchart for creating a task to configure the SCXI-1600 channels, take a measurement, analyze the data, present the data, stop the measurement, and clear the task.

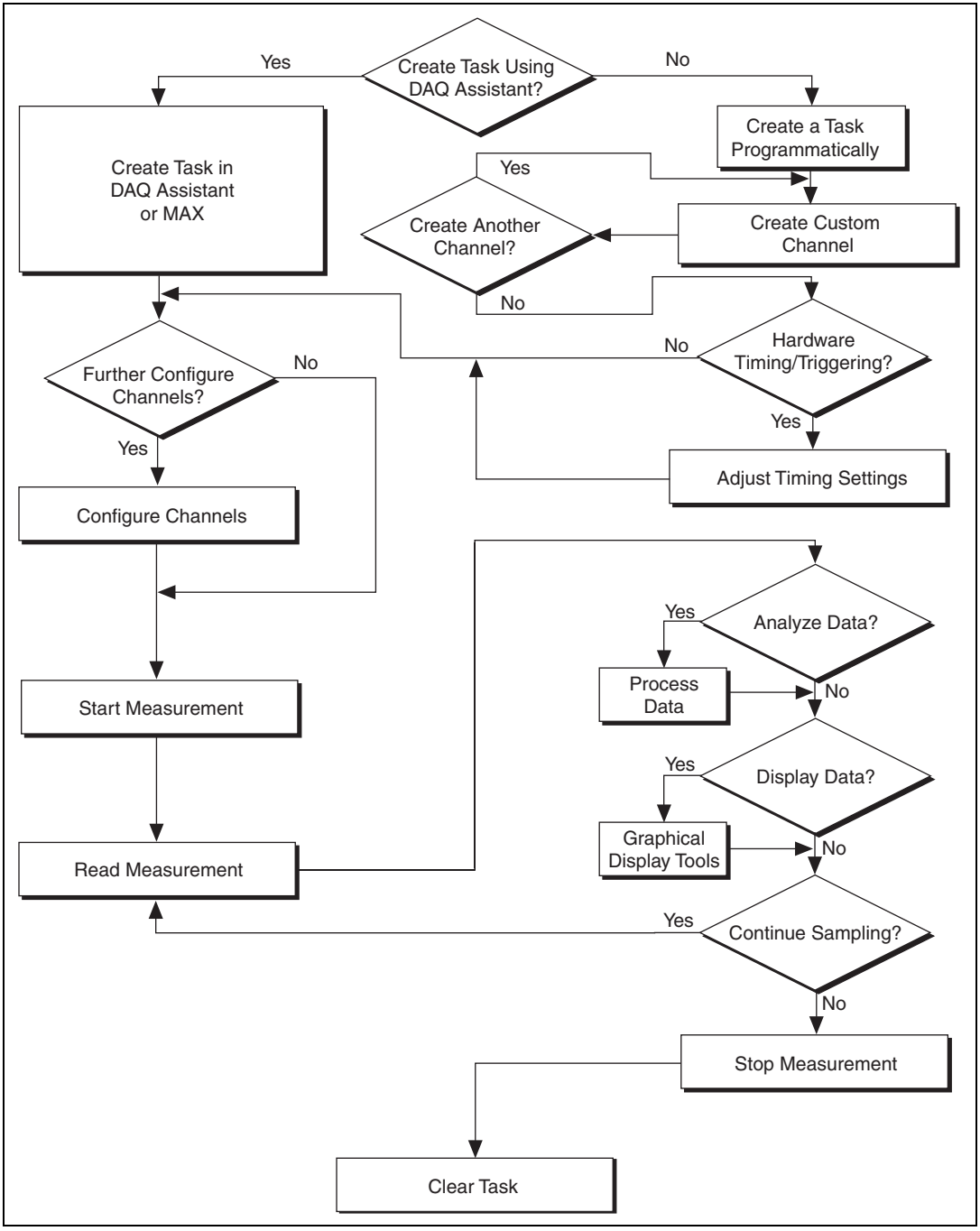


Figure 4-1. Typical Program Flowchart

General Discussion of Typical Flow-Chart

The following sections briefly discuss some considerations for a few of the steps in Figure 4-1. 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 the DAQ Assistant or Programmatically

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

Developing your application using the DAQ Assistant allows you to configure most settings such as measurement type, selection of channels, 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.

Each API includes a collection of programming examples to help you start developing an application. You can modify example code and save it in an application. You can use examples to develop a new application or add example code to an existing application.

To locate LabVIEW and LabWindows/CVI examples, open the National Instruments Example Finder:

- In LabVIEW, select **Help»Find Examples**.
- In LabWindows/CVI, select **Help»NI Example Finder**.

Measurement Studio, Visual Basic, and ANSI C examples are in the following directories:

- NI-DAQmx examples for Measurement Studio supported languages are in the following directories:
  - `MeasurementStudio\VCNET\Examples\NIDaq`
  - `MeasurementStudio\DotNET\Examples\NIDaq`
- NI-DAQmx examples for ANSI C are in the `NI-DAQ\Examples\DAQmx ANSI C Dev` directory.

For additional examples, refer to `ni.com/zone`.

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-1600 access an underlying set of NI-DAQmx properties. For a complete list of NI-DAQmx properties, refer to your ADE help file. For LabVIEW specifically, refer to **Help»VI, Function & How-To Help** and search for your specific module to find the DAQmx channel properties available for you module. To learn how to use the channel properties, refer to the *Using a DAQmx Channel Property Node in LabVIEW* section.

Note You cannot adjust some properties while a task is running. For these properties, you must stop the task, make the adjustment, and restart the application.

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.

Developing an Application Using LabVIEW

This section describes in more detail the steps shown in the typical program flowchart in Figure 4-1, such as how to create a task in LabVIEW. If you need more information or instructions, select **Help»VI, Function, & How-To Help** from the LabVIEW menu bar.

Note Except where otherwise stated, the VIs in Table 4-1 are located on the **Functions»All Functions»NI Measurements»DAQmx - Data Acquisition** subpalette and accompanying subpalettes in LabVIEW.

Table 4-1. Programming a Task in LabVIEW

Flowchart Step	VI or Program Step
Create a Task in the DAQ Assistant	Create a Task located on the **Functions»Input** subpalette **DAQ Assistant**.
Create a Task Programmatically (optional)	The DAQmx Create Task 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 are not saved to a task in MAX.
Adjust Timing Settings (optional)	The DAQmx Timing VI (Sample Clock by default) 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 task in the DAQ Assistant. They are only available for the present session.
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 in your task 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.
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.
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»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. Right-click the **sample mode** terminal of the DAQmx Timing VI and click **Create»Constant**. Click the box that appears and select **Continuous Samples**.

Table 4-1. Programming a Task in LabVIEW (Continued)

Flowchart Step	VI or Program Step
Stop Measurement (optional)	The DAQmx Stop Task VI clears the task and 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. Left-click inside the **Property** box and select **Active Channels** to specify the 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 **ActiveChan** and select **Add Element**. Left-click the new **ActiveChan** box. Navigate through the menus and select the property to define.
7. Change the property to either read the property or to 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.

Specifying Channel Strings in NI-DAQmx

You cannot specify channel strings on the SCXI-1600. Refer to the user documentation for the hardware and software used in your system to specify channel strings for other modules in the system.

Developing an Application Using Text-Based ADEs

You can use text-based ADEs such as LabWindows/CVI, Measurement Studio, Visual Basic, .NET, and C# to create code for using the SCXI-1600.

LabWindows/CVI

LabWindows/CVI works with the **DAQ Assistant** in MAX to generate code for a 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. Configure the NI-DAQmx task.
6. 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 about creating NI-DAQmx tasks in LabWindows/CVI and NI-DAQmx property information.

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

You cannot use the create a task capabilities of Visual Basic, .NET, and C# with the SCXI-1600. Refer to the user documentation for the hardware and software used in your system to create .NET or C# tasks for other modules in the system.

Programmable NI-DAQmx Properties

All of the different ADEs that configure the SCXI-1600 access an underlying set of NI-DAQmx properties. For a complete list of NI-DAQmx properties, refer to your ADE help file.

Other Application Documentation and Material

Refer to the ADE documentation and the DAQ analog input examples for your application software for more detailed information about programming the SCXI modules for scanning in multiplexed mode.

Calibrating the SCXI-1600 System

The SCXI-1600 ships 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 the measurements for offset errors in the module.

To assure the highest level of accuracy, you must periodically calibrate the SCXI-1600. Calibrating the module ensures its accuracy.

In the EEPROM, there is a user-modifiable calibration area in addition to the permanent factory calibration area. The user-modifiable calibration area allows you to load the CalDACs with values either from the original factory calibration or from a calibration that you subsequently performed.

Internal Calibration Procedure

The SCXI-1600 incorporates internal calibration paths that allow routing channel inputs to ground and an onboard reference voltage. NI software disconnects the channel inputs from the front signal connector and reconnects the inputs to ground and an onboard reference when performing an internal calibration. You need not change any input connections for an internal calibration.

This internal calibration process, which generally takes less than two minutes, is the preferred method of assuring accuracy in your application. Initiate an internal calibration to minimize the effects of any offset and gain drifts, particularly those due to warming. You must perform the internal calibration within 24 hours of the measurement to meet the 24 hour accuracy specifications provided in Appendix A, *Specifications*.

Immediately after internal calibration, the only significant residual calibration error could be gain error due to time or temperature drift of the onboard voltage reference. This error is addressed by external calibration, which is discussed in the *External Calibration* section. If you are interested primarily in relative measurements, you can ignore a small amount of gain error, and internal calibration should be sufficient.

Internal Calibration Using MAX

Complete the following steps to perform an internal calibration:

1. Open MAX.
2. Expand **Devices and Interfaces**.
3. Expand **NI-DAQmx Devices**.
4. Right-click **SCXI-1600**.
5. Select **Self-Calibrate**.

The software informs you when the internal calibration is complete and whether it was successful.

Internal Calibration Using LabVIEW

Complete the following steps to perform an internal calibration of the SCXI-1600:

1. Open a blank block diagram in LabVIEW.
2. Select **Functions»All Functions»NI Measurements» DAQmx-Data Acquisition»DAQmx Advanced» DAQmx Calibration»DAQmx Self Calibrate.vi**.
3. Double-click the icon to open the **DAQmx Self Calibrate.vi Front Panel**.
4. In the **device in** drop-down box, select the device corresponding to the SCXI-1600 and run the VI.

Note The SCXI-1600 takes a few seconds to perform the calibration.

After the VI has completed running, the SCXI-1600 has new calibration constants stored for all gain settings and the module is calibrated.

External Calibration

You can download all available external calibration documents from `ni.com/calibration` by clicking **Manual Calibration Procedures**. NI recommends you perform an external calibration once a year.

Calibrating the System

After the SCXI-1600 is calibrated, perform a system calibration using the SCXI-1600 with the SCXI input module in the system to improve accuracy. This is considered system, or end-to-end, calibration. Follow the calibration procedures for the SCXI input module.

A

Specifications

This appendix lists the specifications of the SCXI-1600 module. These specifications are typical at 25 °C unless otherwise noted.

Analog Input

Input Characteristics

Type of ADC..... Successive approximation

Resolution ..... 16 bits, 1 in 65,536

Sampling rate ..... 200 kS/s

Device Gain	Range
0.5	±10 V
1	±5 V
10	±500 mV
100	±50 mV

Input coupling ..... DC

FIFO buffer size..... 4,096 samples

Data transfers ..... USB

Configuration memory size..... 512 words

Max working voltage
(signal + common mode) ..... Each input should remain within ±11 V of ground

External calibration overvoltage protection

Powered on ..... ±25 V

Powered off..... ±15 V

Accuracy Information

Nominal Range at Full Scale (V)	Absolute Accuracy							Relative Accuracy Resolution (µV)	
	% of Reading		Offset (µV)	Noise + Quantization (µV)		Temp Drift (%/°C)	Absolute Accuracy at Full Scale (mV)		
	24 Hours	1 Year		Single Point	Averaged			Single Point	Averaged
±10	0.0546	0.0588	±1601	±1029	±92	0.0010	7.57	1205	121
±5	0.0146	0.0188	±811	±515	±46	0.0005	1.80	603	60.3
±0.5	0.0546	0.0588	±100	±66	±6	0.0010	0.40	78.4	7.9
±0.05	0.0546	0.0588	±29	±31	±3.0	0.0010	0.061	39.8	4.0

Note: Accuracies are valid for measurements following an internal calibration. Averaged numbers assume dithering and averaging of 100 single-channel readings. Measurement accuracies are listed for operational temperatures within ±1 °C of internal calibration temperature and ±10 °C of external or factory calibration temperature.

Transfer Characteristics

Integral nonlinearity (INL) .....±1.5 LSB typ, ±2.0 LSB max

Differential nonlinearity (DNL) .....±0.5 LSB typ, ±3.0 LSB max

No missing codes.....16 bits

Offset error

- Pregain error after calibration.....±1.0 µV max
- Pregain error before calibration.....±28.8 mV max
- Postgain error after calibration .....±157 µV max
- Postgain error before calibration .....±40 mV max

Gain error (relative to calibration reference)

- After calibration (gain = 1).....±74 ppm of reading max
- Before calibration .....±18,900 ppm reading max
- Gain ≠ 1 with gain error adjusted to 0 at gain = 1.....±200 ppm of reading max

Amplifier Characteristics

Input impedance (normal)[1] ..... 100 GΩ parallel with 100 pF

External calibration BNC input impedance

Normal powered on ..... 100 GΩ parallel with 100 pF

Powered off[2] ..... 820 Ω

Overload..... 820 Ω

Input bias current[3] ..... ±200 pA

Common-mode rejection ratio (CMRR), DC to 60 Hz

Gain	Bipolar
0.5, 1	85 dB
10, 100	96 dB

Dynamic Characteristics

Bandwidth

Signal	Bandwidth
Small (–3 dB)	413 kHz
Large (1% THD)	490 kHz

Settling time for full-scale step

Gain 100..... ±4 LSB, 5 µs typ

Gain 10, 1, 0.5..... ±2 LSB, 5 µs max

[1] The resistance value is taken from the AD829 op amp specification sheet, and is a value much smaller than the mux or other op amps. The 100 pF is taken from the mux specification sheet and is much larger than the op amps.

[2] This value is the input protection resistor in front of the analog input mux.

[3] The input bias current is taken from the AD829 op amp specification sheet. This value is much larger than the other op amps. Since the AD829 is used as a single-ended op amp, the input bias current is the same as the input offset current. Therefore, offset current is not listed.

System noise (LSB_{rms}, including quantization)

Gain	LSB_{rms}
0.5, 1.0	1.0
10.0	1.3
100	6.6

Stability

Recommended warm-up time.....15 min

Offset temperature coefficient

Pregain.....±20 µV/°C

Postgain.....±175 µV/°C

Gain temperature coefficient.....±20 ppm/°C

Triggers

AI triggers

Input.....AI START TRIG
AI REF TRIG
AI SAMP CLK
AI CONV CLK
AI GATE
SI SOURCE

Output.....AI Start Trigger,
AI Sample Clock

External sources.....PFI <0, 7>

Compatibility.....5 V TTL

Response.....Rising or falling edge

Pulse width ..... 10 ns min in edge-detect mode

Direction	Level	Min	Max
Input	Low voltage	0.0 V	0.8 V
	High voltage	2.0 V	5.0 V
Output	Low voltage (I_{out} = 5 mA)	—	0.4 V
	High voltage (I_{out} = 3.5 mA)	4.35 V	—

Calibration

Recommended warm-up time ..... 15 min

Interval ..... 1 year

External calibration reference ..... Between >6 V and <10 V

Onboard calibration reference

Level ..... 5.000 V (±3.5 mV)
(over full operating temperature, actual value stored in EEPROM)

Temperature coefficient ..... ±5 ppm/°C max

Long-term stability ..... ±15 ppm/1,000 h

Power Requirement

+22 V supply ..... 115 mA max

–22 V supply ..... 135 mA max

Physical

Dimensions
(D × H × W) ..... 18.3 cm × 17.3 cm × 3.1 cm
(7.2 in. × 6.8 in. × 1.2 in.)

I/O connector ..... 3 BNC connectors,
1 USB front connector

Maximum Working Voltage

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

Channel-to-earth .....11 V, Installation Category I

Channel-to-channel.....11 V, Installation Category I

Environmental

Operating temperature .....0 to 50 °C

Storage temperature .....–20 to 70 °C

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

Maximum altitude.....2,000 m

Pollution Degree (indoor use only) 2

Safety

The SCXI-1600 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
- CAN/CSA C22.2 No. 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

Emissions	EN 55011 Class A at 10 m FCC Part 15A above 1 GHz
Immunity	EN 61326:1997 + A2:2001, Table 1
EMC/EMI	CE, C-Tick and FCC Part 15 (Class A) Compliant

Note For EMC compliance, operate this device with shielded cabling.

CE Compliance

The SCXI-1600 meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

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

Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain 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.

B

Timing Signal Information

This appendix contains information about the timing signals discussed in Chapter 3, *Theory of Operation*.

Connecting Timing Signals

Caution Exceeding the maximum input voltage ratings, which are listed in Table 2-2, *I/O Signal Summary*, can damage the SCXI-1600 module and the computer. NI is *not* liable for any damages resulting from such signal connections.

Timing connections are grouped into the following categories:

- PFI connections
- DAQ timing connections
- General-purpose timing signal connections

PFIs are bidirectional pins. As outputs, they are not programmable and reflect the state of many DAQ and general-purpose timing signals. As inputs, the PFI signals are programmable and can control any DAQ and general-purpose timing signals. All external control over the timing of the SCXI-1600 module is routed through these two PFIs that are labeled PFI 0 and PFI 7.

All digital timing connections are referenced to digital ground. This reference is shown in Figure B-1, which shows an example of how to connect an external AI START TRIG source and an external AI CONV CLK source to two of the SCXI-1600 module PFI pins.

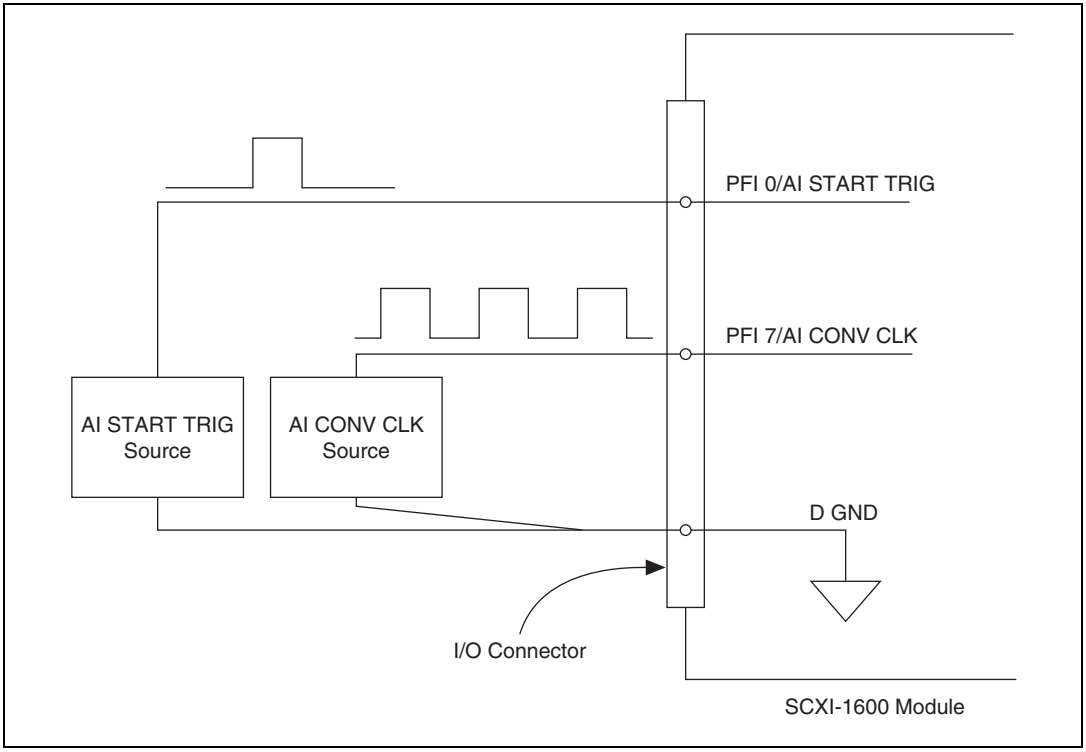


Figure B-1. Timing I/O Connections

Programmable Function Input Connections

There are a total of 13 internal timing signals that you can externally control from the PFI pins. The source for each of these signals is software selectable from any of the PFIs when you want external control. This flexible routing scheme reduces the need to change the physical wiring to the device I/O connector for different applications requiring alternative wiring.

You can individually enable the PFI pins to output a specific internal timing signal. For example, if you need the AI CONV CLK signal as an output on the I/O connector, software powers on the output driver for the PFI 7/AI CONV CLK pin. Do *not* drive a PFI signal externally when it is configured as an output.

When used as an input, you can individually configure each PFI for edge or level detection, and for polarity selection. You can use the polarity selection for any of the 13 timing signals, but the edge or level detection depends

upon the particular timing signal being controlled. The detection requirements for each timing signal are listed within the section that discusses that individual signal.

In edge-detection mode, the minimum pulse width required is 10 ns. This applies for both rising-edge and falling-edge polarity settings. There is no maximum pulse-width requirement in edge-detect mode.

In level-detection mode, there are no minimum or maximum pulse-width requirements imposed by the PFIs themselves, but limits can be imposed by the particular timing signal being controlled.

Data Acquisition Timing Connections

The data acquisition timing signals are the following:

- AI START TRIG
- AI REF TRIG
- AI SAMP CLK
- AI CONV CLK
- AI GATE
- SI SOURCE.

Posttriggered data acquisition allows you to view only data that is acquired after a trigger event is received. Figure B-2 shows a typical posttriggered data acquisition sequence. Pretriggered data acquisition allows you to view data that is acquired before the trigger of interest in addition to data acquired after the trigger. Figure B-3 shows a typical pretriggered data acquisition sequence.

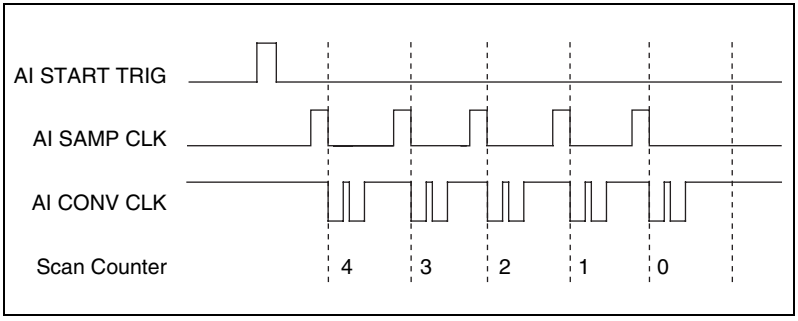


Figure B-2. Typical Posttriggered Acquisition

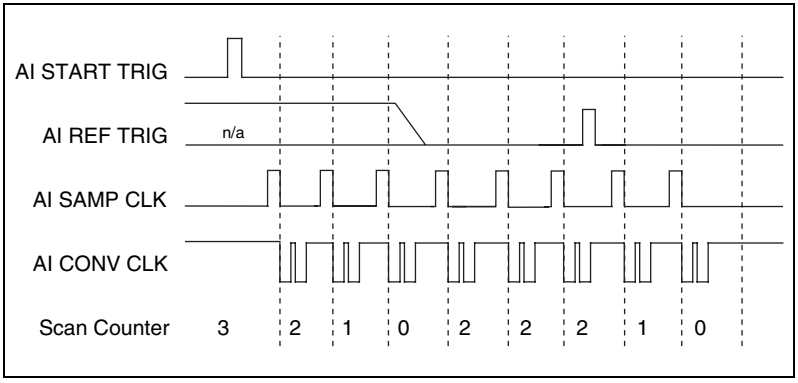


Figure B-3. Typical Pretriggered Acquisition

AI START TRIG Signal

Any PFI pin can externally input the AI START TRIG signal.

Refer to Figure B-4 for the relationship of AI START TRIG to the data acquisition sequence.

As an input, the AI START TRIG signal is configured in the edge-detection mode. You can select any PFI pin as the source for AI START TRIG and configure the polarity selection for either rising or falling edge. The selected edge of the AI START TRIG signal starts the data acquisition sequence for both posttriggered and pretriggered acquisitions.

Figure B-4 shows the input requirements for the AI START TRIG signal.

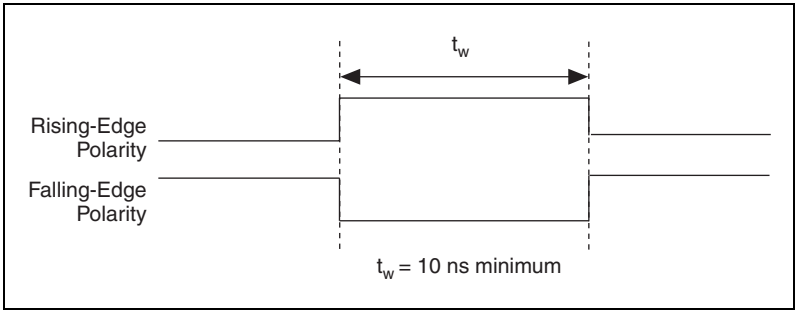


Figure B-4. AI START TRIG Input Signal Timing

The device also uses the AI START TRIG signal to initiate pretriggered data acquisition operations. In most pretriggered applications, the AI START TRIG signal is generated by a software trigger. Refer to the AI REF TRIG signal description for a complete description of the use of AI START TRIG and AI REF TRIG in a pretriggered data acquisition operation.

AI REF TRIG Signal

Any PFI pin can externally input the AI REF TRIG signal.

Refer to Figure B-5 for the relationship of AI REF TRIG to the data acquisition sequence.

As an input, the AI REF TRIG signal is configured in the edge-detection mode. You can select any PFI pin as the source for AI REF TRIG and configure the polarity selection for either rising or falling edge. The selected edge of the AI REF TRIG signal initiates the posttriggered phase of a pretriggered acquisition sequence. In pretriggered mode, the AI START TRIG signal initiates the data acquisition. The scan counter indicates the minimum number of scans before AI REF TRIG is recognized. After the scan counter decrements to zero, it is loaded with the number of posttrigger scans to acquire while the acquisition continues. The device ignores the AI REF TRIG signal if it is asserted prior to the scan counter decrementing to zero. After the selected edge of AI REF TRIG is received, the device acquires a fixed number of scans and the acquisition stops. This mode acquires data both before and after receiving AI REF TRIG.

Figure B-5 shows the input timing requirements for the AI REF TRIG signal.

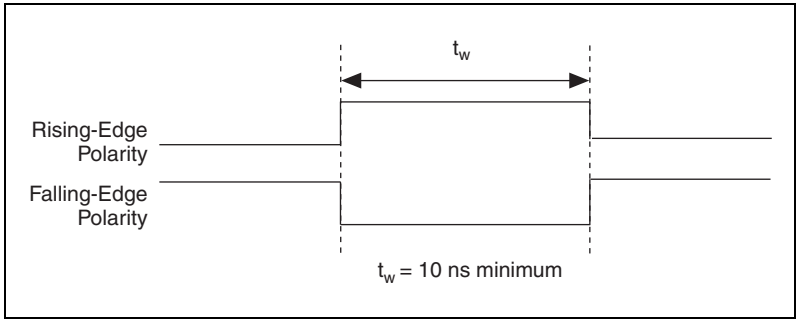


Figure B-5. AI REF TRIG Input Signal Timing

AI SAMP CLK Signal

Any PFI pin can externally input the AI SAMP CLK signal, which is available as an output on the PFI 7/AI SAMP CLK pin.

Refer to Figure B-6 and Figure B-7 for the relationship of AI SAMP CLK to the data acquisition sequence.

As an input, the AI SAMP CLK signal is configured in the edge-detection mode. You can select any PFI pin as the source for AI SAMP CLK and configure the polarity selection for either rising or falling edge. The selected edge of the AI SAMP CLK signal initiates a scan. The sample interval counter is started if you select internally triggered AI CONV CLK.

As an output, the AI SAMP CLK signal reflects the actual start pulse that initiates a scan. This is true even if the starts are externally triggered by another PFI. You have two output options. The first is an active high pulse with a pulse width of 50 to 100 ns, which indicates the start of the scan. The second action is an active high pulse that terminates at the start of the last conversion in the scan, which indicates a scan in progress. AI SAMP CLK deasserts to off after the last conversion in the scan is initiated. This output is set to high-impedance at startup.

Figure B-6 and Figure B-7 show the input and output timing requirements for the AI SAMP CLK signal.

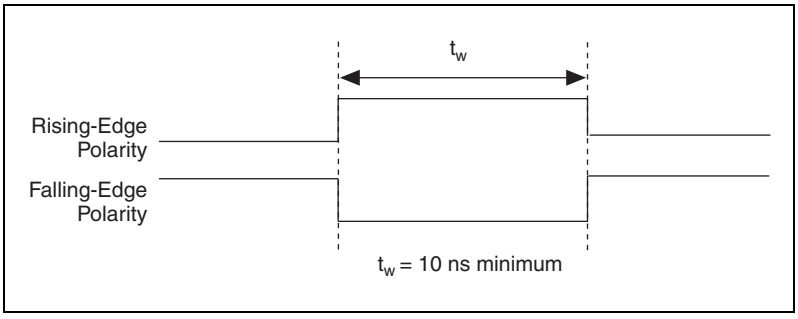


Figure B-6. AI SAMP CLK Input Signal Timing

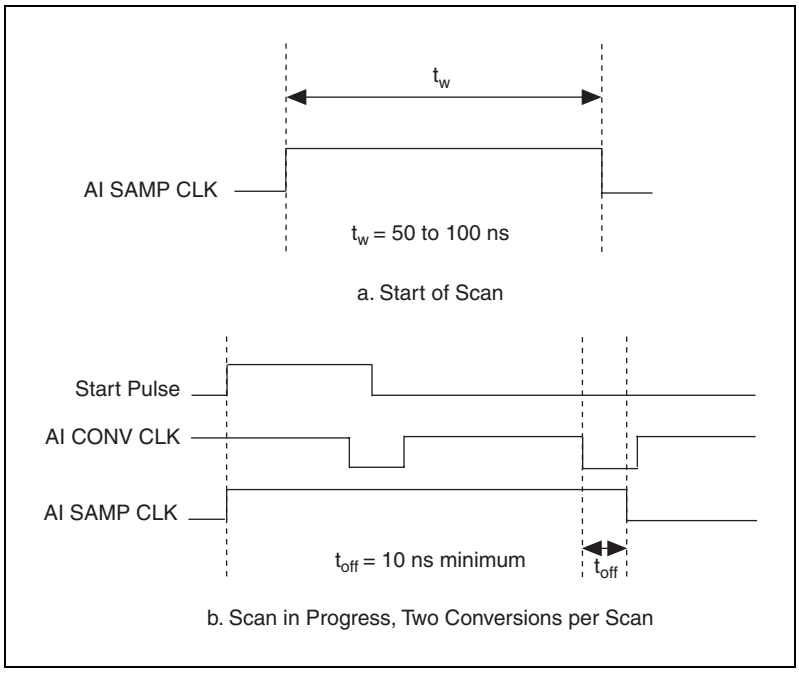


Figure B-7. AI SAMP CLK Output Signal Timing

The AI CONV CLK pulses are masked off until the device generates the AI SAMP CLK signal. If you are using internally generated conversions, the first AI CONV CLK appears when the onboard sample interval counter reaches zero. If you select an external AI CONV CLK, the first external pulse after AI SAMP CLK generates a conversion. Separate the AI SAMP CLK pulses by at least one scan period.

A counter on the SCXI-1600 module internally generates the AI SAMP CLK signal unless you select an external source. This counter is started by the AI START TRIG signal and is stopped either by software or by the sample counter.

Scans generated by either an internal or external AI SAMP CLK signal are inhibited unless they occur within a data acquisition sequence. Either the hardware (AI GATE) signal or software command register gate can gate scans occurring within a data acquisition sequence.

AI CONV CLK Signal

Any PFI pin can externally input the AI CONV CLK signal.

Refer to Figure B-8 for the relationship of AI CONV CLK to the data acquisition sequence.

As an input, the AI CONV CLK signal is configured in the edge-detection mode. You can select any PFI pin as the source for AI CONV CLK and configure the polarity selection for either rising or falling edge. The selected edge of the AI CONV CLK signal initiates an A/D conversion.

Figure B-8 shows the input timing requirements for the AI CONV CLK signal.

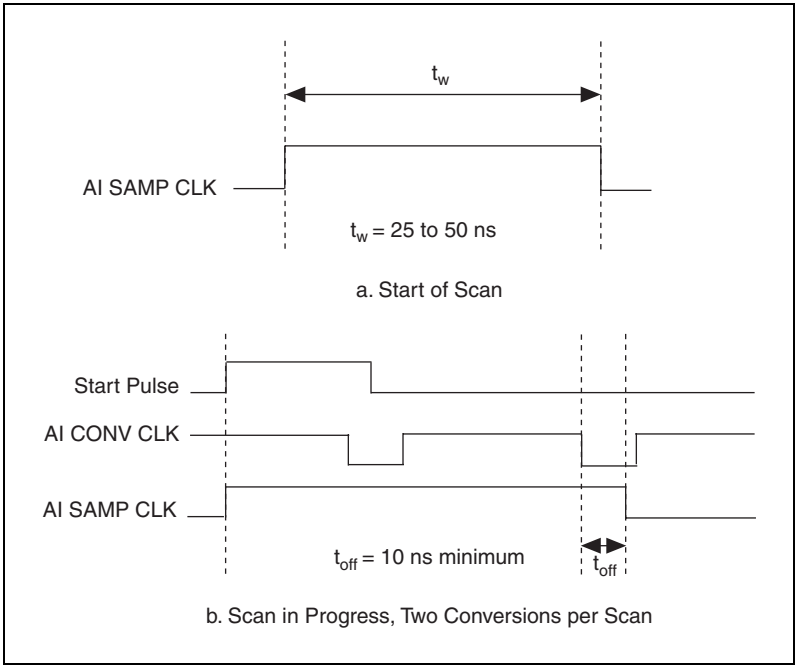


Figure B-8. AI CONV CLK Input Signal Timing

The ADC switches to hold mode within 60 ns of the selected edge. This hold-mode delay time is a function of temperature and does not vary from one conversion to the next. Separate the AI CONV CLK pulses by at least one conversion period.

The sample interval counter on the SCXI-1600 module normally generates the AI CONV CLK signal unless you select an external source. The counter is started by the AI SAMP CLK signal and continues to count down and reload itself until the scan is finished. It then reloads itself in readiness for the next AI SAMP CLK pulse.

A/D conversions generated by either an internal or external AI CONV CLK signal are inhibited unless they occur within a data acquisition sequence. Either the hardware (AI GATE) signal or software command register gate can gate scans occurring within a data acquisition sequence.

AI GATE Signal

Any PFI pin can externally input the AI GATE signal. The AI GATE signal can mask off scans in a data acquisition sequence. You can configure the PFI pin you select as the source for the AI GATE signal in either the level-detection or edge-detection mode. You can configure the polarity selection for the PFI pin for either active high or active low.

In the level-detection mode, if AI GATE is active, the AI SAMP CLK signal is masked off and no scans can occur. In the edge-detection mode, the first active edge disables the AI SAMP CLK signal, and the second active edge enables AI SAMP CLK.

The AI GATE signal can neither stop a scan in progress nor continue a previously gated-off scan; in other words, once a scan has started, AI GATE does not gate off conversions until the beginning of the next scan and, conversely, if conversions are gated off, AI GATE does not gate them back on until the beginning of the next scan.

SI SOURCE Signal

Any PFI pin can externally input the SI SOURCE signal. The onboard scan interval counter uses the SI SOURCE signal as a clock to time the generation of the AI SAMP CLK signal. You must configure the PFI pin you select as the source for the SI SOURCE signal in the level-detection mode. You can configure the polarity selection for the PFI pin for either active high or active low.

The maximum allowed frequency is 20 MHz, with a minimum pulse width of 23 ns high or low. There is no minimum frequency limitation.

Either the 20 MHz or 100 kHz internal timebase generates the SI SOURCE signal unless you select an external source. Figure B-9 shows the timing requirements for the SI SOURCE signal.

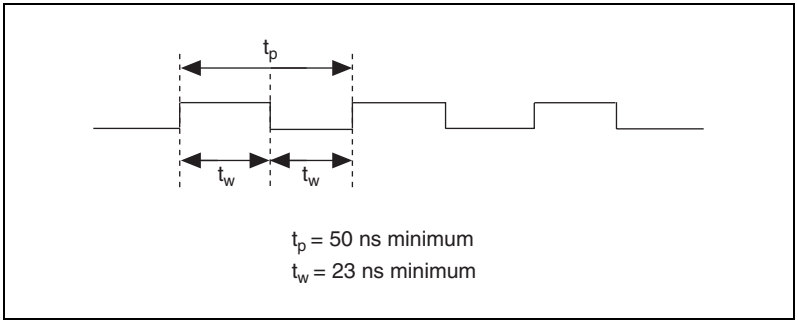


Figure B-9. SI SOURCE Signal Timing

C

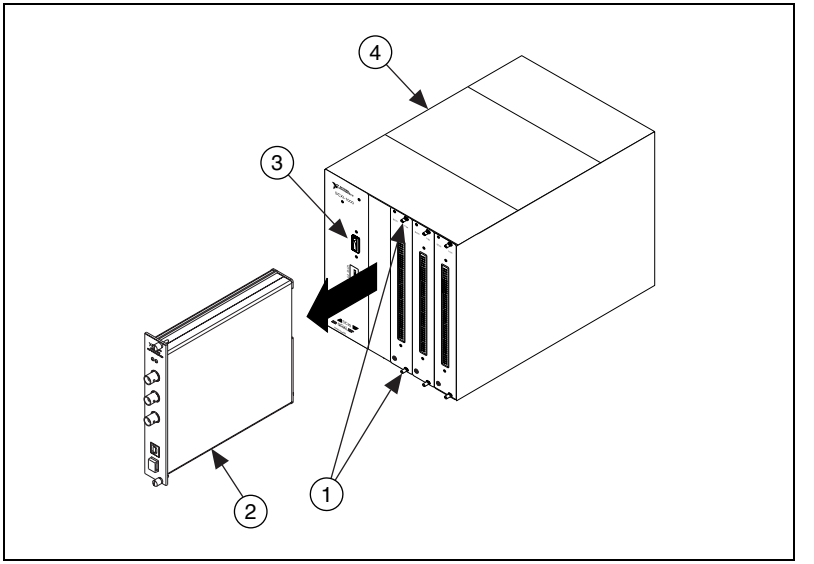
Removing the SCXI-1600

This appendix explains how to remove an SCXI-1600 module from an SCXI chassis and MAX.

Removing the SCXI-1600 from an SCXI Chassis

To remove the SCXI-1600 from an SCXI chassis, complete the following steps:

1. Disconnect the USB cable running from the SCXI-1600 to the computer or USB hub.
2. Power off the SCXI chassis. Do *not* remove the SCXI-1600 from a chassis that is powered on.
3. Rotate the thumbscrews that secure the SCXI-1600 to the chassis counterclockwise until they are loose, but do not completely remove the thumbscrews.
4. Remove the SCXI-1600 by pulling steadily on both thumbscrews until the module slides out completely.



1 Thumbscrews 2 SCXI-1600 3 Power Switch 4 SCXI Chassis

Figure C-1. Removing the SCXI-1600

Removing the SCXI-1600 from MAX

To remove the SCXI-1600 module from MAX, disconnect the USB cable or power off the SCXI chassis. If the SCXI-1600 is still detected, press the <F5> key.

Note When the SCXI-1600 is no longer detected in MAX, neither is the SCXI chassis in which it is located along with the other modules in the chassis.

The SCXI-1600, SCXI chassis, and other SCXI modules are not automatically removed from MAX when the USB cable is disconnected. They still appear in the list, but have a red **X** indicating they are disabled. If the USB cable is reconnected and the chassis is powered on, they are again enabled and the red **X** is removed. To completely remove a module or the entire chassis, right-click the module or chassis and then click **Delete**.

The SCXI-1600 module is now removed from the list of installed devices in MAX.

D

Common Questions

This appendix contains answers to commonly asked questions about the operation and special features of the SCXI-1600 module.

How do I know if my version of Windows supports USB?

Open the **System** properties in the Control Panel. Select the **Hardware** tab and click the **Device Manager** button if a **Universal Serial Bus Controller** along with a USB controller and a USB root hub are listed. If the computer has this and USB ports, the computer supports USB. If the computer has USB ports but no controller is listed in the **Device Manager**, you must upgrade your software.

What is the best way to test the SCXI-1600 without having to program the module?

The SCXI-1600 has no Test Panels, but you can perform a Test Chassis to verify the presence of the SCXI-1600.

What do the different LED patterns on the front panel mean?

The top two green LEDs indicate whether you have power to the SCXI chassis backplane while the bottom two LEDs indicate USB communication. Refer to Table 1-1, *LED Patterns for SCXI-1600 USB States*, for more information. If either of the top two green LEDs is off, check the fuses in the back of the SCXI chassis.

What are PFIs, and how do I configure them?

PFIs are programmable function inputs. These lines serve as connections to virtually all internal timing signals.

If you are using the NI-DAQ language interface or Measurement Studio, use the `Select_Signal` function to route internal signals to the I/O connector, route external signals to internal timing sources, or connect internal timing signals.

If you are using NI-DAQ with LabVIEW and you want to connect external signal sources to the PFI lines, refer to the `Multi-Synch Shared Ext Sample Clk.vi` as an example of making these connections.

Caution If you enable a PFI line for output, do *not* connect any external signal source to it. If you do, you can damage the device, the computer, and the connected equipment.

What are the power-on states of the PFIs?

At system power on and reset, the PFI lines are set to high-impedance by the hardware. This means that the device circuitry is not actively driving the output either high or low. However, these lines can have pull-up or pull-down resistors connected to them as shown in Table 2-1, *I/O Connector Signal Descriptions*. These resistors weakly pull the output to either a logic high or logic low state. For example, PFI 0/AI START TRIG is in the high-impedance state after power on, and Table 2-1 shows that there is a 50 kΩ pull-up resistor. This pull-up resistor sets the PFI 0/AI START TRIG pin to a logic high when the output is in a high-impedance state.

Glossary

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

Numbers/Symbols

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

A

A	amperes
A/D	analog-to-digital
AC	alternating current
ADC	analog-to-digital converter—an electronic device, often an integrated circuit, that converts an analog voltage to a digital number
ADC resolution	the resolution of the ADC, which is measured in bits. A 16-bit ADC has a higher resolution, and thus a higher degree of accuracy, than a 12-bit ADC.
AI CONV CLK	convert signal
AI GATE	analog input gate signal
AI SAMP CLK	start scan signal
amplification	a type of signal conditioning that improves accuracy in the resulting digitized signal and reduces noise
ASIC	application-specific integrated circuit

B

b	bit—one binary digit, either 0 or 1
B	byte—eight related bits of data, an 8-bit binary number. Also used to denote the amount of memory required to store one byte of data.
bipolar	a voltage range spanning both positive and negative voltages
BNC	a type of coaxial signal connector
buffer	temporary storage for acquired or generated data (software)
bus	the group of conductors that interconnect individual circuitry in a computer. Typically, a bus is the expansion interface to which I/O or other devices are connected.

C

C	Celsius
channel	pin or wire lead to which you apply, or from which you read, an analog or digital signal. Analog signals can be single-ended or differential. For digital signals, channels are grouped to form ports.
channel clock	the clock controlling the time interval between individual channel sampling within a scan. Boards with simultaneous sampling do not have this clock.
circuit trigger	a condition for starting or stopping clocks
clock	hardware component that controls timing for reading from or writing to groups
CMRR	common-mode rejection ratio—a measure of the ability of a differential amplifier to reject interference from a common-mode signal, usually expressed in decibels (dB)
code width	the smallest input voltage change that can be measured by a DAQ device
common-mode range	the input range over which a circuit can handle a common-mode signal
common-mode signal	the mathematical average voltage, relative to the ground of the computer, of the signals from a differential input
common-mode voltage	any voltage present at the instrumentation amplifier inputs with respect to amplifier ground
conversion device	device that transforms a signal from one form to another. For example, analog-to-digital converters (ADCs) for analog input, digital-to-analog converters (DACs) for analog output, digital input or output ports, and counter/timers are conversion devices.
conversion time	the time required, in an analog input or output system, from the moment a channel is interrogated (such as with a read instruction) to the moment that accurate data is available
convert clock	clock signal used to increment to the next channel after each DAQ device analog-to-digital conversion
counter/timer	a circuit that counts external pulses or clock pulses (timing)
coupling	the manner in which a signal is connected from one location to another

D

D/A	digital-to-analog
D GND	digital ground signal
DAC	D/A converter—an electronic device, often an integrated circuit, that converts a digital number into a corresponding analog voltage or current
DAQ	data acquisition—(1) collecting and measuring electrical signals from sensors, transducers, and test probes or fixtures and processing the measurement data using a computer; (2) collecting and measuring the same kinds of electrical signals with A/D and/or DIO boards plugged into a computer, and possibly generating control signals with D/A and/or DIO boards in the same computer
dB	decibel—the unit for expressing a logarithmic measure of the ratio of two signal levels: dB = 20log10 V1/V2, for signals in volts
DC	direct current
default setting	a default parameter value recorded in the driver. In many cases, the default input of a control is a certain value (often 0) that means *use the current default setting*. For example, the default input for a parameter may be *do not change current setting*, and the default setting may be *no AMUX-64T boards*. If you do change the value of such a parameter, the new value becomes the new setting. You can set default settings for some parameters in the configuration utility or manually using switches located on the device.
device	a plug-in data acquisition board, module, card, or pad that can contain multiple channels and conversion devices. SCXI modules are distinct from devices, with the exception of the SCXI-1600, which is a hybrid.
DIFF	differential mode
differential input	the two-terminal input to a differential amplifier
digital port	*See* port.
DIO	digital input/output
dithering	the addition of Gaussian noise to an analog input signal

DNL	differential nonlinearity—a measure in LSB of the worst-case deviation of code widths from their ideal value of 1 LSB
drivers/driver software	software that controls a specific hardware device such as a DAQ device

E

EMC	electromechanical compliance
event	the condition or state of an analog or digital signal
external trigger	a voltage pulse from an external source that causes a DAQ operation to begin

F

FIFO	first-in-first-out
filtering	a type of signal conditioning that allows you to remove unwanted frequency components from the signal you are trying to measure

G

gain	the factor by which a signal is amplified, sometimes expressed in dB
gain accuracy	a measure of deviation of the gain of an amplifier from the ideal gain
GATE input pin	a counter input pin that controls when counting occurs in your application
grounded source	signal sources that are connected to ground

H

Hz	hertz—cycles per second of a periodic signal

I

I/O	input/output
ID	identification

in.	inch or inches
INL	integral nonlinearity—a measure in LSB of the worst-case deviation from the ideal A/D or D/A transfer characteristic of the analog I/O circuitry
input bias current	the current that flows into the inputs of a circuit
input impedance	the measured resistance and capacitance between the input terminals of a circuit
input offset current	the difference in the input bias currents of the two inputs of an instrumentation amplifier
instrumentation amplifier	a very accurate differential amplifier with a high input impedance

K

k	kilo—the standard metric prefix for 1,000, or 10^3, used with units of measure such as volts, hertz, and meters
kS	1,000 samples

L

linearity	the adherence of device response to the equation R = KS, where R = response, S = stimulus, and K = a constant
LSB	least significant bit

M

m	meters
M	(1) Mega, the standard metric prefix for 1 million or 10^6, when used with units of measure such as volts and hertz; (2) mega, the prefix for 1,048,576, or 2^{20}, when used with B to quantify data or computer memory

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

N

NI-DAQ	the driver software needed in order to use National Instruments DAQ devices and SCXI components
nodes	execution elements of a block diagram consisting of functions, structures, and subVIs
noise	an undesirable electrical signal—Noise comes from external sources such as the AC power line, motors, generators, transformers, fluorescent lights, soldering irons, CRT displays, computers, electrical storms, welders, radio transmitters, and internal sources such as semiconductors, resistors, and capacitors. Noise corrupts signals you are trying to send or receive.

P

peak to peak	a measure of signal amplitude; the difference between the highest and lowest excursions of the signal
PFI	programmable function input
PGIA	programmable gain instrumentation amplifier
Plug and Play devices	hardware or software that after being installed can immediately be used, as opposed to hardware or software that requires configuration
port	(1) a digital port consisting of multiple I/O lines on a DAQ device; (2) a serial or parallel interface connector on a PC
potentiometer	an electrical device in which the resistance can be manually adjusted; used for manual adjustment of electrical circuits and as a transducer for linear or rotary position
ppm	parts per million

Q

quantization error	the inherent uncertainty in digitizing an analog value due to the finite resolution of the conversion process

R

relative accuracy	a measure in LSB of the accuracy of an ADC. It includes all nonlinearity and quantization errors. It does not include offset and gain errors of the circuitry feeding the ADC.
resolution	the smallest signal increment that a measurement system can detect. Resolution is expressed in bits, in proportions, or in percent of full scale. For example, a system has 12-bit resolution, one part in 4,096 resolution, and 0.0244% of full scale resolution.
rise time	the difference in time between the 10% and 90% points of a system step response
rms	root mean square—the square root of the average value of the square of the instantaneous signal amplitude; a measure of signal amplitude

S

s	seconds
S	samples
S/s	samples per second—used to express the rate at which a DAQ board samples an analog signal
sample clock	the clock controlling the time interval between samples of all channels
sample counter	the clock that counts the output of the channel clock, in other words, the number of samples taken. On boards with simultaneous sampling, this counter counts the output of the scan clock and hence the number of scans.
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
SCXI	Signal Conditioning eXtensions for Instrumentation
sensor	a device that converts a physical phenomenon into an electrical signal
settling time	the amount of time required for a voltage to reach its final value within specified accuracy limits
SI SOURCE	SI counter clock signal
signal conditioning	the manipulation of signals to prepare them for digitizing
software trigger	a programmed event that triggers an event such as data acquisition
source impedance	a parameter of signal sources that reflects current-driving ability of voltage sources (lower is better) and the voltage-driving ability of current sources (higher is better)
STC	system timing controller
successive-approximation ADC	an ADC that sequentially compares a series of binary-weighted values with an analog input to produce an output digital word in *n* steps, where *n* is the bit resolution of the ADC
switchless device	devices that do not require dip switches or jumpers to configure resources on the devices. *See also* Plug and Play devices.
system noise	a measure of the amount of noise seen by an analog circuit or an ADC when the analog inputs are grounded

T

TC	terminal count
THD	total harmonic distortion
transducer	*See* sensor.
transducer excitation	a type of signal conditioning that uses external voltages and currents to excite the circuitry of a signal conditioning system into measuring physical phenomena

trigger	any event that causes or starts some form of data capture
TTL	transistor-transistor logic

U

USB	universal serial bus

V

V	volts
VDC	volts direct current
VI	virtual instrument—(1) a combination of hardware and/or software elements, typically used with a computer, 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

W

wire	data path between nodes
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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