SCXI-1200
User Manual

12-Bit Data Acquisition and Control Module

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Contents

Figures

Tables

About This Manual

This manual describes the electrical and mechanical aspects of the SCXI-1200 module and contains information concerning its operation and programming. The SCXI-1200 is a member of the National Instruments Signal Conditioning eXtensions for Instrumentation (SCXI) Series modules. The SCXI-1200 is a combination DAQ and SCXI module that communicates with the PC through the parallel port.

Organization of This Manual

The *SCXI-1200 User Manual* is organized as follows:

- Chapter 1, *Introduction*, describes the SCXI-1200; lists the contents of your SCXI-1200 kit; describes the optional software, optional equipment, and custom cables; and explains how to unpack the SCXI-1200 kit.
- Chapter 2, *Installation and Configuration*, describes how to install the SCXI-1200 into the SCXI chassis and how to configure the SCXI-1200.
- Chapter 3, *Signal Connections,* describes the signal connections to the SCXI-1200 via the front connector and rear signal connector and includes specifications and connection instructions for the SCXI-1200 connector signals.
- Chapter 4, *Theory of Operation*, contains a functional overview of the SCXI-1200 module and explains the operation of each functional unit of the SCXI-1200.
- Chapter 5, *Calibration*, discusses the calibration of the SCXI-1200.
- Appendix A, *Specifications*, lists the specifications for the SCXI-1200.
- Appendix B, *Installation Troubleshooting*, contains installation troubleshooting information.
- Appendix C, *Customer Communication*, contains forms you can use to request help from National Instruments or to comment on our products.
- The *Glossary* contains an alphabetical list and description of terms used in this manual, including abbreviations, acronyms, metric prefixes, mnemonics, and symbols.
- The *Index* contains an alphabetical list of key terms and topics in this manual, including the page where you can find each one.

Conventions Used in This Manual

The following conventions are used in this manual:

bold italic	Bold italic text denotes a note, caution, or warning.
DIO board	DIO board refers to the National Instruments AT-DIO-32F, MC-DIO-24, MC-DIO-32F, NB-DIO-24, NB-DIO-96, NB-DIO-32F, PC-DIO 24, and PC-DIO-96 digital I/O DAQ boards unless otherwise noted.
DIO-type board	DIO-type board refers to National Instruments DAQ boards that have only digital inputs and outputs. These boards include the DIO-24, DIO-32F, and DIO-96 boards unless otherwise noted.
italic	Italic text denotes emphasis, a cross reference, or an introduction to a key concept.
Lab board	Lab board refers to the National Instruments Lab-LC, Lab-NB, Lab-PC, and Lab-PC+ boards unless otherwise noted.
MC	MC refers to the Micro Channel series computers.
MIO board	MIO board refers to the National Instruments AT-MIO-16, AT-MIO-16D, AT-MIO-16F-5, AT-MIO-16X, AT-MIO-64F-5, MC-MIO-16, NB-MIO-16, and NB-MIO-16X multichannel I/O DAQ boards unless otherwise noted.
MIO-type board	MIO-type board refers to National Instruments DAQ boards that have at least analog and digital inputs and outputs. These boards include the MIO boards, the Lab boards, and the PC-LPM-16 board unless otherwise noted.
`monospace`	Lowercase text in this font denotes text or characters that are to be literally input from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, variables, filenames, and extensions, and for statements and comments taken from program code.
NB	NB refers to the NuBus series computers.
PC	PC refers to the IBM PC/XT, the IBM PC AT, and compatible computers.
SCXIbus	SCXIbus refers to the backplane in the chassis. A signal on the backplane is referred to as the SCXIbus <signal name> line (or signal). The SCXIbus descriptor may be omitted when the meaning is clear.
Slot 0	Slot 0 refers to the power supply and control circuitry in the SCXI chassis.

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

The National Instruments Documentation Set

The *SCXI-1200 User Manual* is one piece of the documentation set for your SCXI system. You should have six types of manuals. Use these different types of manuals as follows:

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

Related Documentation

In addition, the following National Instruments manual contains detailed information for the register-level programmer.

- *SCXI-1200 Register-Level Programmer Manual*

If you want to obtain the register-level programmer manual, please fill out the *Register-Level Programmer Manual Request Form* t the end of Appendix C, *Customer Communication*, and send it to National Instruments. If you are using NI-DAQ, LabVIEW, or LabWindows, you should not need the register-level programmer manual. Using NI-DAQ, LabVIEW, or LabWindows is quicker and easier than and as flexible as using the low-level programming described in the register-level programmer manual. Refer to *Software Programming Choices* in Chapter 1, *Introduction*, of this manual to learn about your programming options.

Customer Communication

National Instruments wants to receive your comments on our products and manuals. We are interested in the applications you develop with our products, and we want to help if you have problems with them. To make it easy for you to contact us, this manual contains comment and configuration forms for you to complete. These forms are in Appendix C, *Customer Communication*.

Chapter 1
Introduction

This chapter describes the SCXI-1200; lists the contents of your SCXI-1200 kit; describes the optional software, optional equipment, and custom cables; and explains how to unpack the SCXI-1200 kit.

About the SCXI-1200

The SCXI-1200 is an SCXI module that works like the Lab-PC+ multifunction analog, digital and timing I/O plug-in board. The SCXI-1200 communicates with the PC through the parallel port and works in both the SCXI-1000 four-slot and the SCXI-1001 12-slot chassis. You can use the SCXI-1200 as a stand-alone module or in conjunction with other SCXI modules. As a stand-alone module, the SCXI-1200 has eight analog input channels, which can be configured as eight single-ended or four differential; a 12-bit successive-approximation ADC; two 12-bit DACs with voltage outputs; 24 lines of TTL-compatible digital I/O; and 16-bit counter/timer channels for timing I/O.

The SCXI-1200 works with other National Instruments SCXI modules and can operate in a single-chassis system. The SCXI-1200 controls the operation of and digitizes the conditioned analog signals from other SCXI modules.

The SCXI-1200 complies with IEEE 1284. This IEEE protocol supports three different parallel port types—the original Centronics or unidirectional port for printers, the PS2 type bidirectional port, and the 386-SL Enhanced Parallel Port (EPP).

A shielded terminal block, the SCXI-1302, has screw terminals for easy signal attachment to the SCXI-1200.

With the SCXI-1200, the SCXI chassis can serve as a DAQ solution for slotless computers, such as laptops, as well as PCs with parallel ports.

What You Need to Get Started

To set up and use your SCXI-1200, you will need the following:

- SCXI-1200 module
- *SCXI-1200 User Manual*
- NI-DAQ software for PC compatibles, with manuals
- *NI-DAQ Software User Manual for PC compatibles*
- *NI-DAQ Function Reference Manual for PC compatibles*
- SCXI parallel cable (1 m)

If your kit is missing any of the components, contact National Instruments.

Detailed specifications of the SCXI-1200 are listed in Appendix A, *Specifications*.

Software Programming Choices

There are four options to choose from when programming your National Instruments DAQ and SCXI hardware. You can use LabVIEW, LabWindows, NI-DAQ, or register-level programming software.

The SCXI-1200 works with LabVIEW for Windows, LabWindows for DOS, LabWindows/CVI for Windows, and NI-DAQ for PC compatibles.

LabVIEW and LabWindows Application Software

LabVIEW and LabWindows are innovative program development software packages for data acquisition and control applications. LabVIEW uses graphical programming, whereas LabWindows enhances traditional programming languages. Both packages include extensive libraries for data acquisition, instrument control, data analysis, and graphical data presentation.

LabVIEW currently runs on three different platforms—AT/MC/EISA computers running Microsoft Windows, the Macintosh platform, and the Sun SPARCstation platform. LabVIEW features interactive graphics, a state-of-the-art user interface, and a powerful graphical programming language. The LabVIEW Data Acquisition VI Library, a series of VIs for using LabVIEW with National Instruments DAQ hardware, is included with LabVIEW. The LabVIEW Data Acquisition VI Libraries are functionally equivalent to the NI-DAQ software, except that the SCXI functions are not included in the LabVIEW software for Sun.

LabWindows has two versions—LabWindows for DOS is for use on PCs running DOS, and LabWindows/CVI is for use on PCs running Windows and for Sun SPARCstations. LabWindows/CVI features interactive graphics, a state-of-the-art user interface, and uses the ANSI standard C programming language. The LabWindows Data Acquisition Library, a series of functions for using LabWindows with National Instruments DAQ hardware, is included with the NI-DAQ software kit. The LabWindows Data Acquisition libraries are functionally equivalent to the NI-DAQ software, except that the SCXI functions are not included in the LabWindows/CVI software for Sun.

Using LabVIEW or LabWindows software will greatly reduce the development time for your data acquisition and control application.

NI-DAQ Driver Software

The NI-DAQ driver software is included at no charge with all National Instruments DAQ hardware. NI-DAQ is not packaged with SCXI or accessory products. NI-DAQ has an extensive library of functions that you can call from your application programming environment. These functions include routines for analog input (A/D conversion), buffered data acquisition (high-speed A/D conversion), analog output (D/A conversion), waveform generation, digital I/O, counter/timer operations, SCXI, RTSI, self-calibration, messaging, and acquiring data to extended memory.

NI-DAQ also internally addresses many of the complex issues between the computer and the DAQ hardware such as programming interrupts and DMA controllers. NI-DAQ maintains a consistent software interface among its different versions so that you can change platforms with minimal modifications to your code. Figure 1-1 illustrates the relationship between NI-DAQ and LabVIEW and LabWindows. You can see that the data acquisition parts of LabVIEW and LabWindows are functionally equivalent to the NI-DAQ software.

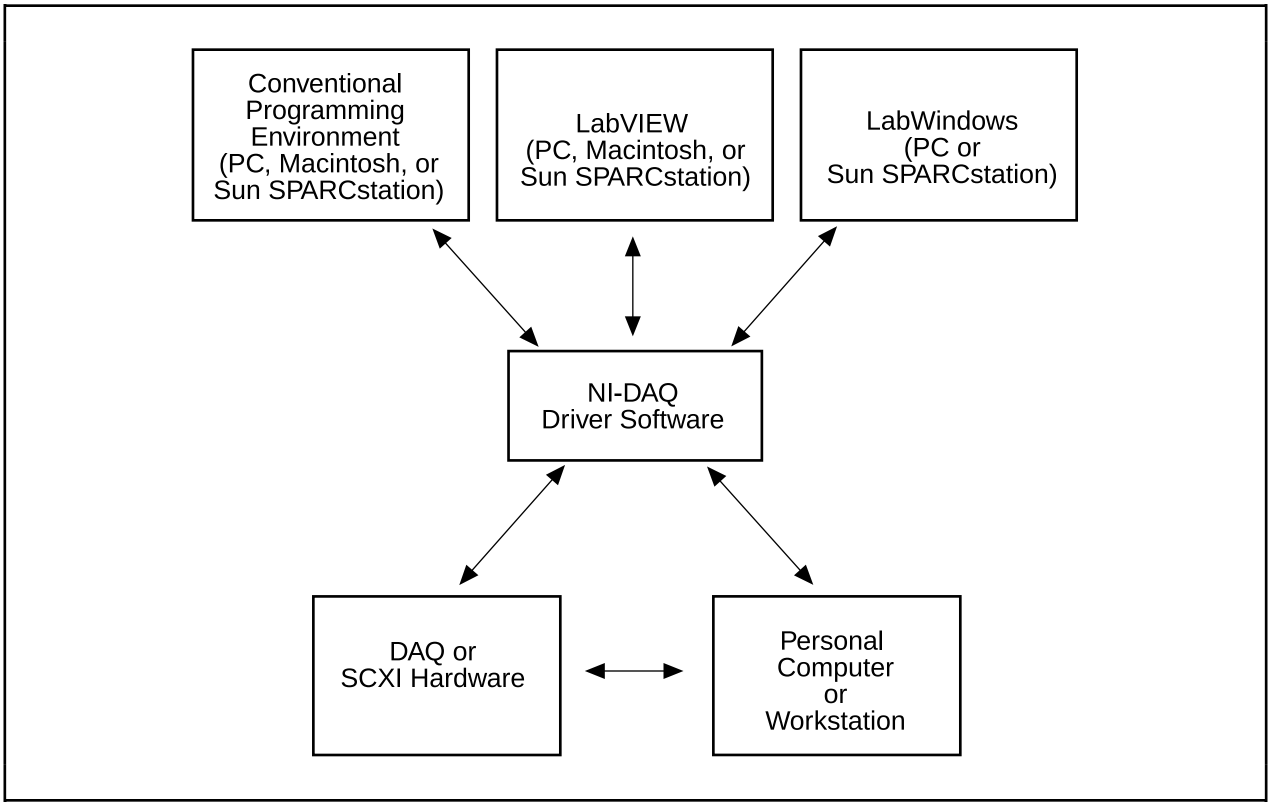


Figure 1-1. The Relationship between the Programming Environment, NI-DAQ, and Your Hardware

The National Instruments PC, AT, MC, DAQCard, and DAQPad Series DAQ hardware are packaged with NI-DAQ software for PC compatibles. NI-DAQ software for PC compatibles comes with language interfaces for Professional BASIC, Turbo Pascal, Turbo C, Turbo C++, Borland C++, and Microsoft C for DOS; and Visual Basic, Turbo Pascal, Microsoft C with SDK, and Borland C++ for Windows. You can use your SCXI-1200, together with other PC, AT, MC, DAQCard, and SCXI hardware, with NI-DAQ software for PC compatibles.

Register-Level Programming

The final option for programming any National Instruments DAQ hardware is to write register-level software. Writing register-level programming software can be very time-consuming and inefficient, and is not recommended for most users. The *only* users who should consider writing register-level software should meet at least one of the following criteria:

- National Instruments does not support your operating system or programming language.
- You are an experienced register-level programmer who is more comfortable writing your own register-level software.

Always consider using NI-DAQ, LabVIEW, or LabWindows to program your National Instruments DAQ hardware. Using the NI-DAQ, LabVIEW, or LabWindows software is easier than, and as flexible as, register-level programming and can save you weeks of development time.

The *SCXI-1200 User Manual* and your software manuals contain complete instructions for programming your SCXI module with NI-DAQ, LabVIEW, or LabWindows. If you are using NI-DAQ, LabVIEW, or LabWindows to control your module, you should not need the register-level programmer manual. The *SCXI-1200 Register-Level Programmer Manual* contains low-level programming details, such as register maps, bit descriptions, and register programming hints, that you will need only for register-level programming. Some hardware user manuals include register map descriptions and register programming hints. If your manual does not contain a register map description and you want to obtain the register-level programmer manual, please fill out the *Register-Level Programmer Manual Request Form* at the end of this manual and send it to National Instruments.

Optional Equipment

Contact National Instruments to order any of the following optional equipment:

- SCXI-1302 front terminal block
- CB-50 I/O connector block
- Type NB1 0.5 or 1.0 m ribbon cable

Custom Cables

The SCXI-1200 front signal connector is a 50-pin male ribbon-cable header. The manufacturer part number of the header National Instruments uses is as follows:

- AMP Inc. (part number 1-103310-0)

The mating connector for the SCXI-1200 rear signal connector is a 50-position polarized ribbon-socket connector with strain relief. National Instruments uses a polarized or keyed connector to prevent inadvertent upside-down connection to the SCXI-1200.

Recommended manufacturer part numbers for this mating connector are as follows:

- Electronic Products Division/3M (part number 3425-7650)
- T&B/Ansley Corporation (part number 609-5041CE)

Standard 50-conductor 28 AWG stranded ribbon cables that work with these connectors are as follows:

- Electronic Products Division/3M (part number 3365/50)
- T&B/Ansley Corporation (part number 171-50)

The SCXI-1200 rear connector (the parallel port connector) is the standard 25-pin D-Subminiature. The manufacturer part number of the connector National Instruments uses is as follows:

- AMP Inc. (part number 747846-5)

The mating connector for the SCXI-1200 rear connector can be a standard DB-25-style male connector.

Unpacking

Your SCXI-1200 module is shipped in an antistatic package to prevent electrostatic damage to the module. Electrostatic discharge can damage several components on the module. To avoid such damage in handling the module, take the following precautions:

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

Chapter 2
Installation and Configuration

This chapter describes how to install the SCXI-1200 into the SCXI chassis and how to configure the SCXI-1200.

The SCXI-1200 combines the functionality of plug-in DAQ boards and SCXI modules. Previously, you connected the SCXI chassis with a ribbon cable to a plug-in board in the PC. Any SCXI module in the chassis could be used for this purpose. Now you can use the SCXI-1200 as a plug-in module that connects to the PC parallel port.

Hardware Installation

You can install the SCXI-1200 in any available SCXI chassis slot. After you have made any necessary changes and have verified and recorded the jumper setting on the form in Appendix C, *Customer Communication*, you are ready to install the SCXI-1200. The following are general installation instructions; consult your chassis user manual or technical reference manual for specific instructions and warnings.

1. Turn off the SCXI chassis. Do not insert the SCXI-1200 into a chassis that is turned on.
2. Insert the SCXI-1200 into the module guides. Gently guide the module into the back of the slot until the connectors make contact.
3. Screw the front mounting panel of the SCXI-1200 to the top and bottom threaded strips of your SCXI chassis.
4. Connect the parallel port cable to the PC parallel port. Connect the other end to the SCXI-1200, and screw in the mounting screws on the connectors to establish a firm connection.
5. Check the installation.
6. Turn on the SCXI chassis.
7. Turn on the computer or reconnect it to your chassis.

The SCXI-1200 board is installed. You are now ready to install and configure your software.

If you are using NI-DAQ, refer to the *NI-DAQ User Manual for PC Compatibles*. The software installation and configuration instructions are in Chapter 1, *Introduction to NI-DAQ*. Find the installation and system configuration section for your operating system and follow the instructions given there.

If you are using LabVIEW, the software installation instructions are in your LabVIEW release notes. After you have installed LabVIEW, refer to the *Configuring LabVIEW* section of Chapter 1 of your LabVIEW user manual for software configuration instructions.

If you are using LabWindows, the software installation instructions are in Part 1, *Introduction to LabWindows*, of the *Getting Started with LabWindows* manual. After you have installed LabWindows, refer to Chapter 1, *Configuring LabWindows,* of the *LabWindows User Manual* for software configuration instructions.

If you are a register-level programmer, refer to the *SCXI-1200 Register-Level Programmer Manual*.

Module Configuration

The SCXI-1200 is software calibrated and software configurable. Seven bits in the SCXI-1200 control registers configure all of the analog I/O options. If you use NI-DAQ software, these bits are automatically set or reset based on your configuration.

The SCXI-1200 has one reserved jumper, which selects the grounding scheme for the SCXIbus guard. The parts locator diagram in Figure 2-1 shows the SCXI-1200 jumper.

An IBM-compatible PC can support up to three parallel printer ports, which are designated LPT1, LPT2 and LPT3. Each port uses three consecutive I/O addresses. When you boot your system, DOS assigns the printer ports to the logical LPT designations, in the following order—LPT1, LPT2, and LPT3. The starting addresses of the parallel printer ports, in the order assigned to LPT designations, are 3BC, 378, and 278 hex. Therefore, if you have installed all three ports, 3BC hex is LPT1, 378 hex is LPT2, and 278 hex is LPT3. If you have not installed port 3BC hex, port 378 hex becomes LPT1 and port 278 hex becomes LPT2. If only one parallel port is present, it is LPT1.

The SCXI-1200 uses the parallel port hardware interrupts for interrupt-driven data acquisition. Interrupt channels 7 and 5 are commonly allocated to parallel ports. Refer to your computer technical reference manual for details about the parallel port base address and its interrupt selection.

If you use the SCXI-1200 with NI-DAQ software, you select the port and interrupt at configuration time.

The configuration utility displays onscreen all the parallel ports addresses that were detected at boot-up. You must then select the port address that you have connected to the SCXI-1200. You must also select the interrupt level of the port. When you try to save these settings, they will be tested and verified. Also, the type of parallel port (Enhanced or Centronics) will be reported. If you incorrectly specify the port address or interrupt, then an error will be reported. Refer to Appendix B, *Installation Troubleshooting,* for tips on troubleshooting.

Figure 2-1. SCXI-1200 Parts Locator Diagram

The following warnings contain important safety information concerning hazardous voltages.

Warnings: ***KEEP AWAY FROM LIVE CIRCUITS. Do not remove equipment covers or shields unless you are trained to do so. If signal wires are connected to the module or terminal block, dangerous voltages may exist even when the equipment is turned off. To avoid dangerous electrical shock, do not perform procedures involving cover or shield removal unless you are qualified to do so.***

DO NOT OPERATE DAMAGED EQUIPMENT. The safety protection features built into this module can become impaired if the module becomes damaged in any way. If it is damaged, turn the module off and do not use until service-trained personnel can check its safety. If necessary, return the module to National Instruments for service and repair to ensure that its safety is not compromised.

DO NOT SUBSTITUTE PARTS OR MODIFY EQUIPMENT. Because of the danger of introducing additional hazards, do not install unauthorized parts or modify the module. Return the module to National Instruments for service and repair to ensure that its safety features are not compromised.

Connections, including power signals to ground and vice versa, that exceed any of the maximum signal ratings on the SCXI-1200 can result in damage to the SCXI-1200 module. National Instruments is NOT liable for any damages or injuries resulting from incorrect signal connections.

Analog I/O Configuration

The SCXI-1200 is shipped from the factory with the following configuration:

- Referenced single-ended input mode
- ±5 V analog input range (bipolar)
- ±5 V analog output range (bipolar)

Table 2-1 lists all the available analog I/O bit configurations for the SCXI-1200 and shows the factory settings.

Table 2-1. Analog I/O Settings

Parameter	Configuration
Analog Output CH0 Polarity	Bipolar— ±5 V (factory setting) Unipolar—0 to 10 V
Analog Output CH1 Polarity	Bipolar— ±5 V (factory setting) Unipolar—0 to 10 V
Analog Input Range	Bipolar— ±5 V (factory setting) Unipolar—0 to 10 V
Analog Input Mode	Referenced single-ended (RSE) (factory setting) Nonreferenced single-ended (NRSE) Differential (DIFF) Analog Bus 0 (SCXI)

Both the analog input and analog output circuitries are software configurable.

Analog Output Configuration

The SCXI-1200 has two channels of analog output voltage at the I/O connector. You can configure each analog output channel for either unipolar or bipolar output. A unipolar configuration has a range of 0 to 10 V at the analog output. A bipolar configuration has a range of -5 V to +5 V at the analog output. In addition, you can select the coding scheme for each DAC as either two's complement or straight binary.

If you select a bipolar range for a DAC, the two's complement coding is recommended. In this mode, data values written to the analog output channel range from F800 hex (-2,048 decimal) to 7FF hex (2,047 decimal). If you select a unipolar range for a DAC, the straight binary coding is recommended. In this mode, data values written to the analog output channel range from 0 to FFF hex (4,095 decimal).

Analog Input Configuration

Input Mode

The SCXI-1200 has three different input modes—referenced single-ended (RSE) input, nonreferenced single-ended (NRSE) input, and differential (DIFF) input. The single-ended input configurations use eight channels. The DIFF input configuration uses four channels. Table 2-2 describes these configurations.

Table 2-2. Analog Input Configurations for the SCXI-1200

Configuration	**Description**
RSE	Referenced single-ended configuration provides eight single-ended inputs with the negative input of the instrumentation amplifier referenced to analog ground (factory setting).
NRSE	Nonreferenced single-ended configuration provides eight single-ended inputs with the negative input of the instrumentation amplifier tied to AISENSE/AIGND and not connected to ground.
DIFF	Differential configuration provides four differential inputs with the positive (+) input of the instrumentation amplifier tied to channels 0, 2, 4, or 6 and the negative (-) input tied to channels 1, 3, 5, or 7, respectively, thus choosing channel pairs (0, 1), (2, 3), (4, 5), or (6, 7).

In addition, the input circuitry can select the SCXI Analog Bus 0 when you are using the SCXI-1200 to sample data output by some other module. On power-up, the AB0 bus is not selected. Refer to the *SCXI-1200 Register-Level Programmer Manual* or your software manual for details on how to use the multiplexed module mode. When Analog Bus 0 is selected by the input circuitry, the DIFF mode is always used. Analog Bus 0+ is tied to the positive (+) input of the instrumentation amplifier. Analog Bus 0- is tied to the negative (-) input of the instrumentation amplifier. In this case, the input mode settings (RSE, NRSE, or DIFF) have no effect. However, the gain and unipolar/bipolar settings are still valid.

While reading the following paragraphs, you may find it helpful to refer to the *Analog Input Signal Connections* section of Chapter 3, *Signal Connections*, which contains diagrams showing the signal paths for the three configurations.

RSE Input (Eight Channels, Factory Setting)

RSE input means that all input signals are referenced to a common ground point that is also tied to the SCXI-1200 analog input ground. The differential amplifier negative input is tied to analog ground. The RSE configuration is useful for measuring floating signal sources. See *Types of Signal Sources* later in this chapter for more information. With this input configuration, the SCXI-1200 can monitor eight different analog input channels.

Considerations for using the RSE configuration are discussed in Chapter 3, *Signal Connections*. Notice that in this mode, the return path of the signal is analog ground, at the connector through the AISENSE/AIGND pin.

NRSE Input (Eight Channels)

NRSE input means that all input signals are referenced to the same common-mode voltage, which floats with respect to the SCXI-1200 analog ground. This common-mode voltage is subsequently subtracted by the input instrumentation amplifier. The NRSE configuration is useful for measuring ground-referenced signal sources.

Considerations for using the NRSE configuration are discussed in Chapter 3, *Signal Connections.* Notice that in this mode, the return path of the signal is through the negative terminal of the amplifier, at the connector through the AISENSE/AIGND pin.

DIFF Input (Four Channels)

DIFF input means that each input signal has its own reference, and the difference between each signal and its reference is measured. The signal and its reference are each assigned an input channel. With this input configuration, the SCXI-1200 can monitor four differential analog input signals.

Considerations for using the DIFF configuration are discussed in Chapter 3, *Signal Connections*. Notice that the signal return path is through the negative terminal of the amplifier and through channel 1, 3, 5, or 7, depending on which channel pair you select.

These three modes are all software selectable.

Analog Input Polarity and Range Configuration

You can select the analog input on the SCXI-1200 for either a unipolar range (0 to 10 V) or a bipolar range (-5 to +5 V). The range and the coding scheme are both software selectable. In addition, you can select the coding scheme for analog input as either two's complement or straight binary. If you select a bipolar range, the two's complement coding is recommended. In this mode, -5 V input corresponds to F800 hex (-2,048 decimal) and +5 V corresponds to 7FF hex (2,047 decimal). If you select a unipolar mode, the straight binary coding is recommended. In this mode, 0 V input corresponds to 0 hex, and +10 V corresponds to FFF hex (4,095 decimal).

Note: ***If Analog Bus 0 is selected by the SCXI-1200, this selection is still valid. If another module is in unipolar mode and drives Analog Bus 0, the SCXI-1200 must also be in unipolar mode.***

SCXI Configuration

The SCXI configuration circuitry is software configurable with the configuration utility. There is also one jumper, as shown in Table 2-3.

When used in the stand-alone mode, the EXTCONV* and COUTB1 lines on the front connector can be driven with suitable signals for causing external conversions and for interval scanning, respectively. When used in conjunction with other modules (the SCXI mode), the SCXI-1200 drives these pins with its own signals. These signals are also routed through the SCXI bus and to other modules. The other modules synchronize the switching of their input channels according to these signals.

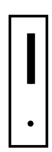
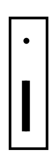
You use jumper J1 for grounding the SCXI guard to analog ground on the SCXI-1200. The position of this jumper is shown in Table 2-3. When used in stand-alone mode, this jumper should be in the default (A-B) setting. When used in conjunction with other modules, the jumper must be in the B-C setting.

Refer to the parts locator diagram in Figure 2-1 as you read the following instructions. To configure this jumper, perform the following steps:

1. Remove the grounding screw of the top cover.
2. Snap out the top cover of the shield by placing a screwdriver in the groove at the bottom of the module.
3. Remove the jumper and replace it on the appropriate pins.
4. Snap the top cover back in place.
5. Replace the grounding screw to ensure proper shielding.

Table 2-3 describes the jumper settings for different configurations.

Table 2-3. Digital Signal Connections, Jumper Settings

Jumper W1 Settings	**Description**
A NC B Guard C Guard 	Position A-B (factory setting)—The SCXI Analog Bus guard is not connected to the SCXI-1200 analog ground. When using the SCXI-1200 in stand-alone mode, use this setting.
A NC B Guard C Guard 	Position B-C—The SCXI Analog Bus guard is connected to the SCXI-1200 analog ground. When using the SCXI-1200 in conjunction with other modules, use this setting.

Chapter 3
Signal Connections

This chapter describes the signal connections to the SCXI-1200 module via the SCXI-1200 front connector and rear signal connector and includes specifications and connection instructions for the SCXI-1200 connector signals.

Warning: ***Connections that exceed any of the maximum ratings of input or output signals on the SCXI-1200 may result in damage to the SCXI-1200 module and to the PC. This includes connecting any power signals to ground and vice versa. National Instruments is NOT liable for any damages resulting from any such signal connections.***

Front Connector

Figure 3-1 shows the pin assignments for the SCXI-1200 front connector. This connector is located on the front panel of the SCXI-1200 module.

ACH0	1	2	ACH1
ACH2	3	4	ACH3
ACH4	5	6	ACH5
ACH6	7	8	ACH7
AISENSE/AIGND	9	10	DAC0OUT
AGND	11	12	DAC1OUT
DGND	13	14	PA0
PA1	15	16	PA2
PA3	17	18	PA4
PA5	19	20	PA6
PA7	21	22	PB0
PB1	23	24	PB2
PB3	25	26	PB4
PB5	27	28	PB6
PB7	29	30	PC0
PC1	31	32	PC2
PC3	33	34	PC4
PC5	35	36	PC6
PC7	37	38	EXTTRIG
EXTUPDATE*	39	40	EXTCONV*
OUTB0	41	42	GATB0
COUTB1	43	44	GATB1
CCLKB1	45	46	OUTB2
GATB2	47	48	CLKB2
+5 V	49	50	DGND

Figure 3-1. SCXI-1200 Front Connector Pin Assignments

Signal Connection Descriptions

The following table describes the connector pins on the SCXI-1200 front connector by pin number and gives the signal name and the significance of each signal connector pin.

Pin	Signal Name	Description
1–8	ACH<0..7>	Analog Channel—Analog Input channels 0 through 7 (single-ended).
9	AISENSE/AIGND	Analog Input Sense/Analog Input Ground—Analog input ground in RSE mode, AISENSE in NRSE mode. Bidirectional.
10	DAC0OUT	Digital-to-Analog Converter 0 Output—Voltage output signal for analog output channel 0.
11	AGND	Analog Ground—Analog output ground for analog output mode. Analog input ground for DIFF or NRSE mode. Bidirectional.
12	DAC1OUT	Digital-to-Analog Converter 1 Output—Voltage output signal for analog output channel 1.
13	DGND	Digital Ground—Bidirectional.
14–21	PA<0..7>	Port A 0 through 7—Bidirectional data lines for port A. PA7 is the MSB, and PA0 is the LSB.
22–29	PB<0..7>	Port B 0 through 7—Bidirectional data lines for port B. PB7 is the MSB, and PB0 is the LSB.
30–37	PC<0..7>	Port C 0 through 7—Bidirectional data lines for port C. PC7 is the MSB, and PC0 is the LSB.
38	EXTTRIG	External Trigger—External control signal to start a timed conversion sequence. Input.
39	EXTUPDATE*	External Update—External control signal to update DAC outputs. Input.
40	EXTCONV*	External Convert—External control signal to trigger A/D conversions when selected as input. Outputs conditioned conversion pulse when selected as output. Bidirectional.
41	OUTB0	Counter B0 Output—Output.
42	GATB0	Counter B0 Gate—Input.
43	COUTB1	Counter B1 Output—Counter B1 output used as HOLDTRIG for SCXI use. Pulled high for user-driven interval scanning input signal.
44	GATB1	Counter B1 Gate—Input.
45	CCLKB1	Counter B1 Clock—Input (selectable).
46	OUTB2	Counter B2—Output.
47	GATB2	Counter B2 Gate—Input.
48	CLKB2	Counter B2 Clock—Input.
49	+5 V	+5 V output, 1 A maximum.
50	DGND	Digital Ground—Output.
*Indicates that the signal is active low.		

The connector pins are grouped into analog input signal pins, analog output signal pins, digital I/O signal pins, timing I/O signal pins and SCXIbus control pins. Signal connection guidelines for each of these groups are described in the following sections.

Analog Input Signal Connections

Pins 1 through 8 are analog input signal pins for the 12-bit ADC. Pin 9, AISENSE/AIGND, is an analog common signal. You can use this pin for a general analog power ground tie to the SCXI-1200 in RSE mode, or as a return path in DIFF or NRSE mode. Pins 1 through 8 are tied to the eight single-ended analog input channels of the input multiplexer through 4.7 kΩ series resistances. Pins 2, 4, 6, and 8 are also tied to an input multiplexer for DIFF mode.

The following input ranges and maximum ratings apply to inputs ACH<0..7>:

- Input signal range
  - Bipolar input ±(5/gain) V
  - Unipolar input 0 to (10/gain) V
- Maximum input voltage rating ±42 V powered on or off

Warning: ***Exceeding the input signal range results in distorted input signals. Exceeding the maximum input voltage rating may cause damage to the SCXI-1200 module and to the computer. National Instruments is NOT liable for any damages resulting from such signal connections.***

How you connect analog input signals to the SCXI-1200 depends on how you configure the SCXI-1200 analog input circuitry and the type of input signal source. With different SCXI-1200 configurations, you can use the SCXI-1200 instrumentation amplifier in different ways. Figure 3-2 shows a diagram of the SCXI-1200 instrumentation amplifier.

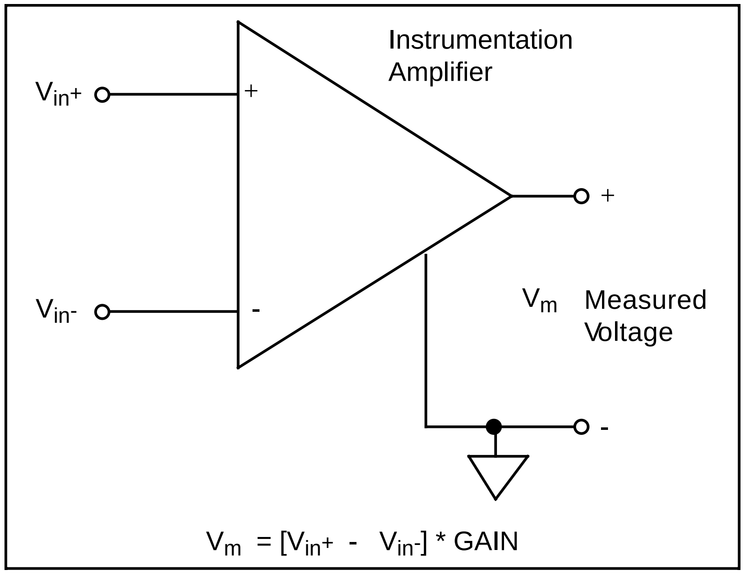


Figure 3-2. SCXI-1200 Instrumentation Amplifier

The SCXI-1200 instrumentation amplifier applies gain, common-mode voltage rejection, and high-input impedance to the analog input signals connected to the SCXI-1200 module. Signals are routed to the positive and negative inputs of the instrumentation amplifier through input multiplexers on the SCXI-1200. The instrumentation amplifier converts two input signals to a signal that is the difference between the two input signals multiplied by the gain setting of the amplifier. The amplifier output voltage is referenced to the SCXI-1200 ground. The SCXI-1200 ADC measures this output voltage when it performs A/D conversions.

All signals must be referenced to ground, either at the source device or at the SCXI-1200. If you have a floating source, you must use a ground-referenced input connection at the SCXI-1200. If you have a grounded source, you must use a nonreferenced input connection at the SCXI-1200.

Types of Signal Sources

When configuring the input mode of the SCXI-1200 and making signal connections, you must first determine whether the signal source is floating or ground referenced. These two types of signals are described as follows.

Floating Signal Sources

A floating signal source is not connected in any way to the building ground system but has an isolated ground-reference point. Some examples of floating signal sources are outputs of transformers, thermocouples, battery-powered devices, optical isolator outputs, and isolation amplifiers. You must tie the ground reference of a floating signal to the SCXI-1200 analog input ground to establish a local or onboard reference for the signal. Otherwise, the measured input signal varies or appears to float. An instrument or device that supplies an isolated output falls into the floating signal source category.

Ground-Referenced Signal Sources

A ground-referenced signal source is connected in some way to the building system ground and is therefore already connected to a common ground point with respect to the SCXI-1200, assuming that the PC is plugged into the same power system. Nonisolated outputs of instruments and devices that plug into the building power system fall into this category.

The difference in ground potential between two instruments connected to the same building power system is typically between 1 mV and 100 mV but can be much higher if power distribution circuits are not properly connected. The connection instructions that follow for grounded signal sources eliminate this ground potential difference from the measured signal.

Input Configurations

You can configure the SCXI-1200 for one of three input modes—RSE, NRSE, or DIFF. The following sections discuss the use of single-ended and differential measurements, and considerations for measuring both floating and ground-referenced signal sources. Table 3-1 summarizes the recommended input configurations for both types of signal sources.

Table 3-1. Recommended Input Configurations for Ground-Referenced and Floating Signal Sources

Type of Signal	Recommended Input Configuration
Ground-Referenced (nonisolated outputs, plug-in instruments)	DIFF NRSE
Floating (batteries, thermocouples, isolated outputs)	DIFF with bias resistors RSE

Differential Connection Considerations (DIFF Configuration)

Differential connections are those in which each SCXI-1200 analog input signal has its own reference signal or signal return path. These connections are available when you configure the SCXI-1200 in the DIFF mode. Each input signal is tied to the positive input of the instrumentation amplifier, and its reference signal, or return, is tied to the negative input of the instrumentation amplifier.

When you configure the SCXI-1200 for DIFF input, each signal uses two of the multiplexer inputs—one for the signal and one for its reference signal. Therefore, only four analog input channels are available when using the DIFF configuration. You should use the DIFF input configuration when any of the following conditions are present:

- Input signals are low level (less than 1 V).
- Leads connecting the signals to the SCXI-1200 are greater than 15 ft.

- Any of the input signals requires a separate ground-reference point or return signal.
- The signal leads travel through noisy environments.

Differential signal connections reduce picked-up noise and increase common-mode signal and noise rejection. With these connections, input signals can float within the common-mode limits of the input instrumentation amplifier.

Differential Connections for Grounded Signal Sources

Figure 3-3 shows how to connect a ground-referenced signal source to an SCXI-1200 module configured for DIFF input. Configuration instructions are included in the *Analog Input Configuration* section in Chapter 2, *Installation and Configuration*.

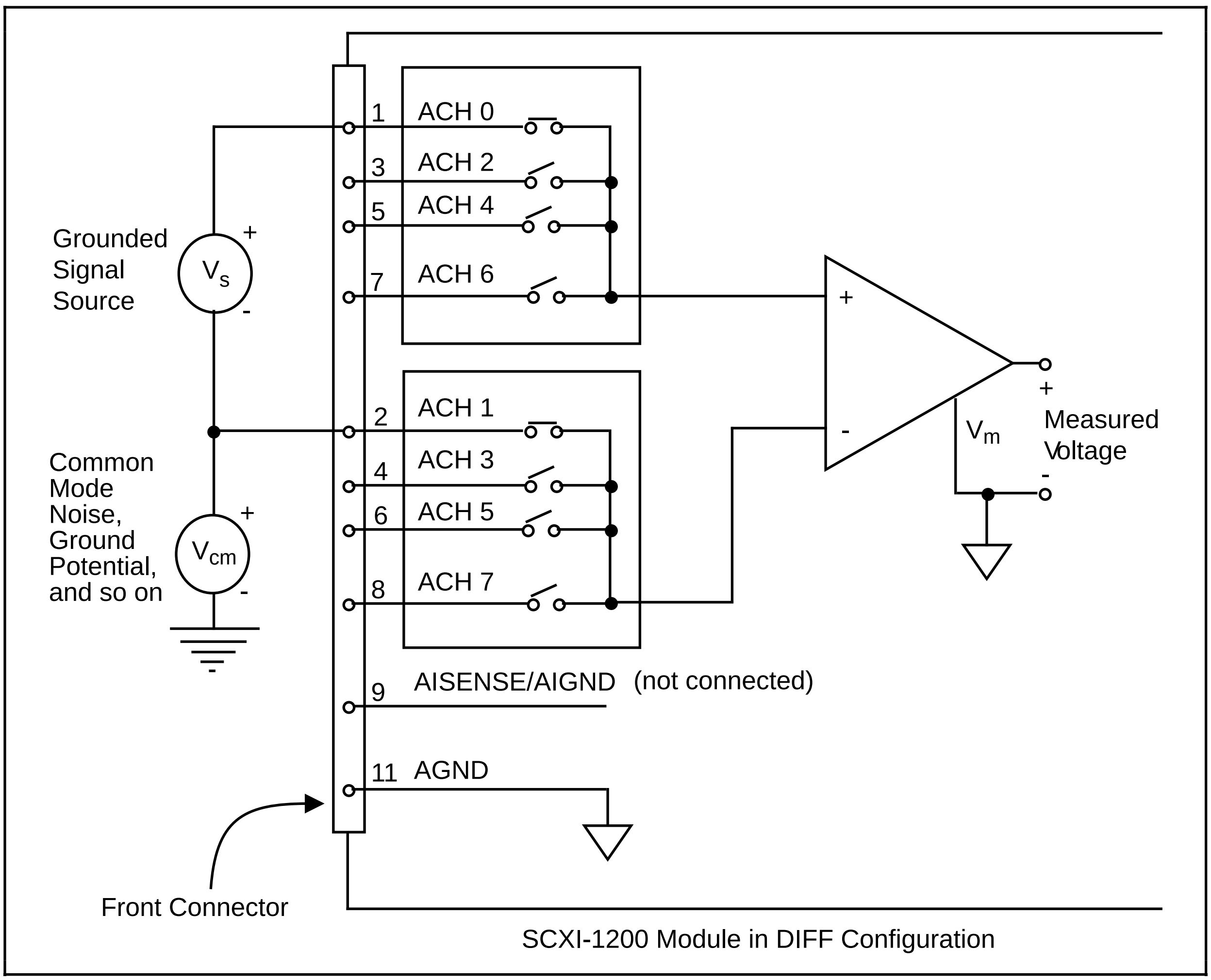


Figure 3-3. Differential Input Connections for Grounded Signal Sources

With this type of connection, the instrumentation amplifier rejects both the common-mode noise in the signal and the ground-potential difference between the signal source and the SCXI-1200 ground (shown as V_{CM} in Figure 3-3).

Differential Connections for Floating Signal Sources

Figure 3-4 shows how to connect a floating signal source to a SCXI-1200 module that is configured for DIFF input. Configuration instructions are included in the *Analog Input Configuration* section of Chapter 2*, Installation and Configuration*.

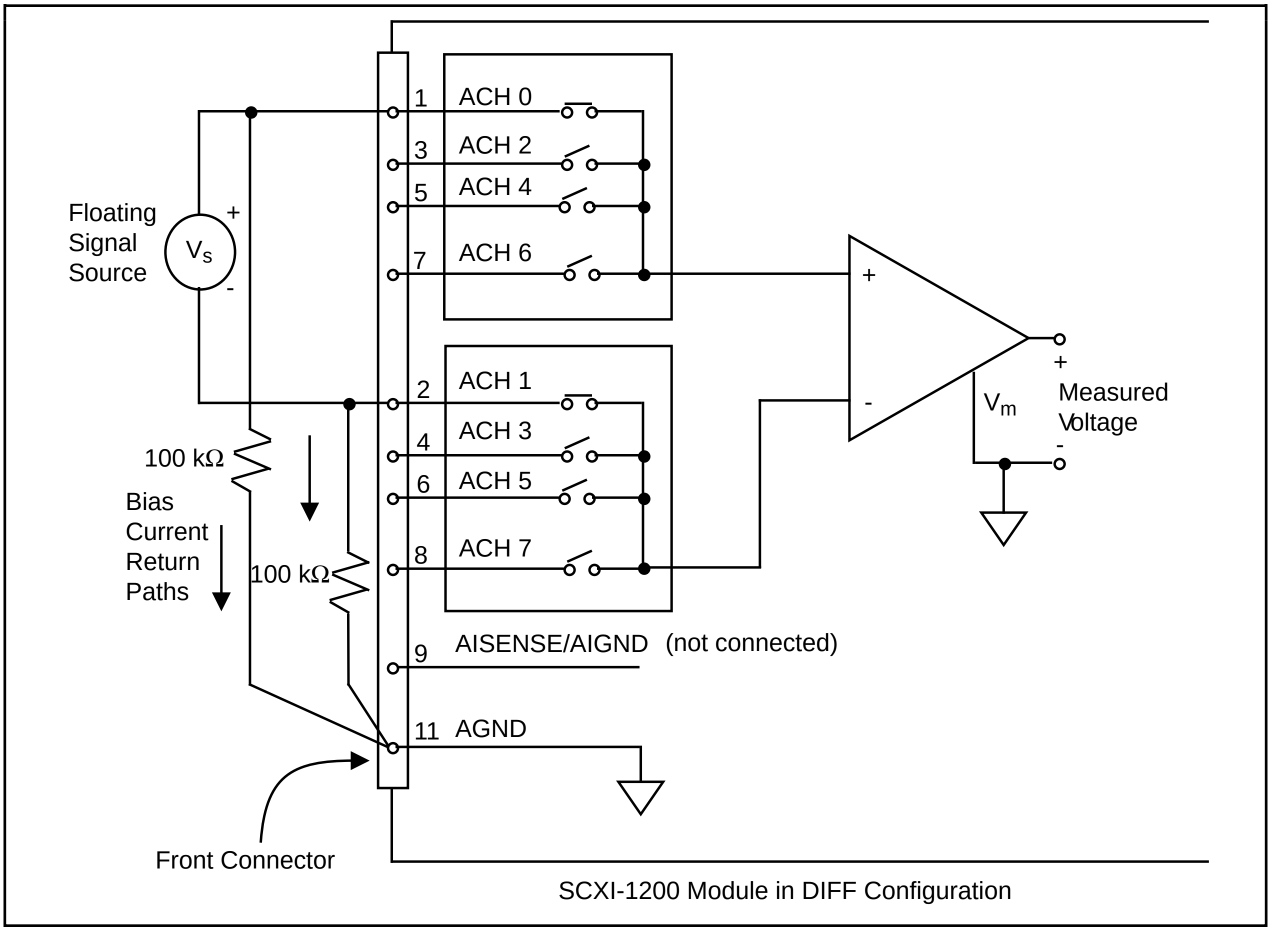


Figure 3-4. Differential Input Connections for Floating Sources

The 100 kΩ resistors shown in Figure 3-4 create a return path to ground for the bias currents of the instrumentation amplifier. If there is no return path, the instrumentation amplifier bias currents charge stray capacitances, resulting in uncontrollable drift and possible saturation in the amplifier. Typically, values from 10 to 100 kΩ are used.

A resistor from each input to ground, as shown in Figure 3-4, provides bias current return paths for an AC-coupled input signal.

If the input signal is DC-coupled, you need only the resistor that connects the negative signal input to ground. This connection does not lower the input impedance of the analog input channel.

Single-Ended Connection Considerations

Single-ended connections are those in which all SCXI-1200 analog input signals are referenced to one common ground. The input signals are tied to the positive input of the instrumentation amplifier, and their common ground point is tied to the negative input of the instrumentation amplifier.

When the SCXI-1200 is configured for single-ended input (NRSE or RSE), eight analog input channels are available. You can use single-ended input connections when the following criteria are met by all input signals:

1. Input signals are high level (greater than 1 V).
2. Leads connecting the signals to the SCXI-1200 are less than 15 ft.
3. All input signals share a common reference signal (at the source).

If any of the preceding criteria are not met, using DIFF input configuration is recommended.

You can jumper configure the SCXI-1200 for two different types of single-ended connections, RSE configuration and NRSE configuration. Use the RSE configuration for floating signal sources; in this case, the SCXI-1200 provides the reference ground point for the external signal. Use the NRSE configuration for ground-referenced signal sources; in this case, the external signal supplies its own reference ground point and the SCXI-1200 should not supply one.

Single-Ended Connections for Floating Signal Sources (RSE Configuration)

Figure 3-5 shows how to connect a floating signal source to a SCXI-1200 module configured for single-ended input. You must configure the SCXI-1200 analog input circuitry for RSE input to make these types of connections. Configuration instructions are included in the *Analog Input Configuration* section of Chapter 2, *Installation and Configuration*.

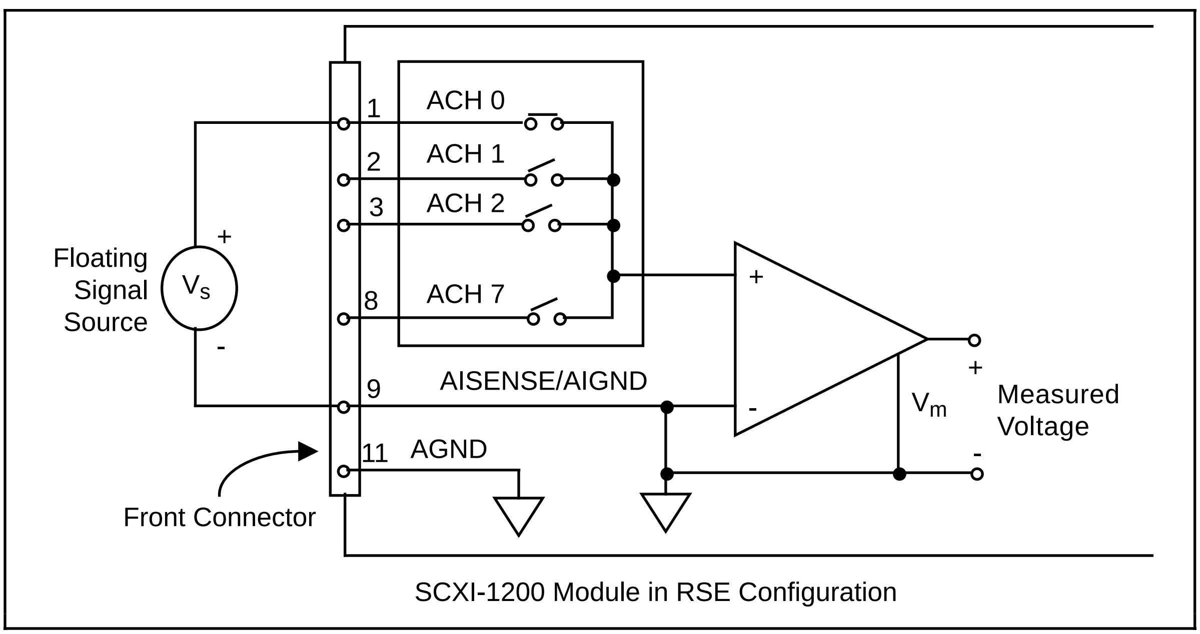


Figure 3-5. Single-Ended Input Connections for Floating Signal Sources

Single-Ended Connections for Grounded Signal Sources (NRSE Configuration)

If you measure a grounded signal source with a single-ended configuration, you must configure the SCXI-1200 in the NRSE input configuration. The signal is connected to the positive input of the SCXI-1200 instrumentation amplifier and the signal local ground reference is connected to the negative input of the SCXI-1200 instrumentation amplifier. Therefore, you must connect the ground point of the signal to the AISENSE pin. Any potential difference between the SCXI-1200 ground and the signal ground appears as a common-mode signal at both the positive and negative inputs of the instrumentation amplifier and is therefore rejected by the amplifier. On the other hand, if the input circuitry of the SCXI-1200 is referenced to ground, such as in the RSE configuration, this difference in ground potentials appears as an error in the measured voltage.

Figure 3-6 shows how to connect a grounded signal source to a SCXI-1200 module configured in the NRSE configuration. Configuration instructions are included in the *Analog Input Configuration* section in Chapter 2, *Installation and Configuration*.

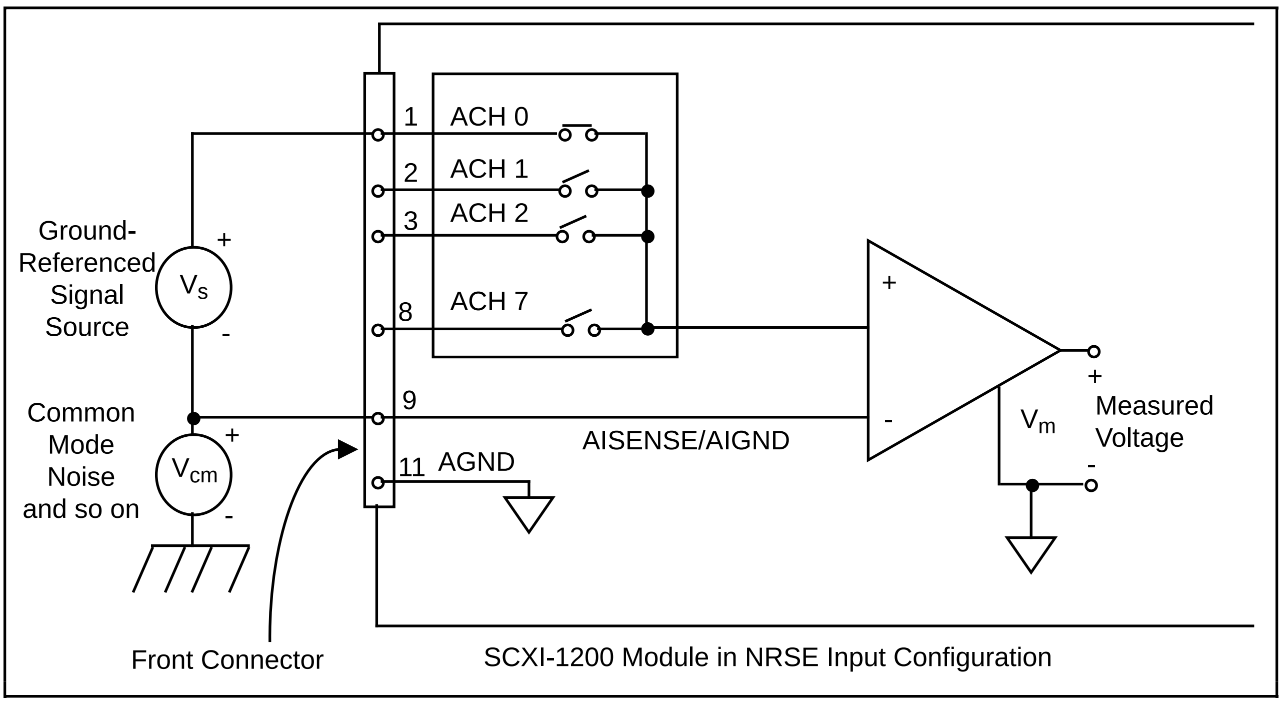


Figure 3-6. Single-Ended Input Connections for Grounded Signal Sources

Common-Mode Signal Rejection Considerations

Figures 3-3 and 3-6 show connections for signal sources that are already referenced to some ground point with respect to the SCXI-1200. In these cases, the instrumentation amplifier can reject any voltage caused by ground-potential differences between the signal source and the SCXI-1200. In addition, with differential input connections, the instrumentation amplifier can reject common-mode noise pickup in the leads connecting the signal sources to the SCXI-1200.

The common-mode input range of the SCXI-1200 instrumentation amplifier is the magnitude of the greatest common-mode signal that can be rejected.

The common-mode input range for the SCXI-1200 depends on the size of the differential input signal ($V_{diff} = V^{+}_{in} - V^{-}_{in}$) and the gain setting of the instrumentation amplifier. In unipolar mode, the differential input range is 0 to 10 V. In bipolar mode, the differential input range is -5 to +5 V. Inputs should remain within a range of -5 to 10 V in both bipolar and unipolar modes.

Analog Output Signal Connections

Pins 10 through 12 of the front connector are analog output signal pins.

Pins 10 and 12 are the DAC0OUT and DAC1OUT signal pins. DAC0OUT is the voltage output signal for analog output channel 0. DAC1OUT is the voltage output signal for analog output channel 1.

Pin 11, AGND, is the ground-reference point for both analog output channels as well as analog input.

The following output ranges are available:

- Output signal range
  - Bipolar input ±5 V*
  - Unipolar input 0 to 10 V*

*Maximum load current ±5 mA for 12-bit linearity.

Figure 3-7 shows how to make analog output signal connections.

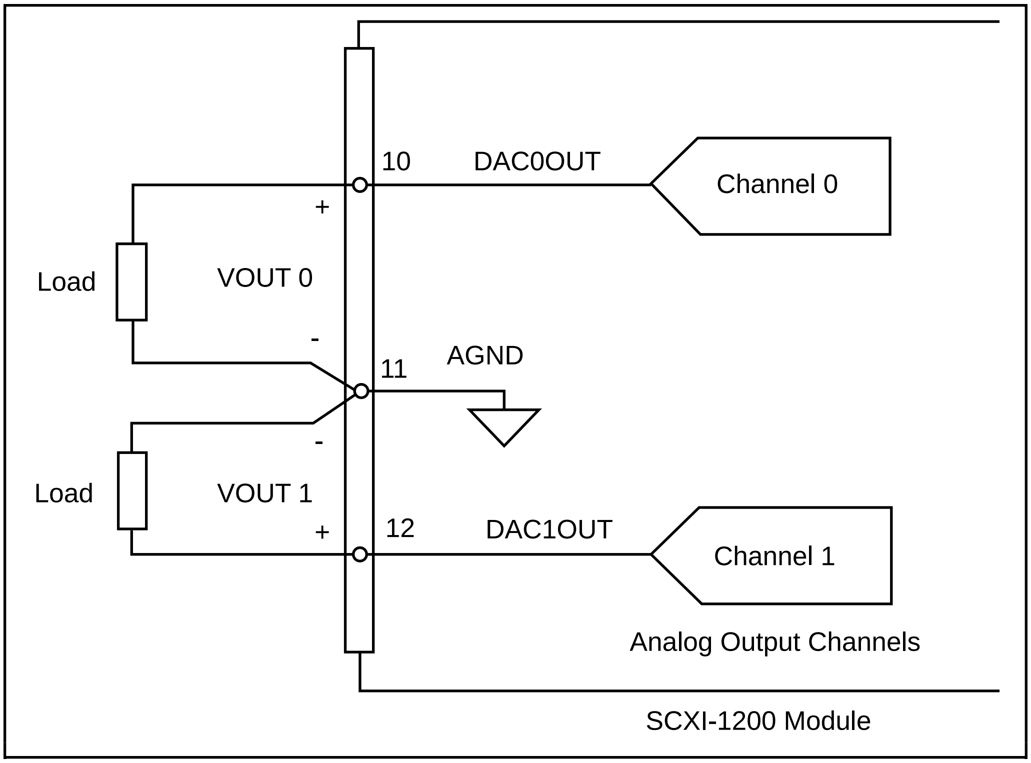


Figure 3-7. Analog Output Signal Connections

Digital I/O Signal Connections

Pins 13 through 37 of the front connector are digital I/O signal pins. Digital I/O on the SCXI-1200 uses the 82C55A integrated circuit. The 82C55A is a general-purpose peripheral interface containing 24 programmable I/O pins. These pins represent the three 8-bit ports (PA, PB, and PC) of the 8255A.

Pins 14 through 21 are connected to the digital lines PA<0..7> for digital I/O port A. Pins 22 through 29 are connected to the digital lines PB<0..7> for digital I/O port B. Pins 30 through 37 are connected to the digital lines PC<0..7> for digital I/O port C. Pin 13, DGND, is the digital ground pin for all three digital I/O ports.

The following specifications and ratings apply to the digital I/O lines.

- Absolute maximum voltage input rating +5.5 V with respect to DGND
  -0.5 V with respect to DGND
- Logical inputs and outputs
- Digital I/O lines

Digital I/O lines	**Min**	**Max**
– Input logic low voltage	0 V	0.8 V
– Input logic high voltage	2.0 V	5.25 V

	Min	Max
• Output logic low voltage (at output current = 1.7 mA)	0 V	0.45 V
• Output logic high voltage (at output current = -200 µA)	2.4 V	5.0 V
• Input load current ($0 < V_{in} < 5$ V)	-10.0 V	10 µA
• Darlington drive current (R_{EXT} = 750 Ω, V_{EXT} = 1.5 V)	-1.0 V	-4.0 mA

Figure 3-8 illustrates signal connections for three typical digital I/O applications.

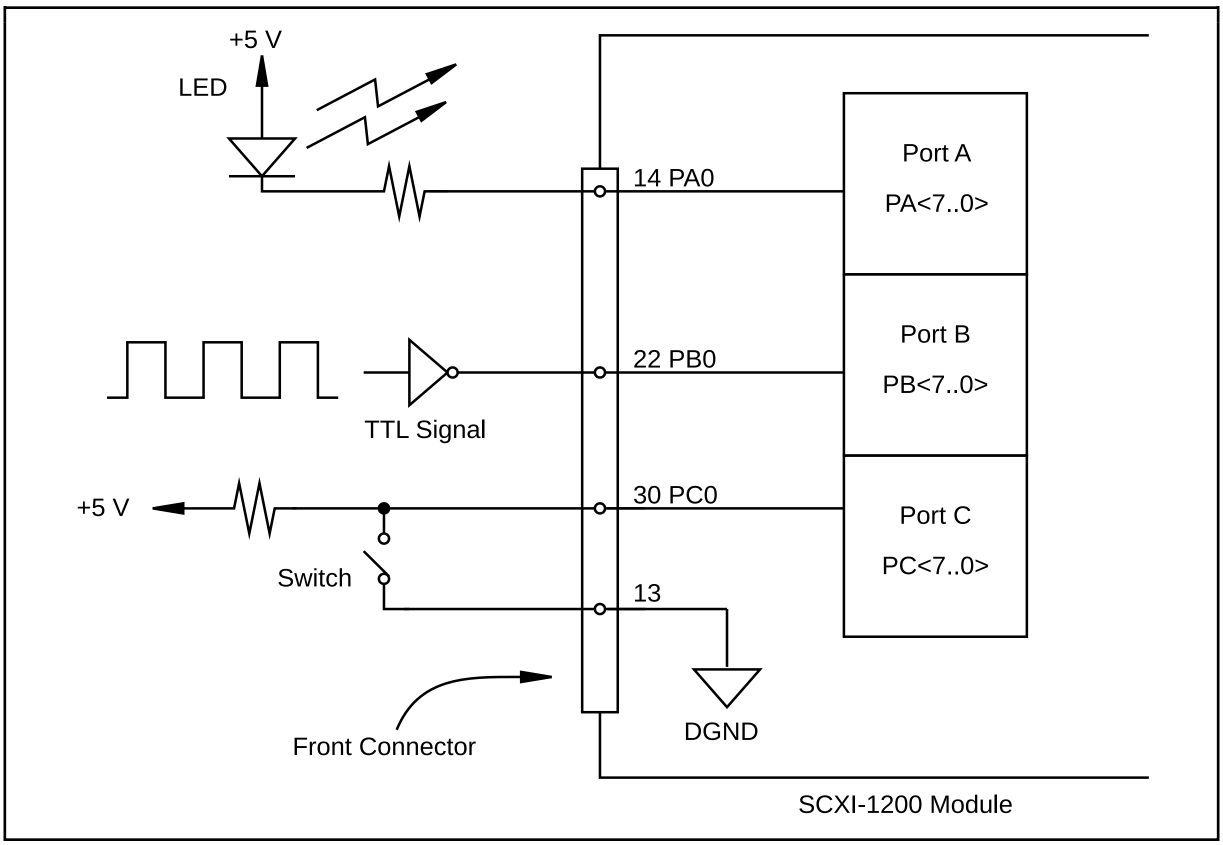


Figure 3-8. Digital I/O Connections

In Figure 3-8, port A is configured for digital output, and ports B and C are configured for digital input. Digital input applications include receiving TTL signals and sensing external device states such as the switch in Figure 3-8. Digital output applications include sending TTL signals and driving external devices such as the LED shown in Figure 3-8.

Port C Pin Connections

The signals assigned to port C depend on the mode in which the 82C55A is programmed. In mode 0, port C is considered to be two 4-bit I/O ports. In modes 1 and 2, port C is used for status and handshaking signals with two or three I/O bits mixed in. The following table summarizes the signal assignments of port C for each programmable mode. Refer to the *SCXI-1200 Register-Level Programmer Manual* for programming information.

Table 3-2. Port C Signal Assignments

Programmable Mode	**Group A**					**Group B**		
	PC7	**PC6**	**PC5**	**PC4**	**PC3**	**PC2**	**PC1**	**PC0**
Mode 0	I/O	I/O	I/O	I/O	I/O	I/O	I/O	I/O
Mode 1 Input	I/O	I/O	IBF_A	STB_A*	$INTR_A$	STB_B*	$IBFB_B$	$INTR_B$
Mode 1 Output	OBF_A*	ACK_A*	I/O	I/O	$INTR_A$	ACK_B*	OBF_B*	$INTR_B$
Mode 2	OBF_A*	ACK_A*	IBF_A	STB_A*	$INTR_A$	I/O	I/O	I/O
*Indicates that the signal is active low.								

Timing Specifications

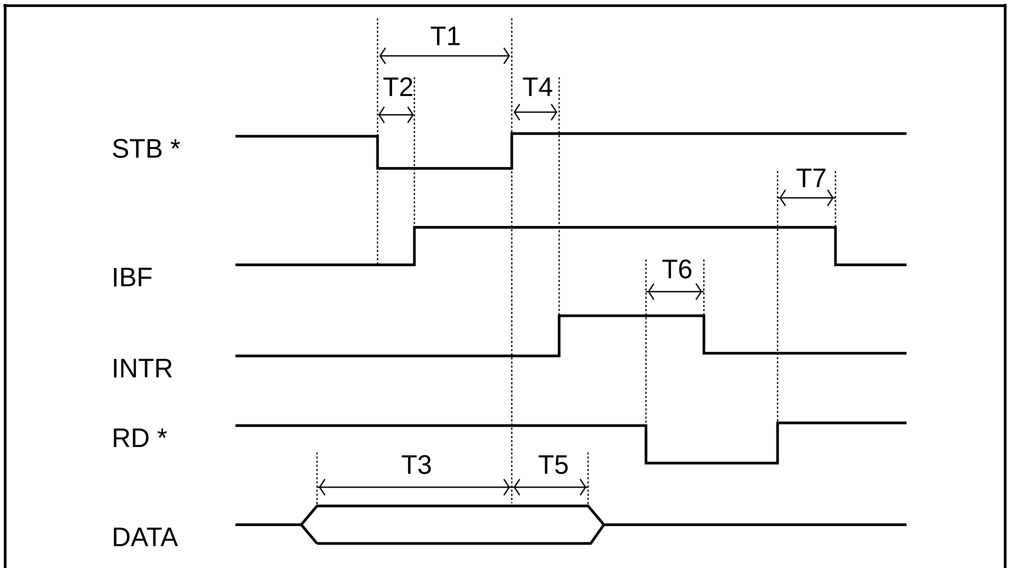
Use the handshaking lines STB* and IBF to synchronize input transfers. Use the handshaking lines OBF* and ACK* to synchronize output transfers.

The following signals are used in the timing diagrams shown later in this chapter:

Name	**Type**	**Description**
STB*	Input	Strobe Input—A low signal on this handshaking line loads data into the input latch.
IBF	Output	Input Buffer Full—A high signal on this handshaking line indicates that data has been loaded into the input latch. This is primarily an input acknowledge signal.
ACK*	Input	Acknowledge Input—A low signal on this handshaking line indicates that the data written from the specified port has been accepted. This signal is primarily a response from the external device that it has received the data from the SCXI-1200.
OBF*	Output	Output Buffer Full—A low signal on this handshaking line indicates that data has been written from the specified port.
INTR	Output	Interrupt Request—This signal becomes high when the 8255A is requesting service during a data transfer. Set the appropriate interrupt enable signals to generate this signal.
RD*	Internal	Read Signal—This signal is the read signal generated from the control lines of the PC I/O channel.
WR*	Internal	Write Signal—This signal is the write signal generated from the control lines of the PC I/O channel.
DATA	Bidirectional	Data Lines at the Specified Port—This signal indicates when the data on the data lines at a specified port is or should be available.

Mode 1 Input Timing

The timing specifications for an input transfer in mode 1 are as follows:

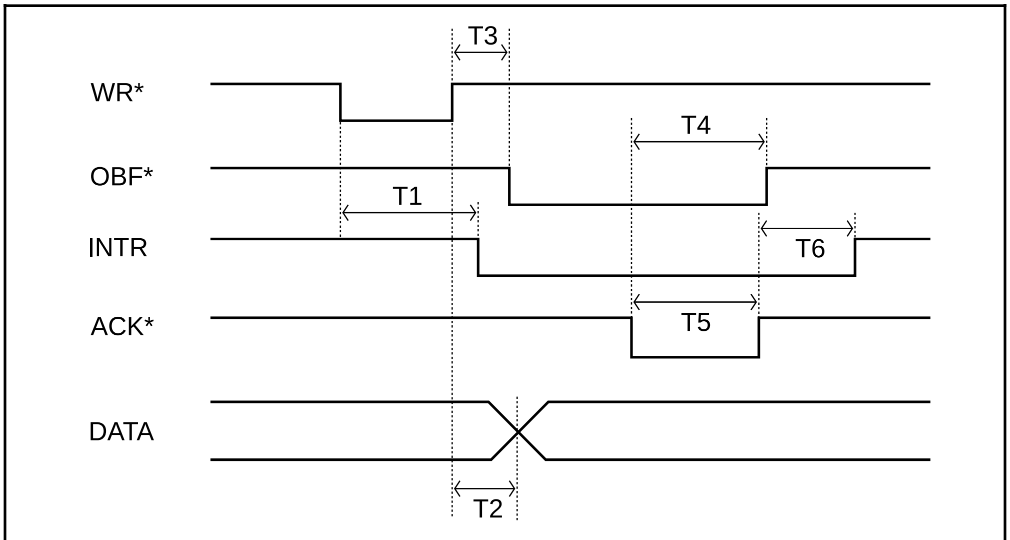


Name	Description	Minimum	Maximum
T1	STB* pulse width	500	–
T2	STB* = 0 to IBF = 1	–	300
T3	Data before STB*= 1	0	–
T4	STB* = 1 to INTR = 1	–	300
T5	Data after STB* = 1	180	–
T6	RD* = 0 to INTR = 0	–	400
T7	RD* = 1 to IBF = 0	–	300
All timing values are in nanoseconds.			

Figure 3-9. Mode 1 Timing Specifications for Input Transfers

Mode 1 Output Timing

The timing specifications for an output transfer in mode 1 are as follows:

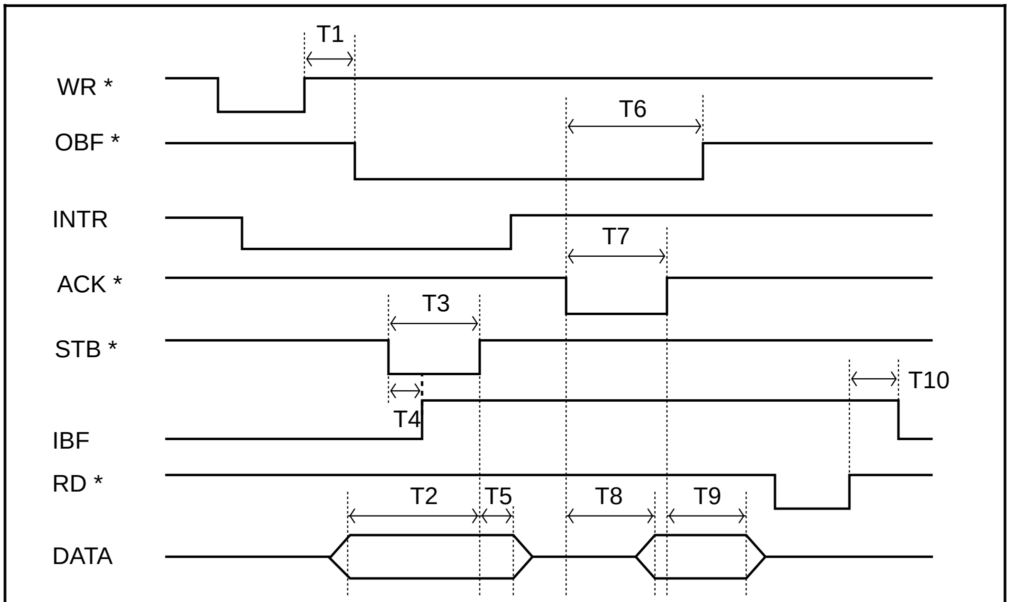


Name	Description	Minimum	Maximum
T1	WR* = 0 to INTR = 0	–	450
T2	WR* = 1 to output	–	350
T3	WR* = 1 to OBF* = 0	–	650
T4	ACK* = 0 to OBF* = 1	–	350
T5	ACK* pulse width	300	–
T6	ACK* = 1 to INTR = 1	–	350
All timing values are in nanoseconds.			

Figure 3-10. Mode 1 Timing Specifications for Output Transfers

Mode 2 Bidirectional Timing

The timing specifications for bidirectional transfers in mode 2 are as follows:



Name	Description	Minimum	Maximum
T1	WR* = 1 to OBF* = 0	–	650
T2	Data before STB*= 1	0	–
T3	STB* pulse width	500	–
T4	STB* = 0 to IBF = 1	–	300
T5	Data after STB* = 1	180	–
T6	ACK* = 0 to OBF = 1	–	350
T7	ACK* pulse width	300	–
T8	ACK* = 0 to output	–	300
T9	ACK* = 1 to output float	20	250
T10	RD* = 1 to IBF = 0	–	300
All timing values are in nanoseconds.			

Figure 3-11. Mode 2 Timing Specification for Bidirectional Transfers

Timing Connections

Pins 38 through 48 of the front connector are connections for timing I/O signals. The SCXI-1200 timing I/O uses two 82C53 counter/timer integrated circuits. One circuit, designated 82C53(A), is used exclusively for DAQ timing, and the other, 82C53(B), is available for general use. Pins 38 through 40 carry external signals that you can use for DAQ timing in place of the dedicated 82C53(A). These signals are explained in the next section, *DAQ Timing Connections*. Pins 41 through 48 carry general-purpose timing signals from 82C53(B). These signals are explained in the *General-Purpose Timing Signal Connections and General-Purpose Counter/Timing Signals* section later in this chapter.

DAQ Timing Connections

Each 82C53 counter/timer circuit has three counters. Counter 0 on the 82C53(A) counter/timer (referred to as A0) is a sample interval counter in timed A/D conversions. Counter 1 on the 82C53(A) counter/timer (referred to as A1) is a sample counter that works in conjunction with counter 0 for data acquisition. These counters are not available for general use. In addition to counter A0, you can use EXTCONV* to externally time conversions. See the *SCXI-1200 Register-Level Programmer Manual* for the programming sequence you need to enable this input. Figure 3-12 shows the timing requirements for the EXTCONV* input. An A/D conversion is initiated by a falling edge on the EXTCONV*.

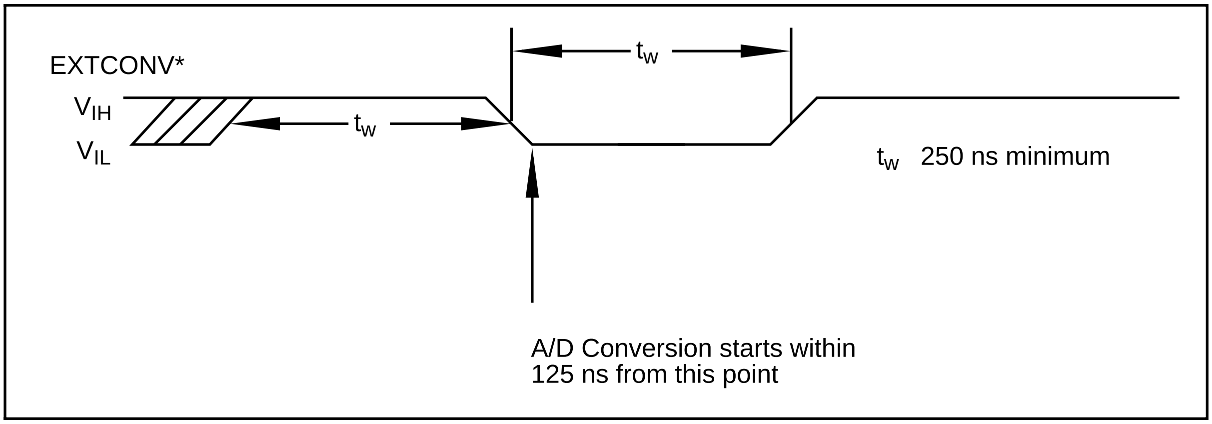


Figure 3-12. EXTCONV* Signal Timing

Another external control, EXTTRIG, can either start a DAQ sequence or terminate an ongoing DAQ sequence, depending on the mode—Hardware Trigger (HWTRIG) or Pretrigger (PRETRIG). These modes are software selectable.

In the HWTRIG mode, EXTTRIG serves as an external trigger to start a DAQ sequence. In this mode, posttrigger mode, the sample interval counter is gated off until a rising edge is sensed on the EXTTRIG line. External conversions, however, are enabled on the first rising edge of EXTCONV*, following the rising edge on the EXTTRIG line. Further transitions on the EXTTRIG line have no effect until a new DAQ sequence is established.

Figures 3-13 and 3-14 illustrate two possible posttrigger DAQ timing cases. In Figure 3-13, the rising edge on EXTTRIG is sensed when the EXTCONV* input is high. Thus, the first A/D conversion occurs on the second falling edge of EXTCONV*, after the rising edge on EXTTRIG. In Figure 3-14, the rising edge on EXTTRIG is sensed when the EXTCONV* input is low. In this case, the first A/D conversion occurs on the first falling edge of EXTCONV*, after the rising edge on EXTTRIG.

Notice that Figures 3-13 and 3-14 show a controlled acquisition mode DAQ sequence; that is, sample counter A1 disables further A/D conversions after the programmed count (3 in the examples shown in Figures 3-13 and 3-14) expires. The counter is not loaded with the programmed count until the first falling edge following a rising edge on the clock input; therefore two extra conversion pulses are generated as shown in Figures 3-13 and 3-14. You can also use EXTTRIG as an external trigger in free-run acquisition mode.

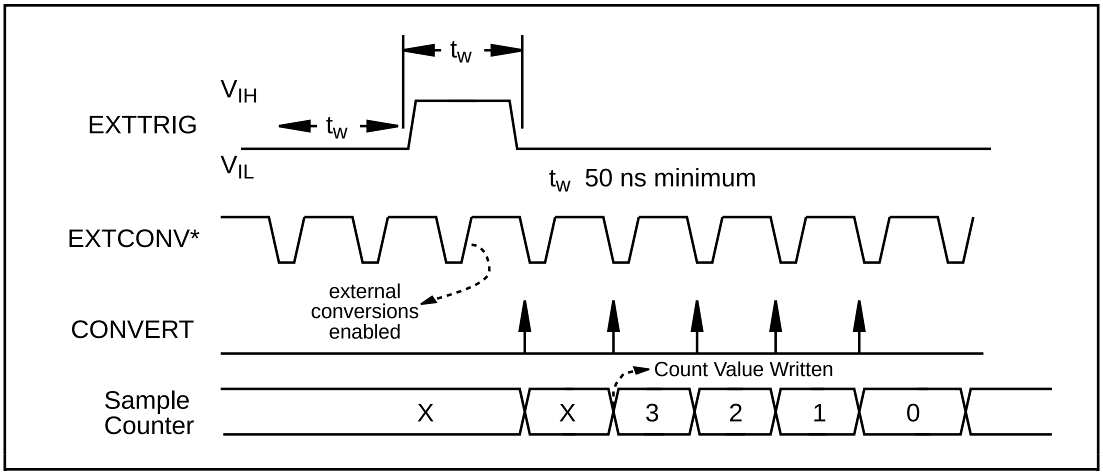


Figure 3-13. Posttrigger DAQ Timing Case 1

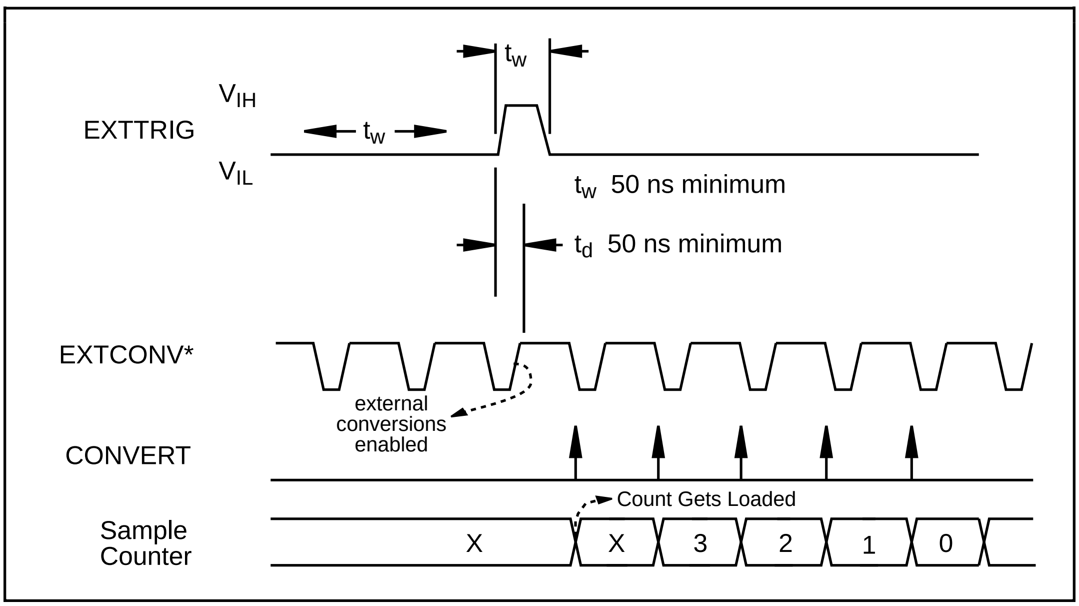


Figure 3-14. Posttrigger DAQ Timing Case 2

In the PRETRIG mode, EXTTRIG serves as a pretrigger signal. In pretrigger mode, A/D conversions are enabled via software before a rising edge is sensed on the EXTTRIG input. However, the sample counter, counter A1, is not gated on until a rising edge is sensed on the EXTTRIG input. Additional transitions on this line have no effect until you initiate a new DAQ sequence. Conversions remain enabled for the programmed count after the trigger; therefore, data can be acquired before and after the trigger. Pretrigger mode works only in controlled acquisition mode, that is, counter A1 is required to disable A/D conversions after the programmed count expires. Thus, the maximum number of samples acquired after the trigger is limited to 65,535. The number of samples acquired before the trigger is limited only by the size of the memory buffer available for data acquisition. Figure 3-15 shows a pretrigger DAQ timing sequence. Notice that, because A1 is loaded and armed, it allows exactly four pulses after the EXTTRIG pulses.

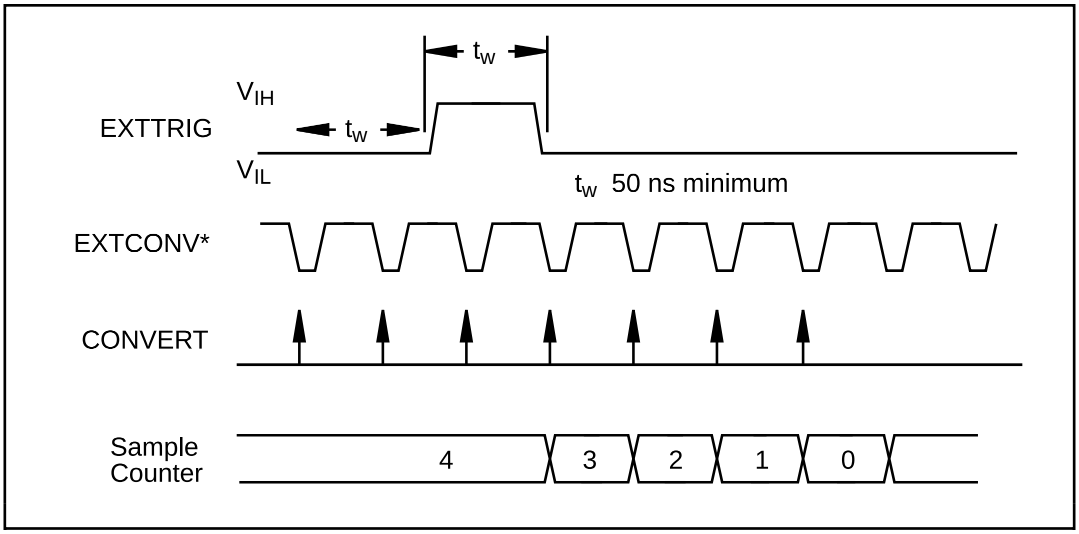


Figure 3-15. Pretrigger DAQ Timing

Because both pretrigger and posttrigger modes use EXTTRIG input, you can only use one mode at a time.

You can use the OUTB1 pin to initiate timing intervals in the interval acquisition modes. This is explained in detail in the *Timing I/O Circuitry* section in Chapter 4, *Theory of Operations*.

You use the final external control signal, EXTUPDATE*, to externally control updating the output voltage of the 12-bit DACs or to generate an externally timed interrupt. There are two update modes, immediate update and later update. In immediate update mode the analog output is updated as soon as the value is written into the DAC. If you select the later update mode, the corresponding DAC voltage is updated by a low level on the EXTUPDATE* signal. Furthermore, if you enable interrupt generation, an interrupt is generated whenever a rising edge is detected on the EXTUPDATE* bit. Therefore, you can perform externally timed, interrupt-driven waveform generation on the SCXI-1200. Figure 3-16 illustrates a waveform generation timing sequence using the EXTUPDATE* signal. Notice that the DACs are updated by a *low level* on the EXTUPDATE* line. Any writes to the DAC data registers while EXTUPDATE* is low therefore result in immediate update of the DAC output voltages.

In the following figures, DAC OUTPUT UPDATE is the pulse that updates the analog output, CNTINT is the signal that interrupts the PC, DACWRT is the signal that writes a new value to the DAC< and TMRINTCLR is the signal that clears the interrupt.

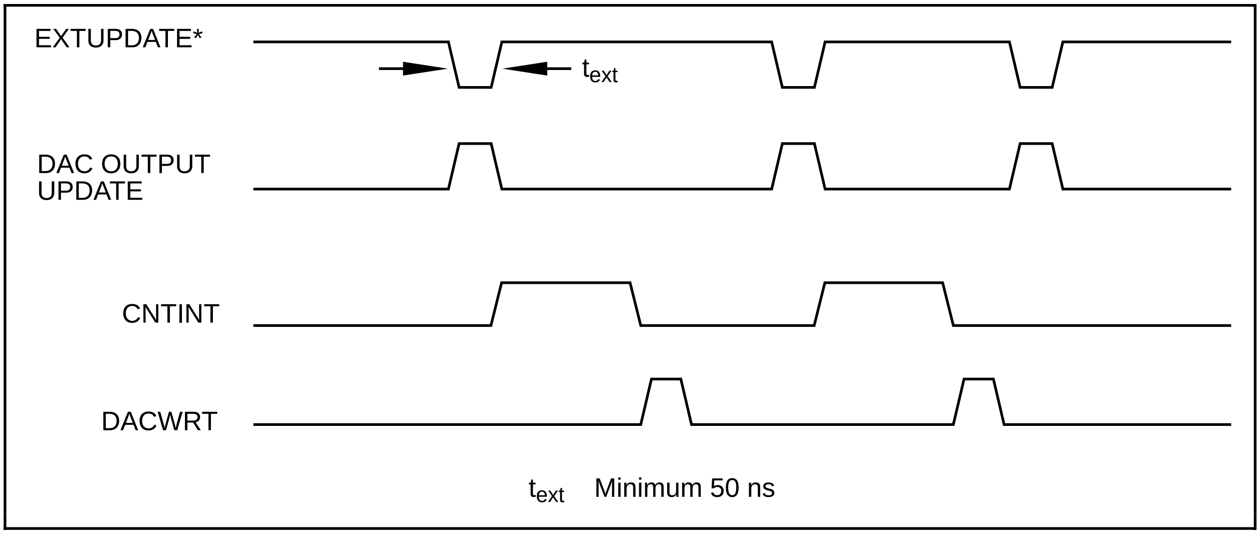


Figure 3-16. EXTUPDATE* Signal Timing for Updating DAC Output

The following rating applies to the EXTCONV*, EXTTRIG and EXTUPDATE* signals.

- Absolute maximum voltage input rating -0.5 to 7.0 V with respect to DGND

General-Purpose Timing Signal Connections and General-Purpose Counter/Timer Signals

The general-purpose timing signals include the GATE, CLK, and OUT signals for the three 82C53(B) counters. The 82C53 counter/timers can be used for general-purpose applications such as pulse and square wave generation; event counting; and pulse-width, time-lapse, and frequency measurement. For these applications, CLK and GATE signals are sent to the counters, and the counters are programmed for various operations. The single exception is counter B0, which has an internal 2 MHz clock.

You perform pulse and square wave generation by programming a counter to generate a timing signal at its OUT output pin.

You perform event counting by programming a counter to count rising or falling edges applied to any of the 82C53 CLK inputs. You can then read the counter value to determine the number of edges that have occurred. You can gate counter operation on and off during event counting. Figure 3-17 shows connections for a typical event-counting operation in which a switch is used to gate the counter on and off.

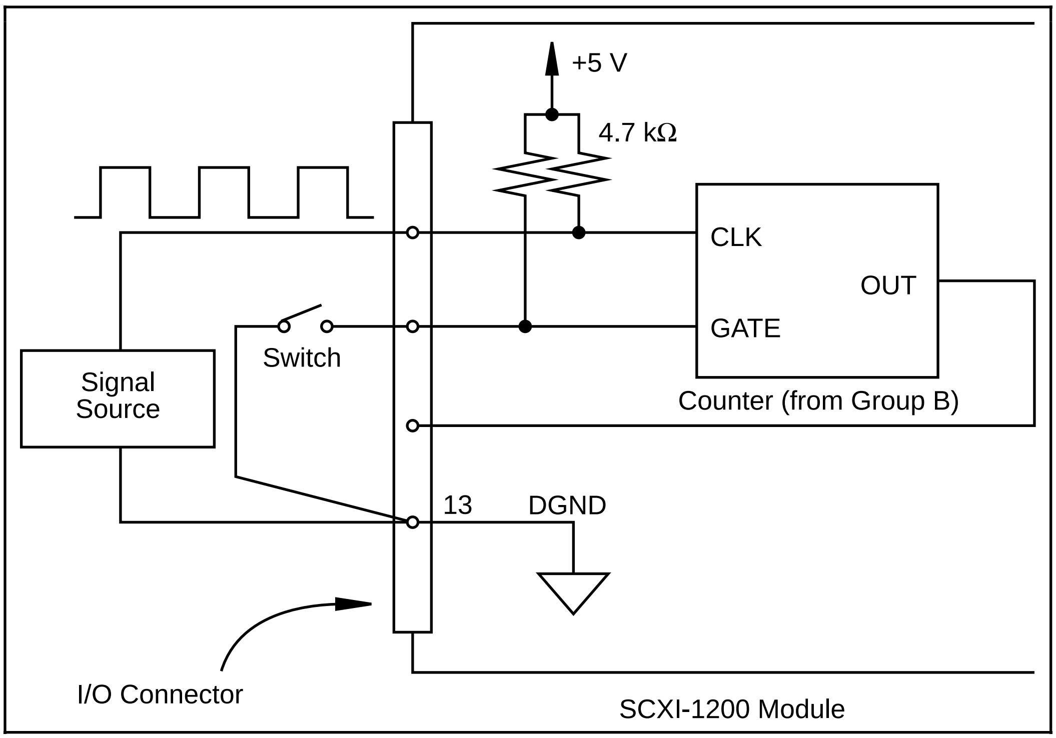


Figure 3-17. Event-Counting Application with External Switch Gating

Pulse-width measurement is performed by level gating. The pulse you want to measure is applied to the counter GATE input. The counter is loaded with the known count and is programmed to count down while the signal at the GATE input is high. The pulse width equals the counter difference (loaded value minus read value) multiplied by the CLK period.

Perform time-lapse measurement by programming a counter to be edge gated. An edge is applied to the counter GATE input to start the counter. You can program the counter to start counting after receiving a low-to-high edge. The time lapse since receiving the edge equals the counter value difference (loaded value minus read value) multiplied by the CLK period.

To perform frequency measurement, program a counter to be level gated and count the number of falling edges in a signal applied to a CLK input. The gate signal applied to the counter GATE input is of known duration. In this case, you program the counter to count falling edges at the CLK input while the gate is applied. The frequency of the input signal then equals the count value divided by the gate period. Figure 3-18 shows the connections for a frequency measurement application. You can also use a second counter to generate the gate signal in this application.

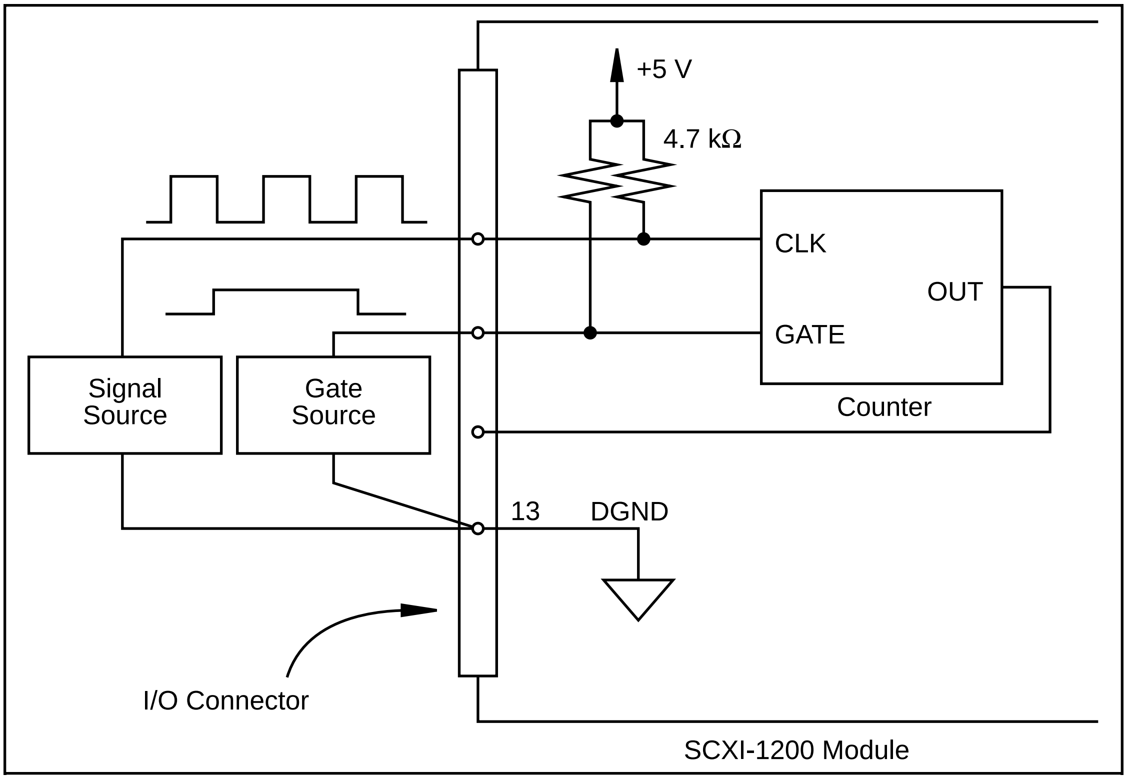


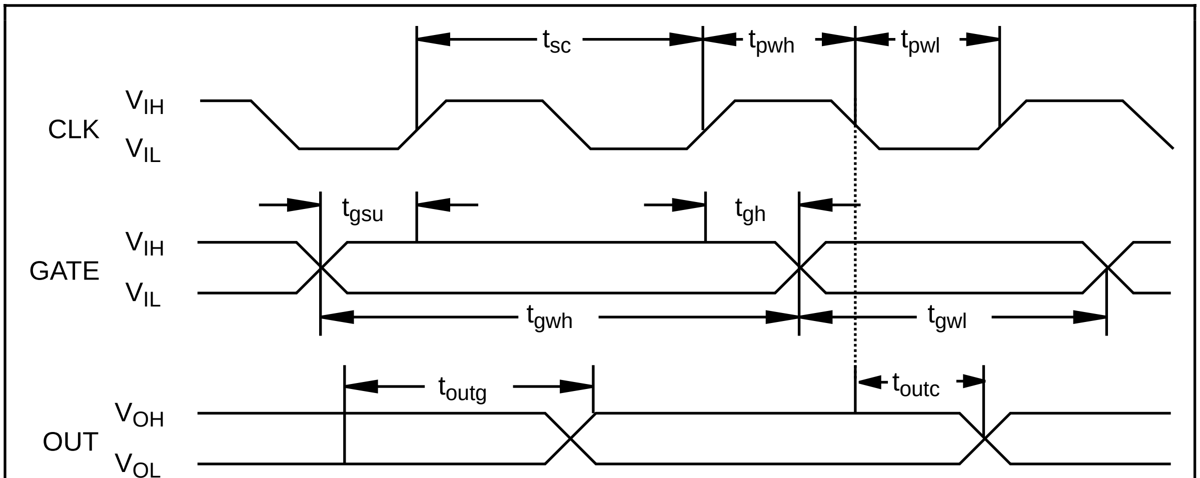
Figure 3-18. Frequency Measurement Application

The GATE, CLK, and OUT signals for counters B1 and B2 are available at the I/O front connector. In addition, the GATE and CLK pins are pulled up to +5 V through a 4.7 kΩ resistor.

The following specifications and ratings apply to the 82C53 I/O signals:

- Absolute maximum voltage input rating -0.5 to 7.0 V with respect to DGND
- 82C53 digital input specifications (referenced to DGND):
  - V_{IH} input logic high voltage 2.2 V minimum
  - V_{IL} input logic low voltage 0.8 V maximum
  - Input load current ±10 µA maximum
- 82C53 digital output specifications (referenced to DGND):
  - V_{OH} output logic high voltage 2.4 V minimum
  - V_{OL} output logic low voltage 0.45 V maximum
  - I_{OH} output source current, at V_{OH} 400 µA maximum
  - I_{OL} output sink current, at V_{OL} 2.2 mA maximum

Figure 3-19 shows the timing requirements for the GATE and CLK input signals and the timing specifications for the OUT output signals of the 82C53.



t_{sc}	clock period	380 ns minimum
t_{pwh}	clock high level	230 ns minimum
t_{pwl}	clock low level	150 ns minimum
t_{gsu}	gate setup time	100 ns minimum
t_{gh}	gate hold time	50 ns minimum
t_{gwh}	gate high level	150 ns minimum
t_{gwl}	gate low level	100 ns minimum
t_{outg}	output delay from clock ↓	300 ns maximum
t_{outc}	output delay from gate ↓	400 ns maximum

Figure 3-19. General-Purpose Timing Signals

The GATE and OUT signals in Figure 3-19 are referenced to the rising edge of the CLK signal.

Digital I/O Signal Connections for the SCXIbus

When used with other SCXI modules, the SCXI-1200 communicates with the SCXIbus by using some digital I/O lines. Four lines from port B are used as outputs and one line of port C is used as input for SCXIbus communication.

Pins 26 through 29, 31, 40, and 43 constitute the front signal connector digital I/O lines that are used with the SCXIbus—the digital output signals, the digital input signals, and the digital timing signals.

The digital input signal for SCXI is pin 31, SERDATIN, which is equivalent to the SCXIbus signal MOSI.

The digital output signals for SCXI are pins 26, 27, 28, and 29. The SCXI-1200 uses these pins to configure the SCXI module. Each digital line emulates the SCXIbus communication signals as follows:

- Pin 26, SERDATOUT, is equivalent to the SCXIbus MISO serial data input line.
- Pin 27, DAQD*/A, is equivalent to the SCXIbus D*/A line, and indicates to the module whether the incoming serial stream on SERDATIN is data (DAQD*/A = 0) or address (DAQD*/A = 1) information.
- Pin 28, SLOT0SEL*, is equivalent to the SCXIbus INTR* line, and indicates whether the data on the SERDATIN line is being sent to Slot 0 (SLOT0SEL* = 0) or to a module (SLOT0SEL* = 1).
- Pin 29, SERCLK, is equivalent to the SCXIbus SPICLK line.

The digital timing signals (SCANCLK and HOLDTRIG) for SCXI are sent out on pins 40 and 43.

- Pin 40, SCANCLK, is equivalent to the SCXIbus TRIG0 line
- Pin 43, HOLDTRIG, is equivalent to the SCXIbus TRIG1 line.

If you use the SCXI-1200 for configuring the modules or Slot 0 of the chassis in which it resides, then these signals are internally routed to the SCXIbus. The signal that is driven by the SCXIbus (categorized as input, above), as well as those driven by the DIO circuitry onto the SCXIbus (categorized as outputs, above), appear on the corresponding DIO pin on the connector.

If the SCXI-1200 programs another chassis through its 50-pin front connector, then these DIO signals tap into the SCXIbus of the second chassis. You must use an SCXI-1341, SCXI-1342, or SCXI-1344 cable assembly for this purpose.

Chapter 4
Theory of Operation

This chapter contains a functional overview of the SCXI-1200 module and explains the operation of each functional unit of the SCXI-1200.

Functional Overview

The block diagram in Figure 4-1 shows a functional overview of the SCXI-1200 board.

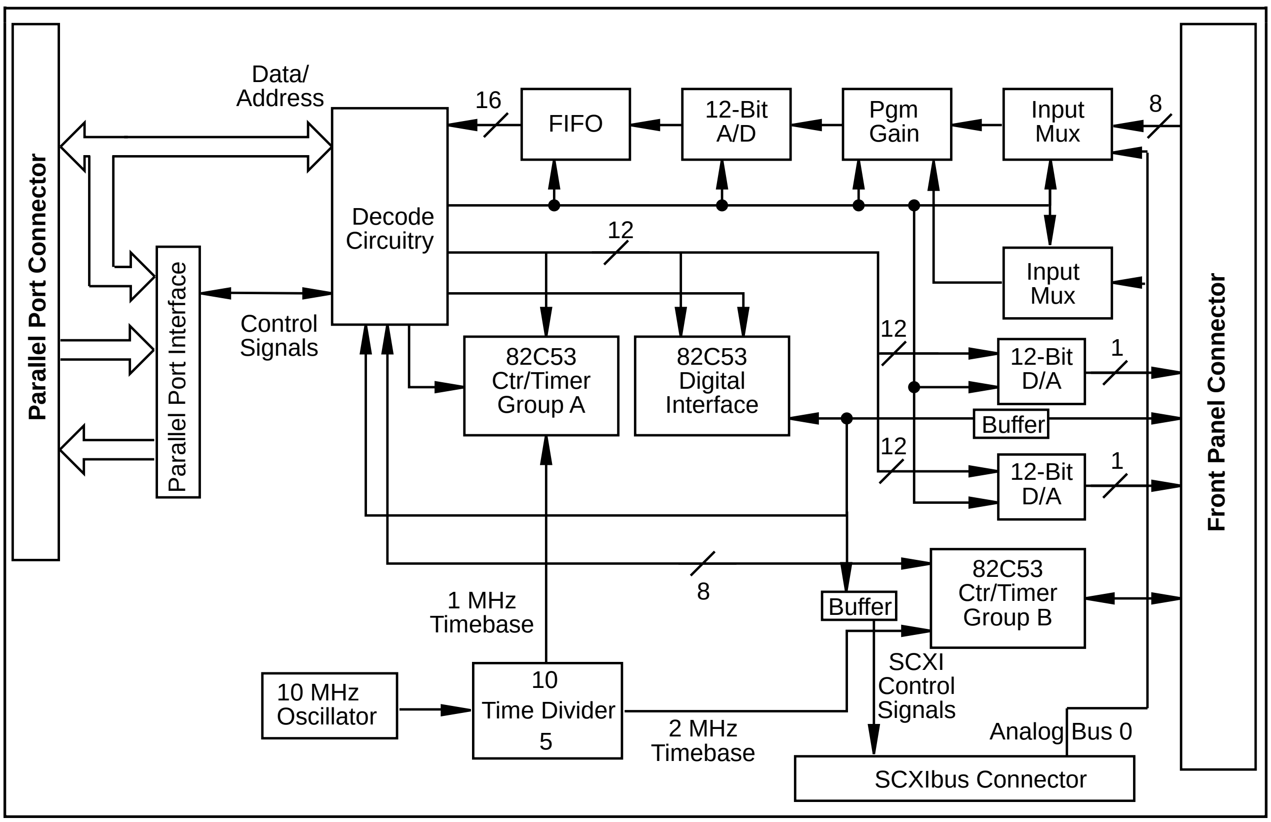


Figure 4-1. SCXI-1200 Block Diagram

The major components of the SCXI-1200 are as follows:

- SCXIbus connector
- Parallel port connector
- Analog input and DAQ circuitry
- Analog output circuitry
- Digital I/O and interface circuitry
- Timing I/O circuitry
- SCXI digital interface

You can execute DAQ functions by using the analog input circuitry and some of the timing I/O circuitry. The internal data and control buses interconnect the components.

The rest of the chapter explains the theory of operation of each of the SCXI-1200 components. The theory of operation for the DAQ circuitry is in the discussion of the analog input circuitry.

Analog Input and DAQ Circuitry

The SCXI-1200 has eight channels of analog input with software-programmable gain and 12-bit A/D conversion. Using the timing circuitry, the SCXI-1200 can also automatically time multiple A/D conversions. Figure 4-2 shows a block diagram of the analog input and DAQ circuitry.

In the following section, "stand-alone mode", "parallel mode", and "single-module parallel scanning" are used interchangeably to indicate a Lab-PC+ mode, in which there is no Slot 0 or multiple-module multiplexed acquisition. The SCXI-1200 samples its input channels and not Analog Bus 0 at all times.

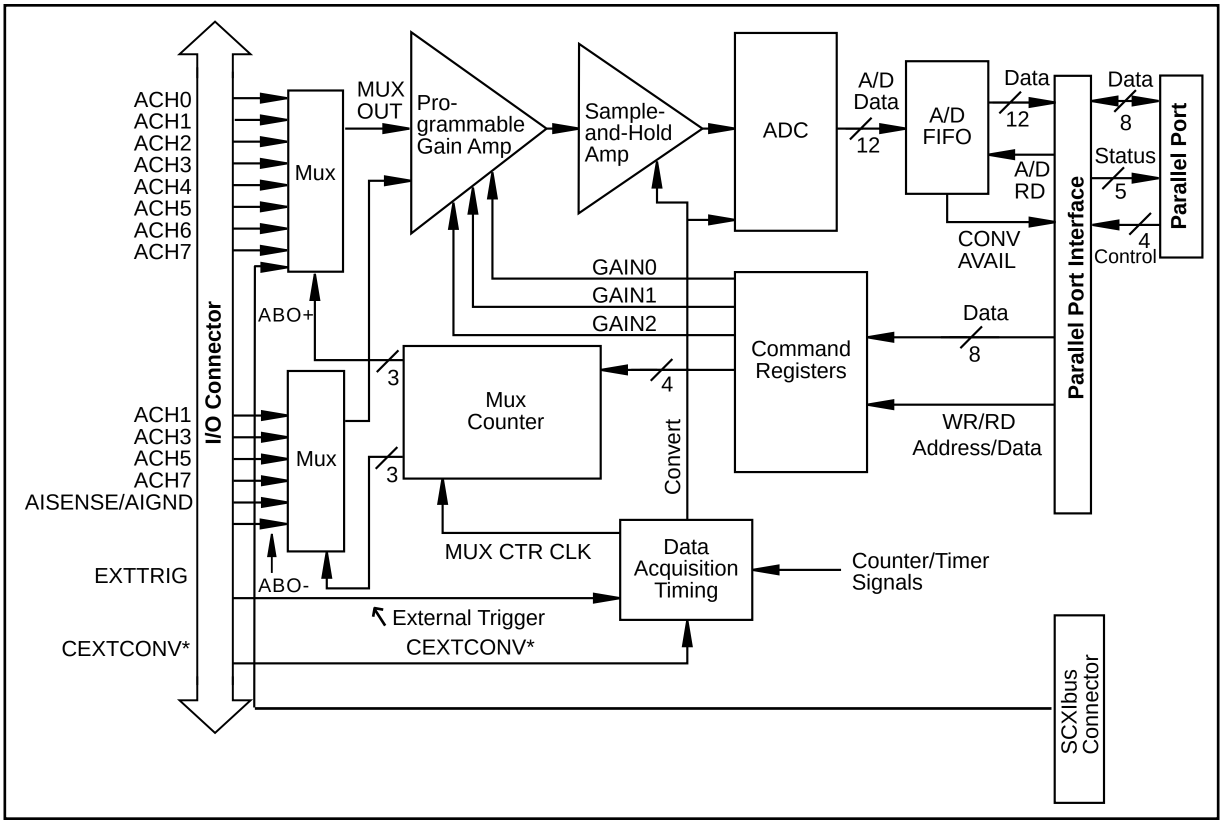


Figure 4-2. Analog Input and DAQ Circuitry Block Diagram

You can operate the SCXI-1200 as a stand-alone module, in which it samples its own input channels, or you can use the SCXI-1200 in conjunction with other SCXI modules, in which case it samples Analog Bus 0.

The stand-alone configuration is explained next. The latter configuration, called SCXI mode, is explained in the *SCXI Scanning Modes* section later in this chapter.

Analog Input Circuitry

The analog input circuitry consists of two analog input multiplexers, a software-programmable gain amplifier, a 12-bit ADC, and a 12-bit FIFO memory that is sign-extended to 16 bits.

One of the input multiplexers has eight analog input channels (channels 0 through 7). The other multiplexer is connected to channels 1, 3, 5, and 7 for differential mode. The input multiplexers provide input overvoltage protection of ±45 V, powered on or off. In addition, you can select the SCXI Analog Bus 0 as the input channel. Use software configuration to accomplish this whenever the SCXI-1200 is in the SCXI mode and you have selected another module for signal conditioning.

The programmable gain amplifier applies gain to the input signal, allowing an input analog signal to be amplified before being sampled and converted, thus increasing measurement resolution and accuracy. The gain of the instrumentation amplifier is software selectable. The SCXI-1200 board provides gains of 1, 2, 5, 10, 20, 50, and 100.

The SCXI-1200 uses a 12-bit successive-approximation ADC. The 12-bit resolution of the converter allows the converter to resolve its input range into 4,096 different steps. This resolution also provides a 12-bit digital word that represents the value of the input voltage level with respect to the converter input range. The ADC has an input range of ±5 V and 0 to 10 V.

When an A/D conversion is complete, the ADC clocks the result into the A/D FIFO. The A/D FIFO is 16 bits wide and 2 kwords deep. This FIFO serves as a buffer to the ADC and provides two benefits. First, when an A/D conversion is complete, the value is saved in the A/D FIFO for later reading, and the ADC can start a new conversion. Secondly, the A/D FIFO can collect up to 2 k A/D conversion values before any information is lost, thus allowing software some extra time to catch up with the hardware. If you store more than 2 k values in the A/D FIFO without reading from the A/D FIFO, an error condition called A/D FIFO overflow occurs and you lose A/D conversion information.

The output from the ADC can be interpreted as either straight binary or two's complement, depending on which input mode you select (unipolar or bipolar). In unipolar mode, the data from the ADC is interpreted as a 12-bit straight binary number with a range of 0 to +4,095. In bipolar mode, the data from the ADC is interpreted as a 12-bit two's complement number with a range of -2,048 to +2,047. In this mode, the MSB of the ADC result is inverted to make it two's complement. The output from the ADC is then sign-extended to 16 bits, causing either a leading 0 or a leading F (hex) to be added, depending on the coding and the sign. Thus, data values read from the FIFO are 16 bits wide.

DAQ Timing Circuitry

A DAQ operation refers to the process of taking a sequence of A/D conversions with the sample interval (the time between successive A/D conversions) carefully timed. The DAQ timing circuitry consists of various clocks and timing signals that perform this timing. The SCXI-1200 board can perform both single-channel data acquisition and multiple-channel (scanned) data acquisition in two modes—continuous and interval. The SCXI-1200 uses a counter to switch between analog input channels automatically during scanned data acquisition.

DAQ timing consists of signals that initiate a DAQ operation, initiate individual A/D conversions, gate the DAQ operation, and generate scanning clocks. Sources for these signals are supplied mainly by timers on the SCXI-1200 board. One of the two 82C53 integrated circuits is reserved for this purpose.

You can acquire data on a single channel or on multiple channels. In either case, you can perform continuous or interval acquisition.

Single-Channel Data Acquisition

During single-channel data acquisition, the channel select and gain bits in Command Register 1 select the gain and analog input channel before data acquisition is initiated. These gain and multiplexer settings remain constant during the entire DAQ process; therefore, you read all A/D conversion data from a single channel. In addition, you can select the SCXI Analog Bus 0 for data acquisition. This happens whenever another module is selected and that module outputs its signal onto AB0.

In single-channel continuous acquisition mode, the SCXI-1200 samples a single channel continuously without delays.

In single-channel interval acquisition mode, the SCXI-1200 samples a single channel a programmable number of times, waits for the duration of the scan interval, and repeats this cycle.

Multiple-Channel (Scanned) Data Acquisition

Multiple-channel data acquisition is performed by enabling scanning during data acquisition. Multiple-channel scanning is controlled by a scan counter.

For scanning operations, the scan counter decrements from the highest numbered channel, which you specify, through channel 0, and then repeats the sequence. Thus, you can scan any number of channels from two to eight. Notice that you use the same gain setting for all channels in the scan sequence.

In scanned continuous acquisition mode, the SCXI-1200 scans the selected channels repeatedly without delays and samples them.

In scanned-interval acquisition mode, the SCXI-1200 scans the selected channels, waits for the duration of the scan interval, and repeats the cycle.

DAQ Rates

Maximum DAQ rates (number of samples per second) are determined by the conversion period of the ADC plus the sample-and-hold acquisition time. During multiple-channel scanning, the DAQ rates are further limited by the settling time of the input multiplexers and programmable gain amplifier. After the input multiplexers are switched, the amplifier must be allowed to settle to the new input signal value to within 12-bit accuracy before you perform an A/D conversion, or else 12-bit accuracy will not be achieved. The settling time is a function of the gain selected.

The SCXI-1200 DAQ timing circuitry detects when DAQ rates are high enough to cause A/D conversions to be lost. This happens if the sampling interval is shorter than the conversion time for the ADC. If this is the case, this circuitry sets an overrun error flag. If the recommended DAQ rates in Table 4-2 are exceeded (an error flag is *not* automatically set), the analog input circuitry may not perform at 12-bit accuracy. If these rates are exceeded by more than a few microseconds, A/D conversions may be lost. Table 4-1 shows the recommended multiplexer and gain settling times for different gain settings. Table 4-2 shows the maximum recommended DAQ rates for both single-channel and multiple-channel data acquisition. Notice that for a single-channel data acquisition, the data can be acquired at the maximum rate at any gain setting. This assumes that the input signal is band-limited. The analog input bandwidth, however, is lower for higher gains. For multiple-channel data acquisition, observing the DAQ rates in Table 4-2 ensures 12-bit accuracy.

For short bursts of less than 2 ksamples, you can obtain a higher rate of 120 kS/s. This rate is limited only by the ADC conversion time, which is specified at 8.33 μs.

Table 4-1. Analog Input Settling Time Versus Gain

Gain Setting	Settling Time Recommended
1, 2, 5, 10, 20, 50 100	18 µs typ, 25 µs guaranteed 40 µs

Table 4-2. SCXI-1200 Maximum Recommended DAQ Rates

Acquisition Mode	Gain Setting	Rate	
		EPP Mode	Centronics Mode
Single channel	1, 2, 5, 10, 20, 50, 100	100 kS/s	25 kS/s
Multiple channel	1, 2, 5, 10, 20, 50 100	55.5 kS/s 25 kS/s	25 kS/s 25 kS/s

The recommended DAQ rates in Table 4-2 assume that voltage levels on all the channels included in the scan sequence are within range for the given gain and are driven by low-impedance sources. The signal ranges for the possible gains are shown in Table 4-3 and Table 4-4. Signal levels outside the ranges shown in Table 4-3 on the channels included in the scan sequence adversely affect the input settling time. Similarly, you may need greater settling time for channels driven by high-impedance signal sources.

Table 4-3. Bipolar Analog Input Signal Range Versus Gain

Gain Setting	Input Signal Range
1	-5 V to 4.99756 V
2	-2.5 V to 2.49878 V
5	-1.0 V to 0.99951 V
10	-500 mV to 499.756 mV
20	-250 mV to 249.877 mV
50	-100 mV to 99.951 mV
100	-50 mV to 49.975 mV

Table 4-4. Unipolar Analog Input Signal Range Versus Gain

Gain Setting	Input Signal Range
1	0 V to 9.99756 V
2	0 V to 4.99878 V
5	0 V to 1.99951 V
10	0 mV to 999.756 mV
20	0 mV to 499.877 mV
50	0 mV to 199.951 mV
100	0 mV to 99.975 mV

Analog Output Circuitry

The SCXI-1200 has two channels of 12-bit D/A output. Each analog output channel can provide unipolar or bipolar output. Figure 4-3 shows a block diagram of the analog output circuitry.

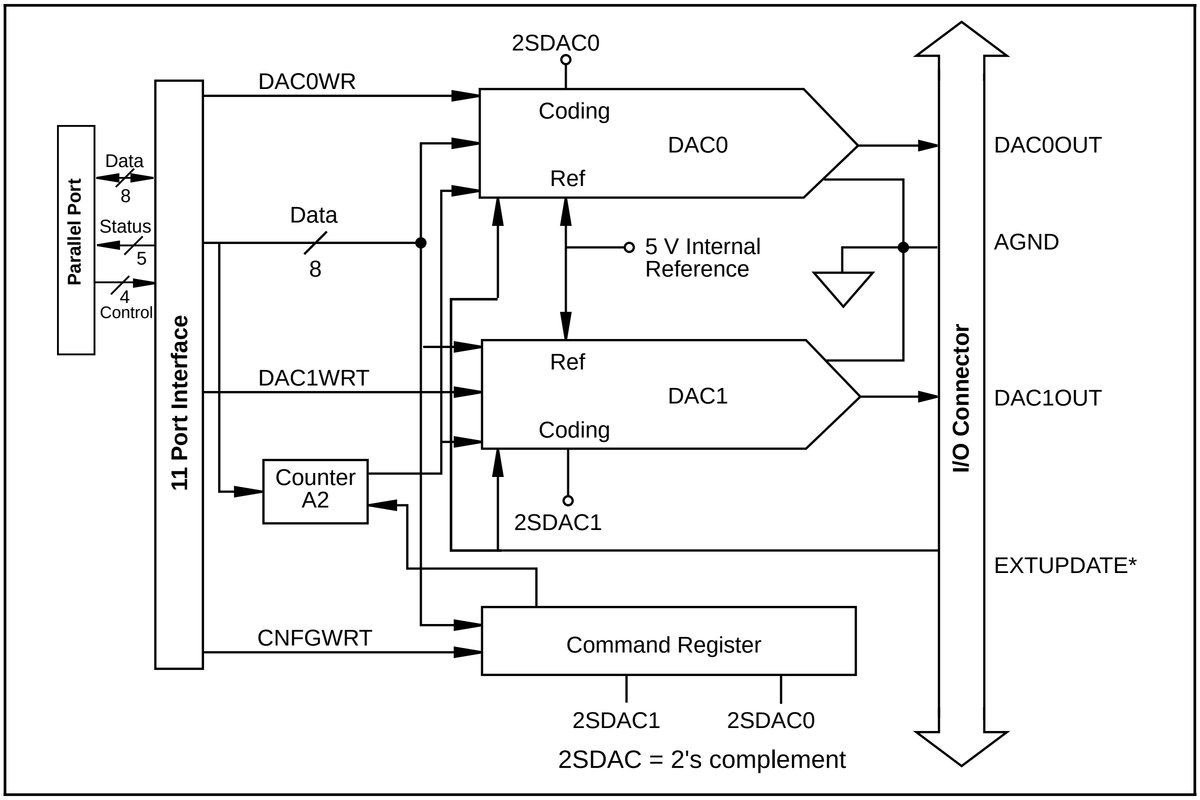


Figure 4-3. Analog Output Circuitry Block Diagram

Each analog output channel contains a 12-bit DAC. The DAC in each analog output channel generates a voltage proportional to the input V_{ref} multiplied by the digital code loaded into the DAC. You can load each DAC with a 12-bit digital code by writing to the DAC0 (L and H) and DAC1 (L and H) Registers on the SCXI-1200. The voltage output from the two DACs is available at the SCXI-1200 I/O connector DAC0OUT and DAC1OUT pins.

There are two ways you can upgrade the DAC voltages. In the first mode, the DAC output voltage is updated as soon as you write to the corresponding DAC Data Register. In the second mode, the DAC output voltage does not change until a falling edge is detected either from counter A2 or from EXTUPDATE*. These two modes are software selectable.

You can program each DAC channel for either a unipolar voltage output or a bipolar voltage output range. A unipolar output gives an output voltage range of 0.0000 to +9.9976 V. A bipolar output gives an output voltage range of -5.0000 to +4.9976 V. For unipolar output, 0.0000 V output corresponds to a digital code word of 0. For bipolar output, -5.0000 V output corresponds to a digital code word of F800 hex.

One LSB is the voltage increment corresponding to a LSB change in the digital code word. For both outputs, one LSB corresponds to:

$$1LSB = \frac{10\ V}{4,096}$$

Digital I/O Circuitry

The digital I/O circuitry has an 82C55A integrated circuit. The 82C55A is a general-purpose PPI containing 24 programmable I/O pins. These pins represent the three 8-bit I/O ports (A, B, and C) of the 82C55A, as well as PA<0..7>, PB<0..7>, and PC<0..7> on the SCXI-1200 I/O connector. Figure 4-4 shows a block diagram of the digital I/O circuitry.

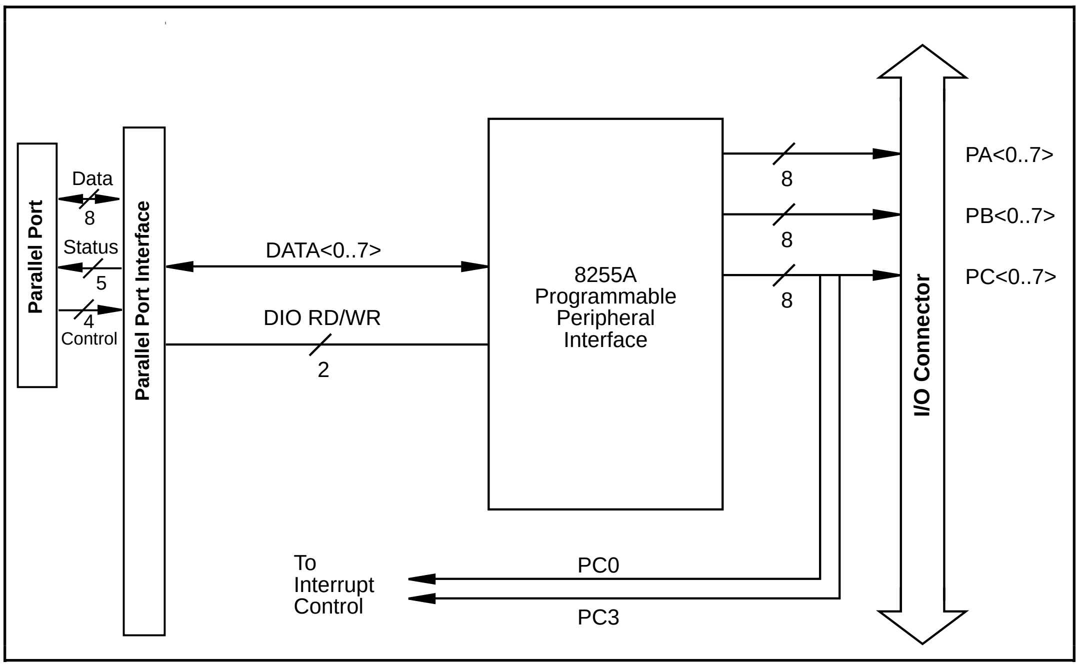


Figure 4-4. Digital I/O Circuitry Block Diagram

All three ports on the 82C55A are TTL-compatible. When enabled, the digital output ports are capable of sinking 2.4 mA of current and sourcing 2.6 mA of current on each digital I/O line. When the ports are not enabled, the digital I/O lines act as high-impedance inputs.

Timing I/O Circuitry

The SCXI-1200 uses two 82C53 counter/timer integrated circuits for DAQ timing and for general-purpose timing I/O functions. One of these is used internally for DAQ timing, and the other is available for general use. Figure 4-5 shows a block diagram of both groups of timing I/O circuitry (counter groups A and B).

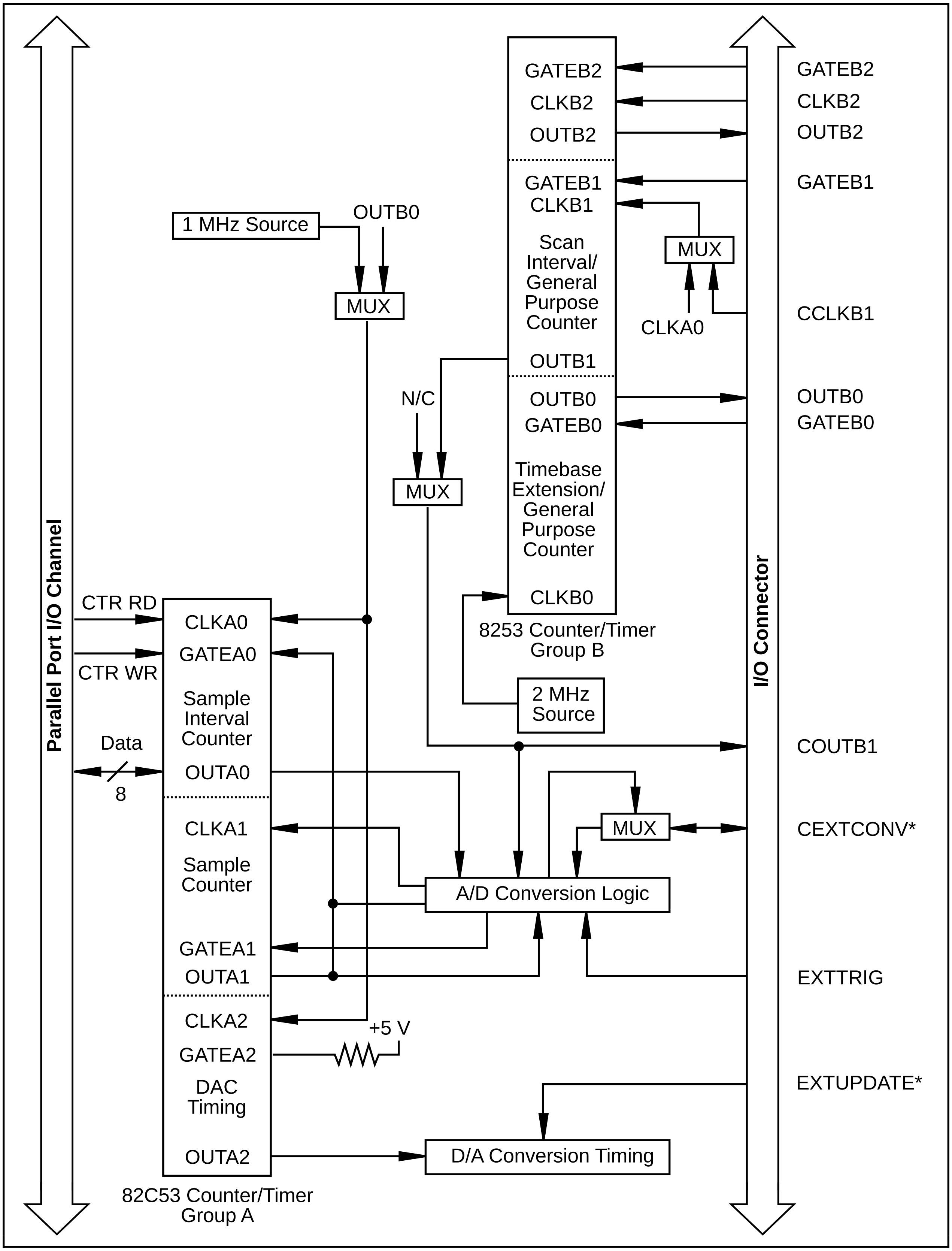


Figure 4-5. Timing I/O Circuitry Block Diagram

Each 82C53 contains three independent 16-bit counter/timers and one 8-bit Mode Register. As shown in Figure 4-5, counter group A is reserved for DAQ timing, and counter group B is free for general use. The output of counter B0 can be used in place of the 1 MHz clock source on counter A0 to allow clock periods greater than 65,536 µs.

The 82C53 for counter group A uses either a 1 MHz clock generated from the onboard 10 MHz oscillator or the output from counter B0, which has a 2 MHz clock source, for its timebase. Optionally, you can use counter B1 to provide interval-scanning timing. In the interval-scanning mode, the CLK pin of counter B1 is driven by the same signal that is driving CLKA0. The OUTB1 pin on the I/O connector initiates scan sequences that are separated by a programmable scan interval time. The timebases for counters B1 and B2 must be supplied externally through the 50-pin I/O connector.

Figure 4-6 shows an example of interval-scanning timing.

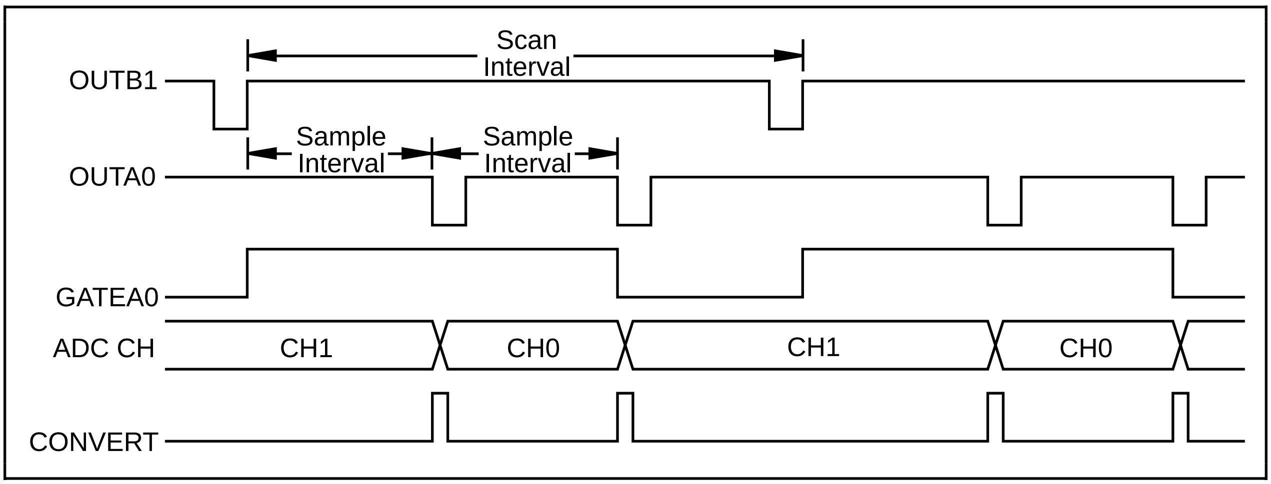


Figure 4-6. Two-Channel Interval-Scanning Timing

The single-channel interval acquisition mode makes use of an additional 8-bit counter, the interval counter. In this mode, counter B1 initiates scan sequences that are separated by a programmable interval time. The interval counter is programmed for the number of samples of the selected channel in each interval. Figure 4-7 shows an example of single-channel interval timing. In this example, counter B1 is programmed for the sample interval and the interval counter is programmed to count three samples, wait for the duration of the scan interval, count three samples, and so on. The acquisition operation ends when the sample counter (counter A1) decrements to 0.

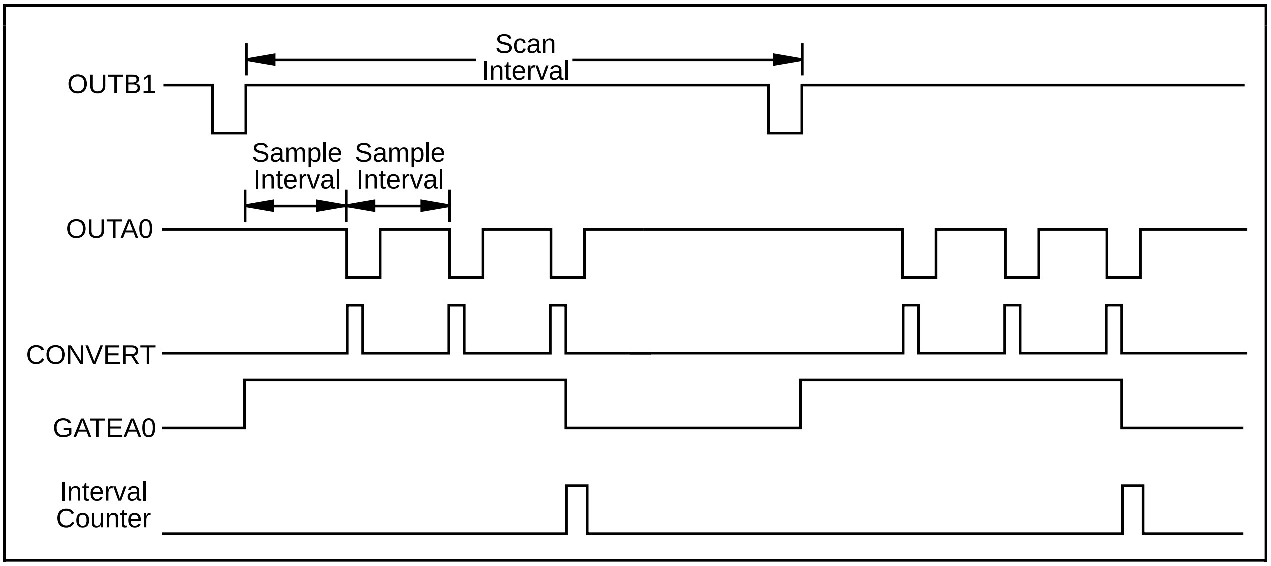


Figure 4-7. Single-Channel Interval Timing

SCXI Digital Interface

Figure 4-8 shows a diagram of the SCXI-1200 and SCXIbus digital interface circuitry.

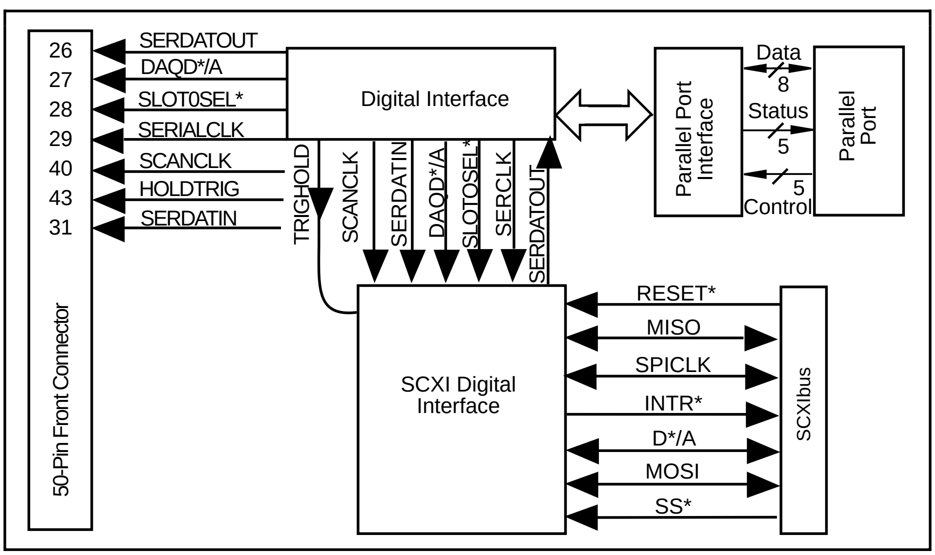


Figure 4-8. Digital Interface Circuitry Block Diagram

The circuitry is divided into an SCXI digital interface section and a rear connector interface section.

The SCXI digital interface buffers signals from the SCXIbus to the module and drives signals from the module onto the SCXIbus.

The digital interface comprises the 82C55A programmable peripheral interface along with buffers. All the SCXI control signals that tap into the 82C55A DIO lines also appear on the 50-pin front connector. You can program another chassis through the 50-pin front connector using an SCXI-1341, SCXI-1342, or SCXI-1344 cable assembly.

SCXI Scanning Modes

The SCXI-1200 has two basic types of scanning modes—single-module parallel scanning and multiple-module multiplexed scanning.

Single-Module Parallel Scanning

Single-module parallel scanning is the simplest scanning mode. Figure 4-9 illustrates this mode. For more information about single-module parallel scanning, refer to the sections titled *Single-Channel Data Acquisition* and *Multiple-Channel (Scanned) Data Acquisition* earlier in this chapter.

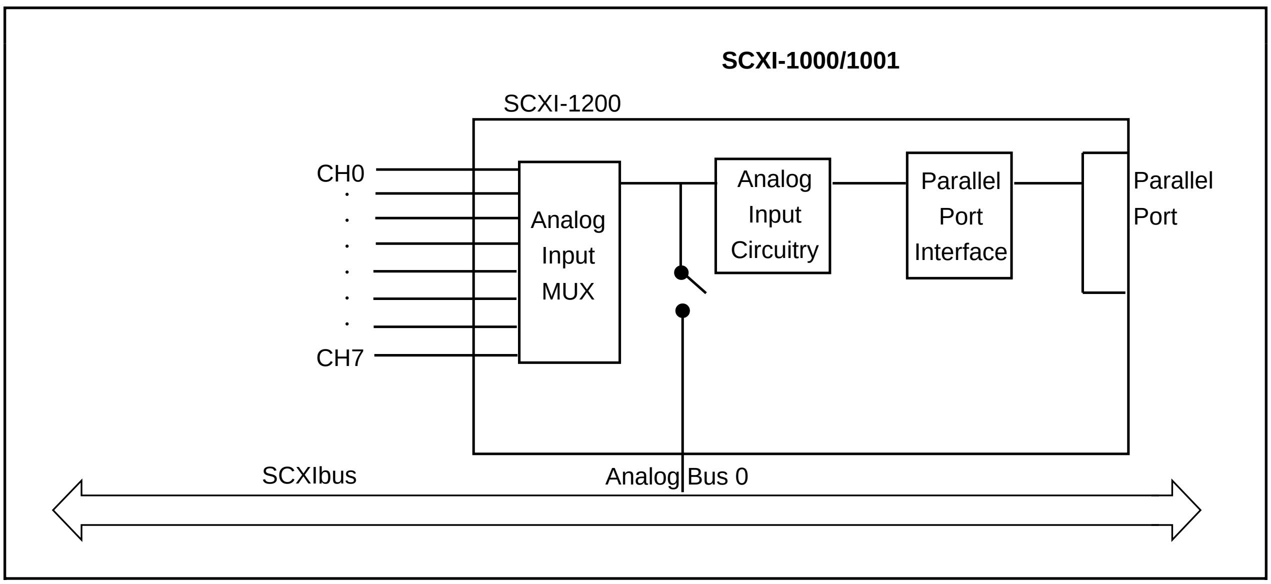


Figure 4-9. Single-Module Parallel Scanning

Multiple-Module Multiplexed Scanning

During multiplexed scanning, the SCXI-1200 provides the SCANCLK signal to Slot 0 over the TRIG0 backplane line, and Slot 0 provides the SCANCON signal to the modules. Slot 0 contains a module list FIFO (first-in first-out) memory chip, similar to the Channel/Gain FIFO on an MIO-16 DAQ board, except that instead of having a channel number and gain setting for each entry, it contains a slot number and a sample count for each entry. The list in slot determines which module is being accessed and for how many samples. It is important to make sure that the lists on the DAQ board and Slot 0 are compatible so that the samples are acquired as intended. Refer to your SCXI chassis manual for more information.

In this mode, all the modules tie into Analog Bus 0 and are enabled sequentially by SCANCON. Slot 0 must be programmed with the sequence of modules and the number of samples per entry.

The SCXI-1200 sends SCANCLK onto TRIG0. Slot 0 counts these SCANCLK pulses and selects the modules accordingly. When some other module is selected, its output buffers are enabled by SCANCON, so that Analog Bus 0 is driven by the output signal. At the same time, Analog Bus 0 is selected by the SCXI-1200 for acquisition. When the SCXI-1200 itself is chosen by Slot 0, the input muxes of the SCXI-1200 select the input channels on the front connector, depending on the bit setting for channel selection and gains.

Figure 4-10 shows a block diagram of multiple-module multiplexed scanning.

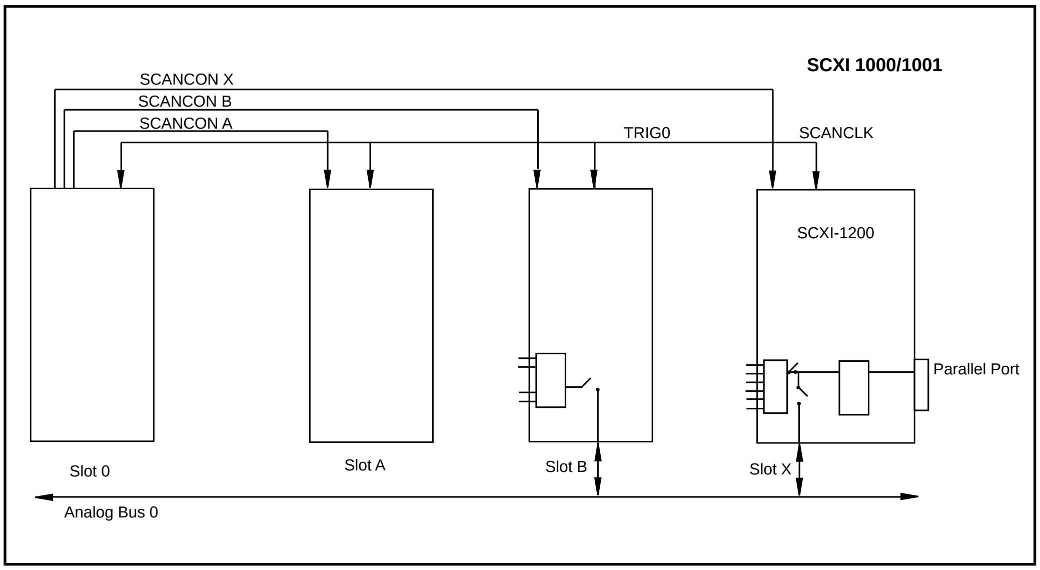


Figure 4-10. Multiple-Module Multiplexed Scanning Diagram

You can configure the SCXI-1200 module in two ways—in a stand-alone mode, or in a multiple-module multiplexed mode. Figure 4-11 shows these two configurations.

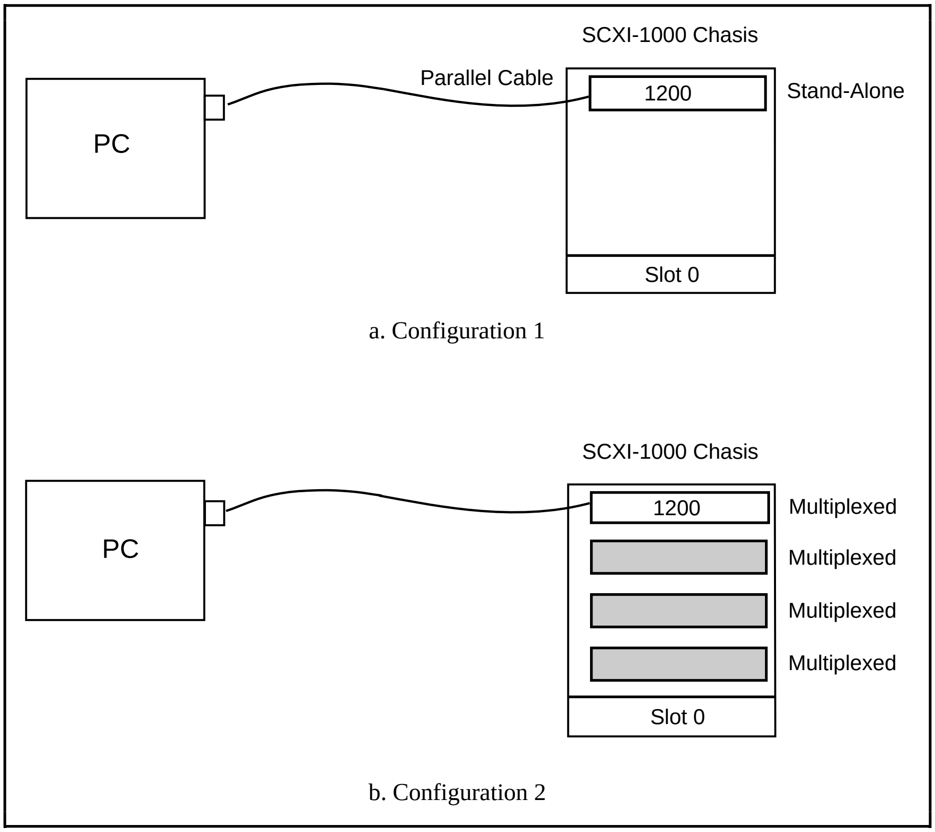


Figure 4-11. SCXI Configurations

Note: ***If the SCXI-1200 is in a chassis, then it must be the master module and program Slot 0. To make the SCXI-1200 the master module, disconnect any MIO or Lab Series plug-in boards that are connected to any other SCXI modules in that chassis.***

Refer to your *SCXI-1000/1000DC/1001 Register-Level Programmer Manual* and the *SCXI-1200 Register-Level Programmer Manual* for further details about programming.

Chapter 5 Calibration

This chapter discusses the calibration of the SCXI-1200. However, the SCXI-1200 is factory calibrated, and National Instruments can recalibrate your module if needed. To maintain the 12-bit accuracy of the SCXI-1200 analog input and analog output circuitry, National Instruments recommends that you recalibrate at six-month intervals.

There are three ways to perform calibrations.

- Use the NI-DAQ `SCXI_1200_Calibrate` function. This is the easiest way, because you do not need to know the details of the calibration process.
- Use the NI-DAQ functions to write to the calibration DACs and the EEPROM.
- Use your own register-level writes to the calibration DACs and the EEPROM.

If you want to perform your own calibrations using the NI-DAQ `SCXI_1200_Calibrate` function, go to the *Using the Calibration Function* section later in this chapter. If you do not want to perform your own calibrations, you can skip the remainder of this chapter.

To accomplish calibration using the last two methods, you need to know the details of the calibration process. This information is in the *Calibration* chapter of the *SCXI-1200 Register-Level Programmer Manual*.

The SCXI-1200 is software calibrated, therefore there are no calibration trimpots. The module is shipped with utility software for calibration. The calibration process involves reading offset and gain errors from the analog input and analog output sections and writing values to the appropriate calibration DACs to null the errors. There are four calibration DACs associated with the analog input section and four calibration DACs associated with the analog output section, two for each output channel. After the calibration process is complete, each calibration DAC is at a known value. Because these values are lost when the board is powered down, they are also stored in the onboard EEPROM for future reference.

The factory information occupies one half of the EEPROM and is protected. The lower half of the EEPROM contains user areas for calibration data. There are eight different user areas. When the SCXI-1200 is powered on, or the conditions under which it is operating change, you should load the calibration DACs with values from the EEPROM, or you can recalibrate the board. Calibration software is included with the SCXI-1200 as part of the NI-DAQ software.

If you use the SCXI-1200 with NI-DAQ and LabVIEW or LabWindows/CVI and do not perform user calibration, the factory calibration constants are loaded into the calibration DACs each time the module is initialized. If you do perform user calibration, you can load these user constants at startup. Therefore, the SCXI-1200 is calibrated with the most recent constants each time you perform analog input or output with the LabVIEW example VIs.

Calibration at Higher Gains

The SCXI-1200 has a maximum gain error of 0.5%. This means that if the board is calibrated at a gain of 1, and if the gain is switched to 100, a maximum of 50 mV error may result in the reading. If your application can tolerate this error, then you do not have to recalibrate at that higher gain. If this error is critical to your application, you should perform gain calibration at all other gains (2, 5, 10, 20, 50, and 100), and store the corresponding values in the other gain calibration data area. Using the `SCXI_1200_Calibrate` function described later in this chapter, you can specify the gain at which the SCXI-1200 operates, and the corresponding value is loaded into the GAINCALDAC (analog input gain calibration DAC) whenever any function related to the SCXI-1200 is called. Notice that at initialization the calibration constant for the particular gain is loaded into the GAINCALDAC. This ensures a maximum error of 0.02% at all gains. Also, the factory calibration area contains gain calibration constants for all these gains.

Calibration Equipment Requirements

For best measurement results, calibrate the SCXI-1200 so that its measurement accuracy is within ±0.012% of its input range (±0.5 LSB). The equipment used to calibrate the SCXI-1200 should be 10 times as accurate, that is, have ±0.001% rated accuracy. Calibration equipment with four times the accuracy of the item under calibration is generally considered acceptable. Four times the accuracy of the SCXI-1200 is 0.003%.

You need the following equipment to calibrate the SCXI-1200 module:

- For analog input calibration, you need a precision variable DC voltage source (usually a calibrator) with the following specifications:
  - Accuracy: ±0.001% standard; ±0.003% sufficient
  - Range: Greater than ±10 V
  - Resolution: 100 µV in ±10 V range (5 1/2 digits)

Using the Calibration Function

NI-DAQ contains the `SCXI_1200_Calibrate` function, with which you can either load the calibration DACs with the factory constants or the USERx constants, or perform your own calibration. To use the `SCXI_1200_Calibrate` function, to perform calibration, you must ground an analog input channel at the front connector (for offset calibration) and apply an accurate voltage reference to another input channel (for gain calibration). In addition, the DAC0 and DAC1 outputs must be wrapped back and applied to two other analog input channels.

Specify the external voltage reference (for gain calibration) as one of the parameters of the function. The other parameters are the number of the input channel connected to AIGND (for pregain and postgain analog input calibration) and the input channel numbers to which DAC0OUT and DAC1OUT are fed back (for analog output calibration). Refer to the *NI-DAQ User Manual for PC Compatibles* and the *NI-DAQ Function Reference Manual for PC Compatibles* for more details on the `SCXI_1200_Calibrate` function.

Appendix A
Specifications

This appendix lists the specifications of the SCXI-1200. These specifications are typical at 25° C unless otherwise stated. The operating temperature range is 0° to 50° C.

Analog Input

Input Characteristics

Number of channels	Eight single-ended, four differential, software selectable
Type of ADC	Successive approximation
Resolution	12 bits, 1 in 4,096
Conversion time (including acquisition time)	8.5 µs

Input signal ranges

Analog Input Signal Gain (Software Selectable)	Analog Input Signal Ranges (Software Selectable)	
	Bipolar	Unipolar
1	±5 V	0 to 10 V
2	±2.5 V	0 to 5 V
5	±1 V	0 to 2 V
10	±500 mV	0 to 1 V
20	±250 mV	0 to 500 mV
50	±100 mV	0 to 200 mV
100	±50 mV	0 to 100 mV

Input coupling	DC
Max working voltage	Input average should remain within 7 V of ground
Overvoltage protection	±45 V powered on or off
Inputs protected	ACH0..ACH7
FIFO buffer size	2,048 samples
Data transfers	Interrupts, programmed I/O

Maximum Sustained DAQ Rates

Acquisition Mode	Gain Setting	Rate	
		EPP Mode	Centronics Mode
Single channel	1, 2, 5, 10, 20, 50, 100	100 kS/s	25 kS/s
Multiple channel	1, 2, 5, 10 20 50 100	83.3 kS/s 62.5 kS/s 55.5 kS/s 25 kS/s	25 kS/s 25 kS/s 25 kS/s 25 kS/s

Transfer Characteristics

Relative accuracy (nonlinearity) ±0.5 LSB typ, ±1.5 LSB max
INL ±0.5 LSB typ, ±1 LSB max
DNL ±0.5 LSB typ, ±1 LSB max
No missing codes 12 bits, guaranteed
Offset error
  After calibration, at all gains ±(0.06 μV + 0.2 mV/gain) max
  Before calibration, at all gains ±(15 mV + 150 mV/gain) max
Offset adjustment range ±37 mV max
Gain error
  After calibration, at all gains 0.020% of reading max
  Before calibration
    Gain = 1 2% of reading max
    Gain ≠1 with gain error adjusted to 0 at gain = 1 0.5% of reading max
Gain adjustment range ±25 mV max

Amplifier Characteristics

Input bias current ±60 pA typ 200 pA max
Input offset current ±20 pA typ, 100 pA max
Input impedance 1 MΩ in parallel with 5 pF
Input protection ±45 V on all inputs (not ground)

CMRR

Gain	CMRR DC to 60 Hz
1	60 dB
2	66 dB
5	74 dB
10 to 100	74 dB

Dynamic Characteristics

Analog input bandwidth

Gain	Single channel bandwidth
1 to 10	400 kHz
20	200 kHz
50	80 kHz
100	40 kHz

Settling time to full-scale step

Gain	Settling time to 0.012% (±0.5 LSB) accuracy
1 to 10	12 µs
20	16 µs typ, 18 µs max
50	18 µs typ, 25 µs max
100	40 µs

System noise (including quantization error)

Gain	Dither off	Dither on
1 to 50	0.3 LSB rms	0.6 LSB rms
100	0.6 LSB rms	0.8 LSB rms

Stability

Recommended warm-up time 15 min

Offset temperature coefficient ±(20 + 100/gain) µV° C

Gain temperature coefficient ±50 ppm/°C

Explanation of Analog Input Specifications

Relative accuracy is a measure of the linearity of an ADC. However, relative accuracy is a tighter specification than a *nonlinearity* specification. Relative accuracy indicates the maximum deviation from a straight line for the analog-input-to-digital-output transfer curve. If an ADC has been calibrated perfectly, then this straight line is the ideal transfer function, and the relative accuracy specification indicates the worst deviation from the ideal that the ADC permits.

A relative accuracy specification of ±1 LSB is roughly equivalent to (but not the same as) a ±0.5 LSB nonlinearity or integral nonlinearity specification because relative accuracy encompasses both nonlinearity and variable quantization uncertainty, a quantity often mistakenly assumed to be exactly ±0.5 LSB. Although quantization uncertainty is ideally ±0.5 LSB, it can be different for each possible digital code and is actually the analog width of each code. Thus, it is more specific to use relative accuracy as a measure of linearity than it is to use what is normally called nonlinearity, because relative accuracy ensures that the *sum* of quantization uncertainty and A/D conversion error does not exceed a given amount.

Integral nonlinearity in an ADC is an often ill-defined specification that is supposed to indicate a converter's overall A/D transfer linearity. The manufacturer of the ADC chip used by National Instruments on the DAQPad-1200 specifies its integral nonlinearity by stating that the analog center of any code will not deviate from a straight line by more than ±1 LSB. This specification is misleading because although a particularly wide code's center may be found within ±1 LSB of the ideal, one of its edges may be well beyond ±1.5 LSB; thus, the ADC would have a relative accuracy of that amount. National Instruments tests its boards to ensure that they meet all three linearity specifications defined in this appendix.

Differential nonlinearity is a measure of deviation of code widths from their theoretical value of 1 LSB. The width of a given code is the size of the range of analog values that can be input to produce that code, ideally 1 LSB. A specification of ±1 LSB differential nonlinearity ensures that no code has a width of 0 LSBs (that is, no missing codes) and that no code width exceeds 2 LSBs.

System noise is the amount of noise seen by the ADC when there is no signal present at the input of the board. The amount of noise that is reported directly (without any analysis) by the ADC is not necessarily the amount of real noise present in the system, unless the noise is considerably greater than 0.5 LSB rms. Noise that is less than this magnitude produces varying amounts of flicker, and the amount of flicker seen is a function of how near the real mean of the noise is to a code transition. If the mean is near or at a transition between codes, the ADC flickers evenly between the two codes, and the noise is very near 0.5 LSB. If the mean is near the center of a code and the noise is relatively small, very little or no flicker is seen, and the noise reported by the ADC as nearly 0 LSB. From the relationship between the mean of the noise and the measured rms magnitude of the noise, the character of the noise can be determined. National Instruments has determined that the character of the noise in the DAQPad-1200 is fairly Gaussian, so the noise specifications given are the amounts of pure Gaussian noise required to produce our readings.

Explanation of Dither

The *dither circuitry*, when enabled, adds approximately 0.5 LSB rms of white Gaussian noise to the signal to be converted to the ADC. This addition is useful for applications involving averaging to increase the resolution of the DAQPad-1200 to more than 12 bits, as in calibration. In such applications, which are often lower frequency in nature, noise modulation is decreased and differential linearity is improved by the addition of the dither. For high-speed 12-bit applications not involving averaging, dither should be disabled because it only adds noise.

When taking DC measurements, such as when calibrating the board, enable dither and average about 1,000 points to take a single reading. This process removes the effects of 12-bit quantization and reduces measurement noise, resulting in improved resolution. Dither, or additive white noise, has the effect of forcing quantization noise to become a zero-mean random variable rather than a deterministic function of input. For more information on the effects of dither, see "Dither in Digital Audio" by John Vanderkooy and Stanley P. Lipshitz, *Journal of the Audio Engineering Society*, Vol. 35, No. 12, Dec. 1987.

Explanation of DAQ Rates

Maximum DAQ rates (number of samples per second) are determined by the conversion period of the ADC plus the sample-and-hold acquisition time, which is specified at 8.5 µs. For single channel, sustained data acquisition, the maximum DAQ rate is limited by the speed of the parallel port, 100 kS/s for EPP and 25 kS/s for Centronics. During multiple-channel scanning, the DAQ rates are further limited by the settling time of the input multiplexers and programmable gain amplifier. After the input multiplexers are switched, the amplifier must be allowed to settle to the new input signal value to within 12-bit accuracy. The settling time is a function of the gain selected.

Analog Output

Output Characteristics	
Number of output channels	Two single ended
Resolution	12 bits, 1 part in 4,096
Max update rate	8 kHz in EPP mode, 4 kHz with standard Centronics port
Type of DAC	Double-buffered
Data transfers	Interrupts, programmed I/O
Transfer Characteristics	
Relative accuracy (INL)	±0.25 LSB typ, ±0.50 LSB max
DNL	±0.25 LSB typ, ±0.75 LSB max
Offset error	
After calibration	±0.2 mV max
Before calibration	±50 mV max
Offset adjustment range, min	±37 mV
Gain error	
After calibration	0.004% of reading max
Before calibration	±1% of reading max
Gain adjustment range, min	±100 mV
Voltage output	
Ranges	0 to +10 V, ±5 V, software selectable
Output coupling	DC
Output impedance	0.2 Ω
Current drive	±2 mA
Protection	Short circuit to ground
Dynamic Characteristics	
Settling time to 0.012%	6 µs for 10 V step
Slew rate	10 V/µs
Offset temperature coefficient	±60 µV/°C
Gain temperature coefficient	±10 ppm/°C

Explanation of Analog Output Specifications

Relative accuracy in a D/A system is the same as nonlinearity because no uncertainty is added due to code width. Unlike an ADC, every digital code in a D/A system represents a specific analog value rather than a range of values. The relative accuracy of the system is therefore limited to the worst-case deviation from the ideal correspondence (a straight line), excepting noise. If a D/A system has been calibrated perfectly, then the relative accuracy specification reflects its worst-case absolute error.

Differential nonlinearity in a D/A system is a measure of deviation of code width from 1 LSB. In this case, code width is the difference between the analog values produced by consecutive digital codes. A specification of ±1 LSB differential nonlinearity ensures that the code width is always greater than 0 LSBs (guaranteeing monotonicity) and is always less than 2 LSBs.

Digital I/O

Number of channels	24
Compatibility	TTL
Digital logic levels	

Level	Min	Max
Input low voltage	0 V	0.8 V
Input high voltage	2.0 V	5 V
Input low current (V_{in} = 0.8 V)	–	-10 µA
Input high current (V_{in} = 2.4 V)	–	10 µA
Output low voltage (1.7 mA)	–	0.45 V
Output logic high voltage (-200 µA)	2.4 V	–

Darlington drive output current (Ports B and C only) R_{EXT} = 750 Ω; V_{EXT} = 1.5 V	-1.0 mA min, -4.0 mA max
Handshaking	3 wire, 2 ports
Power-on state	inputs
Data Transfers	Programmed I/O, interrupts

Timing I/O

Number of channels	Three 16-bit counter/timers (uses two 82C53 STCs)
Resolution counter/timers	16 bits
Compatibility	TTL, counter gate and clock inputs are pulled up with 10 kΩ resistors onboard.
Base clocks available	2 MHz
Base clock accuracy	±0.001%
Max source frequency	8 MHz
Min source pulse duration	60 ns
Min gate pulse duration	50 ns

Power Requirement

+5 VDC	50 mA
V+ DC	81 mA
V- DC	40.25 mA

The SCXI-1000 chassis supplies a maximum of 200 mA current on the 5 V power supply and the SCXI-1001 supplies a minimum of 600 mA on the 5 V power supply. Because the SCXI-1000 has four slots and the SCXI-1001 has 12 slots, each module can draw a maximum of 200/4 or 600/12, which is 50 mA current on the 5 V line. However, if any slot is unoccupied, other modules can use its share of the 50 mA. The +5 V on the front connector can thus supply a current equal to 50 mA * (number of unoccupied slots). This is the unused +5 V power. If all of the slots are occupied, you must not use this +5 V to drive external circuitry.

Physical

Dimensions	1.2 by 6.8 by 8.0 in. (3 by 17.3 by 20.3 cm)
Connectors	50-pin male ribbon-cable front connector 25-pin female Centronics type B rear connector

Environment

Operating temperature	0° to 70° C
Storage temperature	-55° to 150° C
Relative humidity	5% to 90% noncondensing

Appendix B
Installation Troubleshooting

This appendix contains installation troubleshooting information.

1. The configuration utility (WDAQCONF for Windows and DAQCONF for DOS) reports an error when I try to save the settings.

   Check the following items if you receive this message:

   > "WDAQCONF could not find the device being configured on the LPT at address 0xXXX. Check your LPT base address and your LPT connections and retry."

   a. Make sure your chassis is switched on and the screws of the cable are tightly fastened.

   b. Check that your base address is correct. This can be done either by checking your computer technical manual or, in some cases, by checking the base address jumper. In Windows applications, you may have a Hardware Control panel that will allow you to enable and disable the parallel port. Common parallel port addresses are 0x378, 0x278, 0x3BC, 0x280, and 0x290.

   Note: ***If your parallel port address does not appear under the Base Addr window in WDAQCONF, you must turn off the Auto Test option under the Options menu in the main window to access the other parallel port addresses.***

   c. Check that you are using the included 1 m parallel port cable. If you suspect that you have a bad parallel port cable, replace with a new cable or one that you know works with another peripheral. If you are using another parallel port cable, check to make sure it meets the required specifications (see the last note below). See below for problems with longer cable lengths.

   d. If you are still having problems, please report the computer make and model number to National Instruments. If you have a noncompatible parallel port and you have an available slot for a plug-in board, try using the Far Point EPP card described in the *Optional Equipment* section of Chapter 1, *Introduction*.

   Check the following items if you receive this message:

   > "The device is not responding to the selected interrupt (IRQA). If the IRQ on your board is jumper configurable, make sure that the jumper settings correspond to the interrupt you have selected. If they do, you will have to try a different interrupt level."

   a. IRQ levels 7 and 5 are the most common interrupt levels reserved for the parallel port. Try saving your configuration for both IRQ7 and IRQ5.

Note: ***If either IRQ level 7 or 5 are unselectable under the IRQ menu in WDAQCONF, then another National Instruments board is using this interrupt. You will have to free the appropriate IRQ level to allocate it for your parallel port.***

b. You may have an interrupt conflict with a non-National Instruments device. If you have installed a PCMCIA card or a plug-in board, you will have to ensure that IRQ5 or IRQ7 have not been allocated for these devices.

Note: ***For some PCMCIA cards installed with Cardware, it may be possible to exclude your parallel port interrupt level by including the line*** `XIRQ=7, E for IRQ 7` ***or*** `XIRQ=5, E for IRQ 5` ***in the*** `cardware.ini` ***file.***

c. You may have an interrupt conflict with a Windows-based application. You will have to ensure that IRQ5 or IRQ7 have not been allocated for this application. One place to search is your `system.ini` file under Windows.

d. If you are still having problems, please report the computer make and model number to National Instruments.

2. The configuration utility works fine when I use a 1 m parallel port cable but reports an error when I try to use a longer parallel port cable.

a. Ensure that your parallel port cable meets the required specifications.

b. You may have to use a unidirectional parallel port extender in order to achieve long distance solutions (one such extender is made by BRAVO Communications). Your parallel port will be recognized as a Centronics port with this extender.

3. I have an EPP port, but the configuration utility reports that I have a Centronics port when I try to save the configuration settings.

a. You may have to enable your parallel port as an EPP port. Check for such utilities and ensure that your port is configured for EPP.

b. It is possible that your EPP port does not meet the EPP specifications as given by the 1284 IEEE parallel port specifications. In this case, your parallel port will be treated as a Centronics port.

Note: ***Your parallel port cable should meet the following specifications:***

Characteristic impedance of 62 Ω ±6 Ω, 4 to 16 MHz.
Capacitance of less than 107 pF/m.
DC resistance equal to 0.22 Ω/m.
Propagation delay less than 58 ns.

Appendix C
Customer Communication

For your convenience, this appendix contains forms to help you gather the information necessary to help us solve technical problems you might have as well as a form you can use to comment on the product documentation. Filling out a copy of the *Technical Support Form* before contacting National Instruments helps us help you better and faster.

National Instruments provides comprehensive technical assistance around the world. In the U.S. and Canada, applications engineers are available Monday through Friday from 8:00 a.m. to 6:00 p.m. (central time). In other countries, contact the nearest branch office. You may fax questions to us at any time.

Corporate Headquarters
(512) 795-8248
Technical support fax: (800) 328-2203
(512) 794-5678

Branch Offices	**Phone Number**	**Fax Number**
Australia	(03) 879 9422	(03) 879 9179
Austria	(0662) 435986	(0662) 437010-19
Belgium	02/757.00.20	02/757.03.11
Denmark	45 76 26 00	45 76 71 11
Finland	(90) 527 2321	(90) 502 2930
France	(1) 48 14 24 00	(1) 48 14 24 14
Germany	089/741 31 30	089/714 60 35
Italy	02/48301892	02/48301915
Japan	(03) 3788-1921	(03) 3788-1923
Mexico	95 800 010 0793	95 800 010 0793
Netherlands	03480-33466	03480-30673
Norway	32-848400	32-848600
Singapore	2265886	2265887
Spain	(91) 640 0085	(91) 640 0533
Sweden	08-730 49 70	08-730 43 70
Switzerland	056/20 51 51	056/20 51 55
Taiwan	02 377 1200	02 737 4644
U.K.	0635 523545	0635 523154

Technical Support Form

Photocopy this form and update it each time you make changes to your software or hardware, and use the completed copy of this form as a reference for your current configuration. Completing this form accurately before contacting National Instruments for technical support helps our applications engineers answer your questions more efficiently.

If you are using any National Instruments hardware or software products related to this problem, include the configuration forms from their user manuals. Include additional pages if necessary.

Name ____

Company ____

Address ____

____

Fax (___)________________ Phone (___)________________

Computer brand ____________ Model ____________ Processor ____________

Operating system ____

Speed __________ MHz RAM __________ MB Display adapter __________

Mouse ______ yes ______ no Other adapters installed ______________

Hard disk capacity __________ MB Brand ______________________

Instruments used ____

National Instruments hardware product model __________ Revision __________

Configuration ____

National Instruments software product __________ Version __________

Configuration ____

The problem is ____

____

____

____

____

List any error messages ________________________________

____

____

____

____

The following steps will reproduce the problem ____________________

____

____

SCXI-1200 Hardware and Software Configuration Form

Record the settings and revisions of your hardware and software on the line to the right of each item. Complete a new copy of this form each time you revise your software or hardware configuration, and use this form as a reference for your current configuration. Completing this form accurately before contacting National Instruments for technical support helps our applications engineers answer your questions more efficiently.

National Instruments Products

- Interrupt Level of SCXI-1200 ____________________
- Analog Output Channel 0 Configuration (Factory Setting–Bipolar) ____________________
- Analog Output Channel 1 Configuration (Factory Setting–Bipolar) ____________________
- Analog Input Configuration (Factory Setting–Bipolar) ____________________
- NI-DAQ or LabWindows Version ____________________

Other Products

- Microprocessor ____________________
- Clock Frequency ____________________
- Computer Make and Model ____________________
- Type of Video Board Installed ____________________
- Operating System ____________________
- Operating System Version ____________________
- Programming Language ____________________
- Programming Language Version ____________________
- Other Boards in System ____________________
- Base I/O Address of Other Boards ____________________
- DMA Channels of Other Boards ____________________
- Interrupt Level of Other Boards ____________________

Register-Level Programmer Manual Request Form

National Instruments offers a register-level programmer manual at no charge to customers who are not using National Instruments software.

Title: **SCXI-1200 Register-Level Programmer Manual**

Part Number: **340699A-01**

Please indicate your reasons for obtaining the register-level programmer manual. Check all that apply.

☐ National Instruments does not support your operating system or programming language.

☐ You are an experienced register-level programmer who is more comfortable writing your own register-level software.

☐ Other. Please explain.

____

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____

____

Thank you for your help.

Name ____

Title ____

Company ____

Address ____

____

Phone (_______)__________________________

Mail to: Customer Service Department
National Instruments Corporation
6504 Bridge Point Parkway
Austin, TX 78730-5039

Fax to: Customer Service Department
National Instruments Corporation
(512) 794-5794

Documentation Comment Form

National Instruments encourages you to comment on the documentation supplied with our products. This information helps us provide quality products to meet your needs.

Title: **SCXI-1200 User Manual**

Edition Date: **August 1994**

Part Number: **320673B-01**

Please comment on the completeness, clarity, and organization of the manual.

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If you find errors in the manual, please record the page numbers and describe the errors.

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Thank you for your help.

Name ____

Title ____

Company ____

Address ____

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Glossary

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

°	degrees
>	greater than
≥	greater than or equal to
<	less than
-	negative of, or minus
Ω	ohms
%	percent
±	plus or minus
+	positive of, or plus
A	amperes
ACH<0..7>	Analog Channel signal
ACK*	Acknowledge Input signal
A/D	analog-to-digital
ADC	analog-to-digital converter
AGND	Analog Ground signal
AISENSE/AIGND	Analog Input Sense/Analog Input Ground signal
ANSI	American National Standards Institute
AWG	American Wire Gauge
C	Celsius
CCLKB1	Counter B1 Clock signal
CLKB2	Counter B2 Clock signal
cm	centimeters
COUTB1	Counter B1 Output signal
D/A	digital-to-analog
D*/A	Data/Address signal
DAC	digital-to-analog converter
DAQ	data acquisition
DAQD*/A	Data acquisition board data/address line signal
DAC0OUT	Digital-to-Analog Converter 0 and 1 Output signal
DATA	Data Lines at the Specified Port signal
dB	decibels
DGND	digital ground signal
DIFF	differential
DIN	Deutsche Industrie Norme

EEPROM	electrically erased programmable read-only memory
EXTCONV*	External Convert signal
EXTTRIG	External Trigger signal
EXTUPDATE*	External Update signal
ft	feet
GATB<0..2>	Counter B0, B1, and B2 gate signals
hex	hexadecimal
IBF	Input Buffer Full signal
in.	inches
INTR	Interrupt Request signal
I/O	input/output
LSB	least significant bit
m	meters
max	maximum
MB	megabytes of memory
min	minimum
MIO	multifunction I/O
MSB	most significant bit
NRSE	nonreferenced single-ended
OBF*	Output Buffer Full signal
OUTB0, OUTB1	counter B0, B1 output signals
PA, PB, PC<0..7>	Port A, B, or C 0 through 7 signal
RD*	Read signal
RSE	referenced single-ended
s	seconds
SCXI	Signal Conditioning eXtensions for Instrumentation (bus)
SDK	Software Developer's Kit
SERCLK	Serial Clock signal
SERDATIN	Serial Data In signal
SERDATOUT	Serial Data Out signal
SLOT0SEL*	Slot 0 Select signal
SPICLK	Serial Peripheral Interface Clock signal
SS*	Slot-Select signal
STB*	Strobe Input signal
TTL	transistor-transistor logic
UP/BP*	Unipolar/bipolar bit
V	volts
VI	Virtual Instrument
W	watts
WR*	Write signal

Index

Numbers

A

B

C

D

E

F

G

H

I

J

L

M

N

T

U

W