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SCXI™-1120/D
User Manual

Eight-Channel Isolated Analog Input Module and

Eight-Channel Wide Band Isolated Analog Input Module

for Signal Conditioning

June 1997 Edition
Part Number 320425C-01

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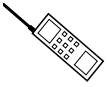
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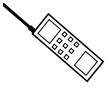
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This manual describes the electrical and mechanical aspects of the SCXI-1120 and SCXI-1120D (SCXI-1120/D) modules and contains information concerning their installation and operation.

The SCXI-1120 and SCXI-1120D are National Instruments Signal Conditioning eXtensions for Instrumentation (SCXI) Series modules. The SCXI-1120/D provides eight isolated input channels. Each channel is independently configurable via jumpers.

The SCXI-1120 module is designed for low-cost signal conditioning of thermocouples, volt sources, millivolt sources, and 4 to 20 mA sources or 0 to 20 mA process-current sources where high common-mode voltages exist.

The SCXI-1120D module is designed for low-cost signal conditioning of volt, millivolt, and current sources that require a 20 kHz bandwidth and where high common-mode voltages exist.

Organization of the SCXI-1120/D User Manual

The *SCXI™-1120/D User Manual* is organized as follows:

- Chapter 1, *Introduction*, describes the SCXI-1120/D; lists what you need to get started; describes the optional software, optional equipment, and custom cables; and explains how to unpack your SCXI-1120/D kit.
- Chapter 2, *Configuration and Installation*, describes how to configure the SCXI-1120/D jumpers and how to install the SCXI-1120/D into the SCXI chassis.
- Chapter 3, *Signal Connections*, describes the input and output signal connections to the SCXI-1120/D board via the SCXI-1120/D front connector and rear signal connector, and includes specifications and connection instructions for the signals given on the SCXI-1120/D connectors.

- Chapter 4, *Theory of Operation*, contains a functional overview of the SCXI-1120/D module and explains the operation of each functional unit making up the SCXI-1120/D.
- Chapter 5, *Calibration*, discusses the SCXI-1120/D calibration procedures.
- Appendix A, *Specifications*, lists the specifications for the SCXI-1102 and SCXI-1120/D.
- Appendix B, *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.
italic	Italic text denotes emphasis, a cross reference, or an introduction to a key concept.
Lab/1200	Lab board refers to the Lab-LC, Lab-NB, Lab-PC, Lab-PC+, Lab-PC-1200, and Lab-PC-1200AI.
`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.
PC	PC refers to the IBM PC/XT, the IBM PC AT, and compatible computers.
SCXI-1120	SCXI-1120 refers to only the SCXI-1120 module.
SCXI-1120D	SCXI-1120D refers to only the SCXI-1120D module.
SCXI-1120/D	SCXI-1120/D refers to both the SCXI-1120D module and the SCXI-1120 module.

Slot 0	Slot 0 refers to the power supply and control circuitry in the SCXI chassis.
♦	The ♦ indicates that the text following it applies to only to a specific SCXI module.

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

National Instruments Documentation

The *SCXI-1120/D User Manual* is one piece of the documentation set for your DAQ system. You could have any of several types of manuals depending on the hardware and software in your system. Use the manuals you have as follows:

- *Getting Started with SCXI*—If you are using 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 hardware user manuals—If you are using SCXI, read these manuals next for detailed information about signal connections and module configuration. They also explain in greater detail how the module works and contain application hints.
- Your DAQ hardware documentation—This documentation has detailed information about the DAQ hardware that plugs into or is connected to your computer. Use this documentation for hardware installation and configuration instructions, specification information about your DAQ hardware, and application hints.
- Software documentation—You may have both application software and NI-DAQ software documentation. National Instruments application software includes ComponentWorks, LabVIEW, LabWindows®/CVI, Measure, and VirtualBench. After you set up your hardware system, use either your application software documentation or the NI-DAQ documentation to help you write your application. If you have a large, complicated system, it is worthwhile to look through the software documentation before you configure your hardware.

- Accessory installation guides or manuals—If you are using accessory products, read the terminal block and cable assembly installation guides. They explain how to physically connect the relevant pieces of the system. Consult these guides when you are making your connections.
- *SCXI Chassis Manual*—If you are using SCXI, read this manual for maintenance information on the chassis and installation instructions.

Related Documentation

The following National Instruments manual contains detailed information for the register-level programmer:

- *SCXI-1120/D Register-Level Programmer Manual*

This manual is available from National Instruments by request. If you are using NI-DAQ, LabVIEW, LabWindows/CVI, or other application software, you should not need the register-level programmer manual. Using NI-DAQ, LabVIEW, LabWindows/CVI or other application software, is easier than, and as flexible as, using the low-level programming described in the register-level programmer manual. Refer to the *Software Programming Choices* section 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 B, *Customer Communication*, at the end of this manual.

Chapter 1

Introduction

This chapter describes the SCXI-1120/D; lists what you need to get started; describes the optional software, optional equipment, and custom cables; and explains how to unpack the SCXI-1120/D kit.

About the SCXI-1120/D

The SCXI-1120/D has eight isolated input channels. The SCXI-1120 is a module for signal conditioning of thermocouples, volt sources, millivolt sources, 4 to 20 mA current sources, and 0 to 20 mA process-current sources. If external excitation is provided, thermistors, RTDs, and strain gauges can also be measured. The SCXI-1120D is a module for signal conditioning and isolating volt sources, millivolt sources, and current sources that require a bandwidth of up to 20kHz. If you provide external excitation, you can use strain gauges and other vibration sensors. The SCXI-1120/D can operate in two output modes—in the parallel-output mode with all eight input channels connected in parallel to eight DAQ board channels, or in the multiplexed-output mode with all eight channels multiplexed into a single DAQ board channel.

The SCXI-1120/D operates with full functionality with the National Instruments MIO, 1200 Series, and Lab PC+ boards. You can use the Lab-NB, the Lab-PC, the Lab-LC, and the PC-LPM-16/PnP boards with the SCXI-1120/D, but these boards cannot scan the module when it is configured in the multiplexed-output mode. These boards can perform only single-channel reads in this mode. You can multiplex several SCXI-1120/D modules into a single channel, thus greatly increasing the number of analog input signals that can be digitized.

The addition of a shielded terminal block provides screw terminals for easy signal attachment to the SCXI-1120/D. In addition, a temperature sensor for cold-junction compensation (CJC) of thermocouples is included on the terminal block. This cold-junction reference (CJR) is either multiplexed along with the eight channels or connected by jumpers to a different channel of the DAQ board.

With the SCXI-1120/D, the SCXI chassis can serve as a fast-scanning signal conditioner for laboratory testing, production testing, and industrial process monitoring.

Detailed specifications of the SCXI-1120/D are listed in Appendix A, *Specifications*.

What You Need to Get Started

To set up and use your SCXI-1120/D, you will need the following items:

- ❑ SCXI-1120 or SCXI-1120D module
- ❑ *SCXI™-1120/D User Manual*
- ❑ One of the following chassis and the *SCXI Chassis Manual*:
  SCXI-1000
  SCXI-1000DC
  SCXI-1001
  SCXI-2000
- ❑ An SCXI terminal block/connector assembly (optional)
- ❑ DAQ board or SCXI-1200
- ❑ Your computer

Software Programming Choices

There are several options to choose from when programming your National Instruments plug-in DAQ and SCXI hardware. You can use LabVIEW, LabWindows/CVI, NI-DAQ, ComponentWorks, Measure, VirtualBench, or register-level programming.

National Instruments Application Software

ComponentWorks contains tools for data acquisition and instrument control built on NI-DAQ driver software. ComponentWorks provides a higher-level programming interface for building virtual instruments through standard OLE controls and DLLs. With ComponentWorks, you

can use all of the configuration tools, resource management utilities, and interactive control utilities included with NI-DAQ.

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

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

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

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

NI-DAQ Driver Software

The NI-DAQ driver software is included at no charge with all National Instruments DAQ hardware. 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 plug-in board, 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. Whether you are using

conventional programming languages, LabVIEW, or LabWindows/CVI, your application uses the NI-DAQ driver software, as illustrated in Figure 1-1.

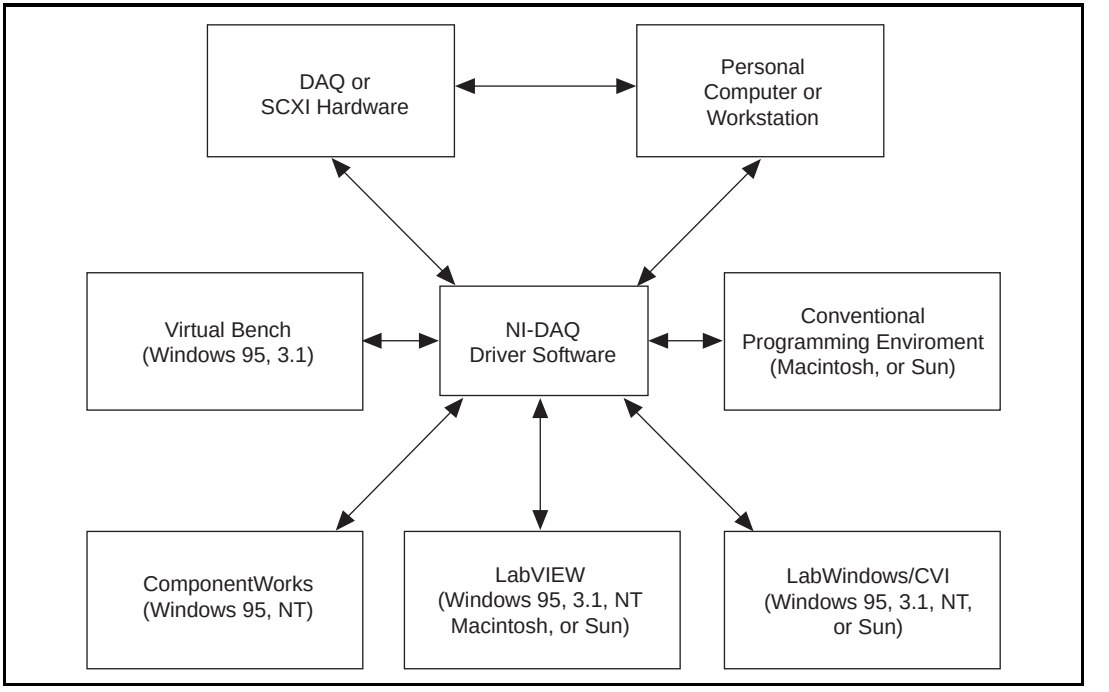


Figure 1-1. The Relationship between the Programming Environment, NI-DAQ, and Your Hardware

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.

Even if you are an experienced register-level programmer, consider using NI-DAQ, LabVIEW, LabWindows/CVI, or other National Instruments software to program your National Instruments DAQ hardware. Using the National Instruments application software is easier than, and as flexible as, register-level programming, and can save weeks of development time.

Optional Equipment

National Instruments offers a variety of products to use with your SCXI-1120/D, as follows:

- Cables and cable assemblies, shielded and ribbon
- Shielded terminal blocks and connector-and-shell assemblies
- SCXI process current resistor kit
- SCXI modules and accessories for isolating, amplifying, exciting, and multiplexing signals for relays and analog output. With SCXI you can condition and acquire up to 3,072 channels.

For additional information about optional equipment available from National Instruments refer to your National Instruments catalogue or call the office nearest you.

Custom Cables

The SCXI-1120/D rear signal connector is a 50-pin male ribbon-cable header. The manufacturer part number used by National Instruments for this header is as follows: AMP Inc. (part number 1-103310-0).

The mating connector for the SCXI-1120/D 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-1120/D. 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 can be used with these connectors are as follows:

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

The SCXI-1120/D front connector is a 32-pin DIN C male connector with columns A and C even pins only. The manufacturer part number used by National Instruments for this connector is as follows: Panduit Corporation (part number 100-932-023).

The mating connector for the SCXI-1120/D front connector is a 32-pin DIN C female connector. National Instruments uses a polarized connector to prevent inadvertent upside-down connection to the SCXI-1120/D. Recommended manufacturer part numbers for this mating connector are as follows:

- Panduit Corporation (part number 100-932-434; straight-solder eyelet pins)
- Panduit Corporation (part number 100-932-633; right-angle pins)

Refer to the *Signal Connections* section in Chapter 2, *Configuration and Installation*, for additional information on cabling, connectors, and adapters.

Unpacking

Your SCXI-1120/D 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 object.
- Touch the antistatic package to a metal part of your SCXI chassis before removing the module from the package.
- Remove the module from the package and inspect the module for loose components or any other sign of damage. Notify National Instruments if the module appears damaged in any way. *Do not* install a damaged module into your SCXI chassis.
- *Never* touch the exposed pins of connectors.

Configuration and Installation

Chapter 2

This chapter describes how to configure the SCXI-1120/D jumpers and how to install the SCXI-1120/D into the SCXI chassis.

Module Configuration

The SCXI-1120/D includes 46 jumpers that are shown in Figure 2-1.

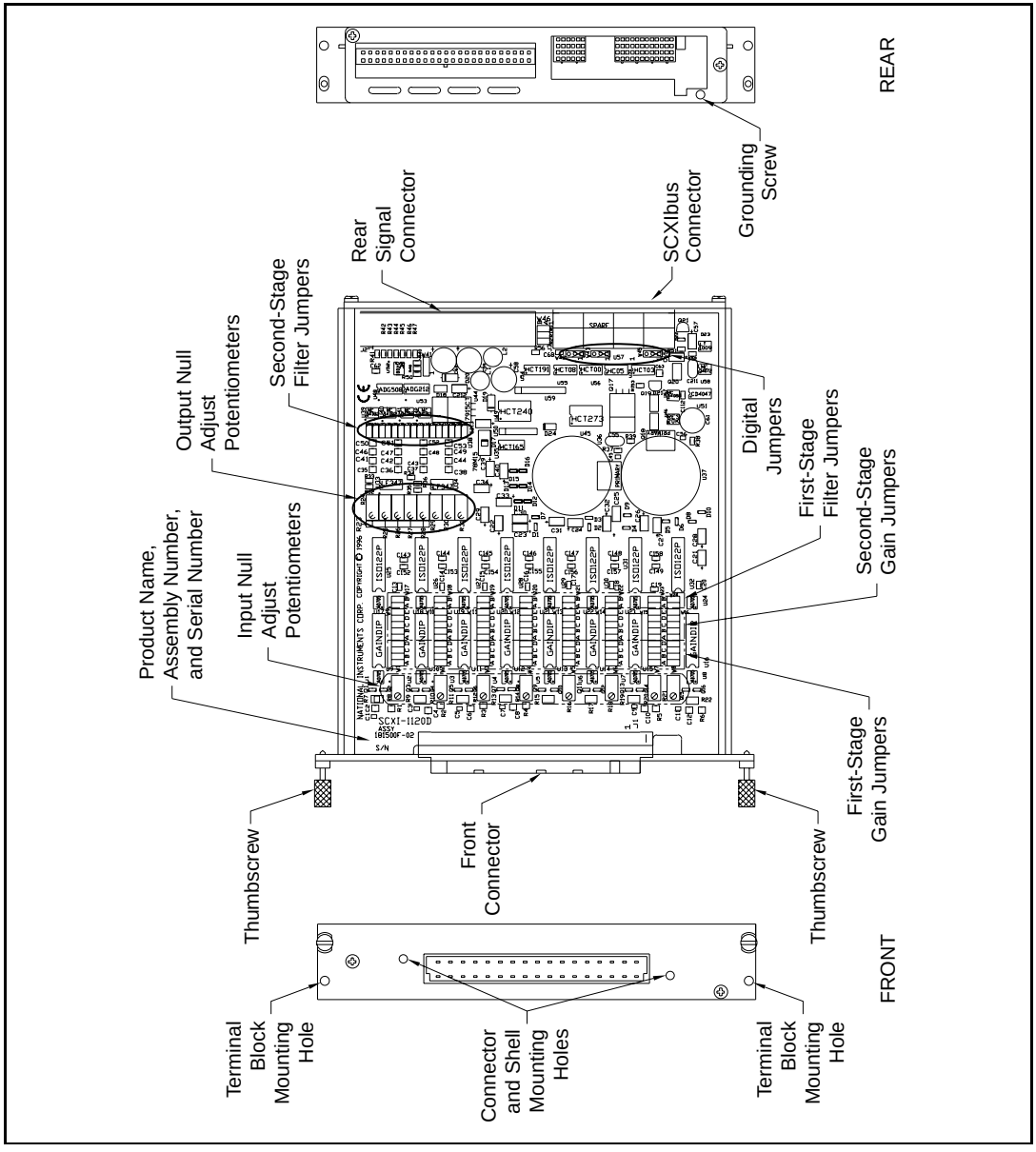


Figure 2-1. SCXI-1120/D Parts Locator Diagram

The jumpers are used as follows:

- Fixed jumpers
  - On Revision A and B SCXI-1120 modules, jumper W42 is unused and should not be connected.
  - Jumper W45 is reserved and should not be reconfigured.
  - On Revision A and B SCXI-1120 modules, jumper W44 carries the SLOT0SEL* signal from the rear signal connector, after buffering, to the SCXIbus INTR* line and should be left in the SCXI-1120 factory-default position (position 1). On all SCXI-1120D modules and on Revision C and later SCXI-1120 modules, jumper W44 does not exist.

☞ **Note:** ***The revision letter is located on the National Instruments label located on the side of each SCXI-1120/D module. The revision letter is found in the part number and is the letter found in that part number.***

- User-configurable jumpers
  - Jumper W43 carries the SCXIbus MISO line, after buffering, to the SERDATOUT signal on the rear signal connector.
  - On all SCXI-1120D and on Revision C and later SCXI-1120 modules, jumper 42 connects a pullup resistor to the SERDATOUT signal on the rear signal connector.
  - Jumper W46 configures the guard, the analog output ground, and enables the NRSE mode.
  - Jumpers W1 through W8 configure the first-stage gain of channels 0 through 7, respectively.
  - Jumpers W9 through W16 configure the second-stage gain of channels 0 through 7, respectively.
  - Jumpers W17 through W24 configure the first-stage filtering of input channels 0 through 7, respectively.
  - Jumpers W25 through W40 configure the second-stage filtering of input channels 0 through 7, respectively.
  - Jumper W41 directly connects the temperature sensor to the rear signal connector. To do so, set jumper W46 in the AB-R2 or AB-R0 position first.

Tables 2-1 to 2-2 list the description and configuration of the user-configurable jumpers. To change the configuration of the module, refer to Figures 2-1 and 2-2 as you perform the following steps:

1. Remove the grounding screw of the SCXI module top cover.
2. Snap out the top cover of the shield by placing a screwdriver in the groove at the bottom of the module and pushing down.
3. Remove the jumpers you want to change and replace them on the appropriate pins.
4. Record the new jumper settings on the *SCXI-1120 Hardware Configuration Form* or on the *SCXI-1120D Hardware Configuration Form* in Appendix B, *Customer Communication*.
5. Snap the top cover back in place.
6. Replace the grounding screw to ensure proper shielding.

You must use software to further configure the module. Refer to your software manual or to the *SCXI-1120/D Register-Level Programmer Manual* if you are a register-level programmer.

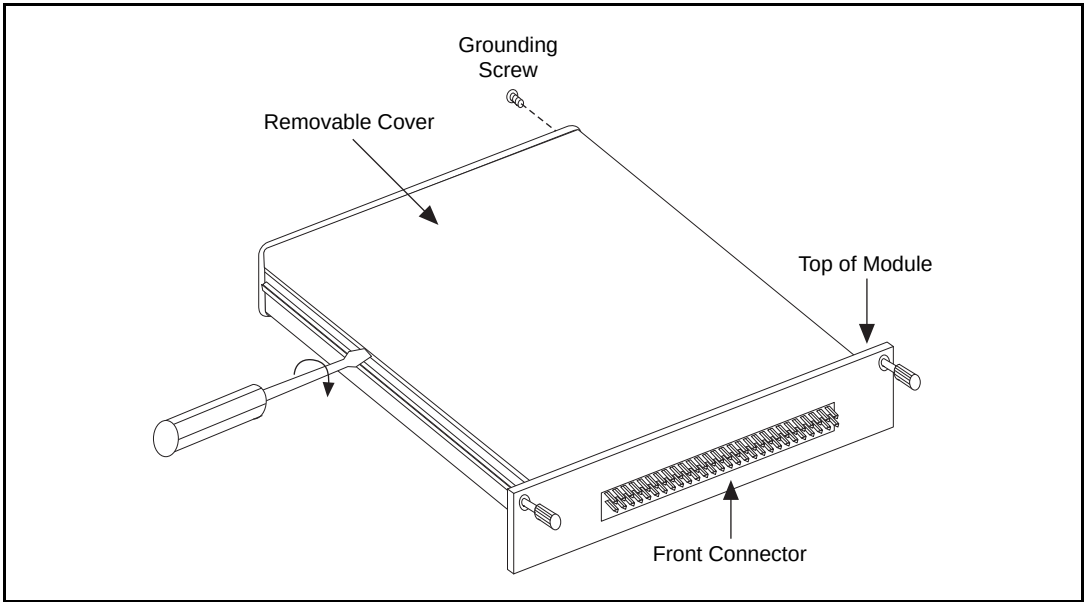


Figure 2-2. Removing the SCXI Module Cover

Digital Signal Connections

The four digital signal connection jumpers have *position 1* marked on the board. Position 3 is not marked explicitly on the board.

The SCXI-1120/D has three jumpers dedicated for communication between the DAQ board and the SCXIbus. These jumpers are W42, W43, and W44.

Using Jumpers W42 and W43

Leave jumpers W42 and W 43 in their factory-default settings if any one of the following applies:

- The SCXI-1120/D is not cabled to a DAQ board
- The SCXI-1120/D is cabled to a DAQ board, and the SCXI chassis is the only SCXI chassis cabled to that DAQ board
- The SCXI-1120/D is cabled to a DAQ board, and there are multiple SCXI chassis cabled to that DAQ board with shielded cables

In the factory-default setting, jumper W43 connects, after buffering, the SCXIbus Master-In-Slave-Out (MISO) line to the SERDATOUT pin of the rear signal connector. In this setting, along with the proper setting of jumper W42, the DAQ board can read the SCXI-1120/D Module ID Register. See Chapter 3, *Signal Connections*, for the pin equivalencies of the SCXI-1120/D rear signal connector and the DAQ board I/O connector.

Revisions A and B of the SCXI-1120

On Revision A and B SCXI-1120 modules, jumper W42 is not used. Set jumper W43 as explained in the cases above, except in the case of a multichassis ribbon cable system. In a multichassis ribbon cable system with Revision A and B SCXI-1120 modules cabled to the DAQ board, you can access the MISO line in only one chassis. Pick one of the chassis that has the SCXI-1120 cabled to the DAQ board. Set jumper W43 on the SCXI-1120 to position 1. On the SCXI-1120 modules that are in the other chassis and cabled to the DAQ board, set jumper W43 to position 3. Notice that you will only be able to access digital information from the chassis that has the SCXI-1120 with jumper W43 set to position 1.

Revisions C and Later of the SCXI-1120 and All Revisions of the SCXI-1120D

Jumper W42 in position 1 connects a 2.2 kΩ pullup resistor to the SERDATOUT line. Position 3 does not connect the pullup resistor to the SERDATOUT line.

The SERDATOUT line is driven with an open-collector driver. (An open-collector driver drives low or goes to a high-impedance state, relying on a pullup resistor to make the signal line go high.)

When using a single chassis, leave W42 and W43 in position 1 on the SCXI-1120/D that is connected to the DAQ board. In this setting, the module drives MISO to SERDATOUT and connects the necessary pullup resistor to the SERDATOUT line.

When using multiple chassis cabled to your DAQ board with shielded cables, leave jumper W42 and W43 in position 1 on the SCXI-1120/D modules that are connected to the DAQ board. In this setting, the module drives MISO to SERDATOUT and connects the necessary pullup resistor to the SERDATPUT line. All of the shielded adapters buffer and combine the SERDATOUT from each chassis to the DAQ board.

When using multiple chassis cabled to your DAQ board with ribbon cables, leave jumper W43 in position 1 on all of the SCXI-1120/D modules that are cabled to the DAQ board. Set jumper W42 to position 1 on only one of the SCXI-1120/D modules cabled to the DAQ board. All the other SCXI-1120/D modules that are cabled to the DAQ board should have jumper W42 in position 3. If too many pullup resistors are attached to the SERDATOUT line, the drivers cannot drive the line low. See Table 2-1 for the description and configuration of the jumper settings.

Using Jumper W44 on Revisions A and B of the SCXI-1120

On Revision A and B SCXI-1120 modules, the jumper is in factory-default position 1, which connects SLOT0SEL* to the SCXIbus INTR* line after buffering. In this setting, the DAQ board controls the SCXIbus INTR* line. See Chapter 3, *Signal Connections*, for the pin

equivalences of the SCXI-1120 rear signal connector and the DAQ board I/O connector.

☞ **Note:** ***Do not use position 3; it is reserved.***

Using Jumper W44 on Revision C of the SCXI-1120 and All Revisions of the SCXI-1120D

On Revision C SCXI-1120 modules and all revisions of the SCXI-1120D modules, jumper W44 is not loaded, and SLOT0SEL* is always buffered to the INTR* line.

Table 2-1. Digital Signal Connections, Jumper Settings

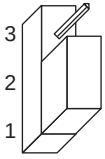
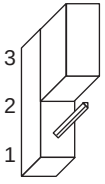
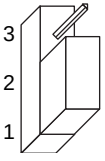
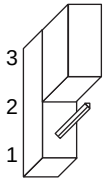
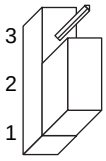
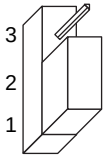
Jumper	Description	Configuration
W42	Position 1—Connects pullup to SERDATOUT (factory-default setting). Applies only to SCXI-1120 Revisions C or later and all SCXI-1120D modules.	
W42	Position 3—Parking position (not connected on Revisions A and B of the SCXI-1120).	
W43	Position 1—Connects MISO to SERDATOUT (factory-default setting).	

Table 2-1. Digital Signal Connections, Jumper Settings (Continued)

Jumper	Description	Configuration
W43	Position 3—Parking position	
W44	Connects SLOT0SEL* to the SCXIbus INTR* line after buffering (factory-default setting). Applies to Revision A and B of the SCXI-1120 modules only.	
W45	Factory-default setting	

Analog Configuration

The SCXI-1120/D has 42 analog configuration jumpers.

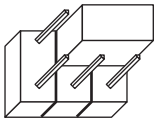
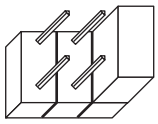
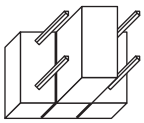
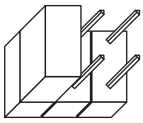
Notice that the jumper configurations for each channel are similar; only the jumper reference designator number changes.

Grounding, Shielding, and Reference-Mode Selection

Jumper W46

☞ **Note:** ***The SCXI-1120/D will drive pins 4, 6, 8, 10, 12, 14, 16, and 18 on the rear signal connector, although the SCXI-1120/D is in multiplexed mode.***

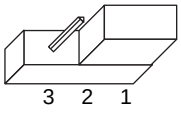
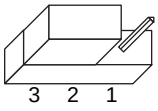
Table 2-2. Jumper W46 Settings

Description	Configuration
B-R0R1—Factory-default setting in parking position	
AB-R0—Connects the analog reference to AOGND (pins 1 and 2 of the rear signal connector). Use with RSE DAQ boards. Do not use with DIFF (differential) input DAQ boards.	
AB-R1—Connects SCXIbus guard to the analog reference	
AB-R2—Enables the NRSE mode and connects OUTREF, pin 19, of the rear signal connector to the analog reference. Use when SCXI-1120/D has to operate with DAQ boards that have NRSE input. Do not use with DIFF input DAQ boards.	

Direct Temperature Connection

Jumper W41

Table 2-3. Jumper W41 Settings

Description	Configuration
Position 1—Temperature sensor accessed in MTS mode (factory-default setting)	
Position 3—Temperature sensor accessed in DTS mode, DAQ board configured for NRSE or RSE mode. Can access sensor in parallel with other eight outputs or scan with other channels without software interference. Connects to pin 18 of the rear signal connector and corresponds to ACH15 of the MIO boards or the PC-LPM-16/PnP.	

Gain Jumpers for the SCXI-1120/D

Each input channel has two user-configurable gain stages. The first gain stage provides gains of 1, 10, 50, and 100, and the second stage provides gains of 1, 2, 5, 10, and 20. Tables 2-4 and 2-5 show how to set up the gain for each channel.

Table 2-4. Gain Jumper Allocation

Input Channel Number	First Gain Jumper	Second Gain Jumper
0	W1	W9
1	W2	W10
2	W3	W11

Table 2-4. Gain Jumper Allocation (Continued)

Input Channel Number	First Gain Jumper	Second Gain Jumper
3	W4	W12
4	W5	W13
5	W6	W14
6	W7	W15
7	W8	W16

Notice that the SCXI-1120D has an additional fixed pre-stage gain of 0.5.

The SCXI-1120 is shipped with the first-stage gain set to 100 (position A), and a second-stage gain set to 10 (position D). The SCXI-1120D is shipped with the first-stage gain set to 100 (position A), and the second-stage gain set to 20 (position E). To change the gain of your module, move the appropriate jumper on your module to the position indicated in Tables 2-3 and 2-4. Refer to Figure 2-1 for jumper locations on your module.

To determine the overall gain of a given channel on the SCXI-1120 use the following formula:

$$Overall\ gain = First\ stage\ gain \bullet Second\ stage\ gain$$

To determine the overall gain of a given channel on the SCXI-1120D use the following formula:

$$Overall\ gain = \frac{1}{2} \bullet First\ stage\ gain \bullet Second\ stage\ gain$$

Table 2-5. Gain Jumper Positions

Gain	Setting	Jumper Position
First-stage	1	D
	10	C
	50	B
	100	A (factory-default setting)
Second-stage	1	A
	2	B
	5	C
	10	D (factory-default setting for the SCXI-1120)
	20	E (factory-default setting for the SCXI-1120D)

SCXI-1120 Filter Jumpers

Two-stage filtering is also available on your SCXI-1120 module. The first stage is located in the isolated section of the input channel, whereas the second stage is located in the nonisolated section of your input channel. Two-stage filtering eliminates the noise generated by the

isolation amplifier, producing a higher signal-to-noise ratio. Furthermore, two filter bandwidths are available, 10 kHz and 4 Hz.

Table 2-6. SCXI-1120 Filter Jumper Allocation

Input Channel Number	First Filter Jumper		Second Filter Jumper	
	4 Hz (Factory Default)	10 kHz	4 Hz (Factory Default)	10 kHz
0	W17-A	W17-B	W25	W26
1	W18-A	W18-B	W27	W28
2	W19-A	W19-B	W29	W30
3	W20-A	W20-B	W31	W32
4	W21-A	W21-B	W33	W34
5	W22-A	W22-B	W35	W36
6	W23-A	W23-B	W37	W38
7	W24-A	W24-B	W39	W40

Your SCXI-1120 is shipped in the 4 Hz position. Verify that both stages are set to the same bandwidth to ensure that the required bandwidth is achieved. Notice that one jumper block is available for each filter stage.

SCXI-1120D Filter Jumpers

Two-stage filtering is also available on your SCXI-1120D module. The first stage is located in the isolated section of the input channel, whereas the second stage is located in the nonisolated section of your input channel. Two-stage filtering eliminates the noise generated by the

isolation amplifier, producing a higher signal-to-noise ratio. Furthermore, two filter bandwidths are available, 22.5 kHz and 4.5 kHz.

Table 2-7. SCXI-1120D Filter Jumper Allocation

Input Channel Number	First Filter Jumper		Second Filter Jumper	
	4.5 kHz (Factory Default)	22.5 kHz	22.5 kHz	4.5 kHz (Factory Default)
0	W17-A	W17-B	W25	W26
1	W18-A	W18-B	W27	W28
2	W19-A	W19-B	W29	W30
3	W20-A	W20-B	W31	W32
4	W21-A	W21-B	W33	W34
5	W22-A	W22-B	W35	W36
6	W23-A	W23-B	W37	W38
7	W24-A	W24-B	W39	W40

Your SCXI-1120D is shipped in the 4.5 kHz position. Verify that both stages are set to the same bandwidth to ensure that the required bandwidth is achieved. Notice that one jumper block is available for each filter stage.

Hardware Installation

You can install the SCXI-1120/D in any available SCXI chassis. After you have configured, verified, and recorded the jumper settings on the form in Appendix B, *Customer Communication*, you can install the SCXI-1120/D. The following are general installation instructions; consult your SCXI chassis manual for specific instructions and warnings.

1. Turn off the computer that contains the DAQ board or disconnect it from your SCXI chassis.
2. Turn off the SCXI chassis. Do not insert the SCXI-1120/D into a chassis that is powered on.
3. Insert the SCXI-1120/D into the module guides. Gently guide the module into the back of the slot until the connectors make contact. If you have already installed a cable assembly in the rear of the chassis, the module and cable assembly must be firmly engaged; however, do not *force* the module into place.
4. Screw the front mounting panel of the SCXI-1120/D to the top and bottom threaded strips of your SCXI chassis.
5. If you are connecting the module to a DAQ board, connect the cable assembly from the rear signal connector of your module to the I/O connector of your DAQ board by following the instructions in your cable installation guide.

☞ **Note:** ***Cable your DAQ board to only one module in each chassis.***

6. Visually verify the installation.
7. Turn on the SCXI chassis.
8. Turn on the computer or reconnect it to your chassis.

The SCXI-1120/D board is installed and ready for operation.

Signal Connections

Chapter 3

This chapter describes the input and output signal connections to the SCXI-1120/D board via the SCXI-1120/D front connector and rear signal connector, and includes specifications and connection instructions for the signals given on the SCXI-1120/D connectors.

The following cautions contain important safety information concerning hazardous voltages.

Caution: ***DO NOT OPERATE THE DEVICE IN AN EXPLOSIVE ATMOSPHERE OR WHERE THERE MAY BE FLAMMABLE GASES OR FUMES.***

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 device, hazardous voltages may exist even when the equipment is turned off. To avoid a shock hazard, do not perform procedures involving cover or shield removal unless you are qualified to do so and disconnect all field power prior to removing covers or shields.

Equipment described in this document must be used in an Installation Category II environment per IEC 664. This category requires local level supply mains-connected installation.

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

Do not operate this equipment in a manner that contradicts the information specified in this document. Misuse of this equipment could result in a shock hazard.

Terminals are for use only with equipment that has no accessible live parts.

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

When using the device with high common-mode voltages, you MUST insulate your signal wires for the highest input voltage. National Instruments IS NOT liable for any damages or injuries resulting from inadequate signal wire insulation. Use only 26 to 14 AWG wire with a voltage rating of 300 V and 60° C for measuring 250 to 300 V; use only 600 V and 60° C for measuring 480 V. Prepare your signal wire by stripping the insulation no more than 7 mm.

When connecting or disconnecting signal lines to the SCXI terminal block screw terminals, make sure the lines are powered off. Potential differences between the lines and the SCXI ground create a shock hazard while you connect the lines.

When using this module with a terminal block, connect the signal wires to the screw terminals by inserting the stripped end of the wire fully into the terminals. Tighten the terminals to a torque of 5 to 7 in.-lb.

Connections, including power signals to ground and vice versa, that exceed any of the maximum signal ratings on the SCXI device, can create a shock or fire hazard or can damage any or all of the boards connected to the SCXI chassis, the host computer, and the SCXI device. National Instruments IS NOT LIABLE FOR ANY DAMAGES OR INJURIES resulting from incorrect signal connections.

If high voltages (≥30 V_{rms} and 42.4 V_{peak} or 60 VDC) are present, YOU MUST CONNECT A SAFETY EARTH GROUND WIRE TO THE TERMINAL BLOCK SAFETY GROUND SOLDER LUG. This complies with safety agency requirements and protects against electric shock when the terminal block is not connected to the chassis. To connect the safety earth ground to the safety ground solder lug, run an earth ground wire in the cable from the signal source to the terminal block. National Instruments IS NOT liable for any damages or injuries resulting from inadequate safety earth ground connections.

Do not loosen or re-orient the safety ground solder lug hardware on the terminal block when connecting the safety ground wire. To do so reduces the safety isolation between the high voltage and safety ground.

Clean devices and terminal blocks by brushing off light dust with a soft, nonmetallic brush. Remove other contaminants with deionized water and a stiff nonmetallic brush. The unit must be completely dry and free from contaminants before returning to service.

Use only National Instruments high voltage TBX Series cable assemblies with high-voltage TBX Series terminal blocks.

Caution: ***To comply with the UL North America or CE, use this module with a UL or CE marked SCXI chassis.***

SCXI-1120/D Front Connector

Figure 3-1 shows the pin assignments for the SCXI-1120/D front connector.

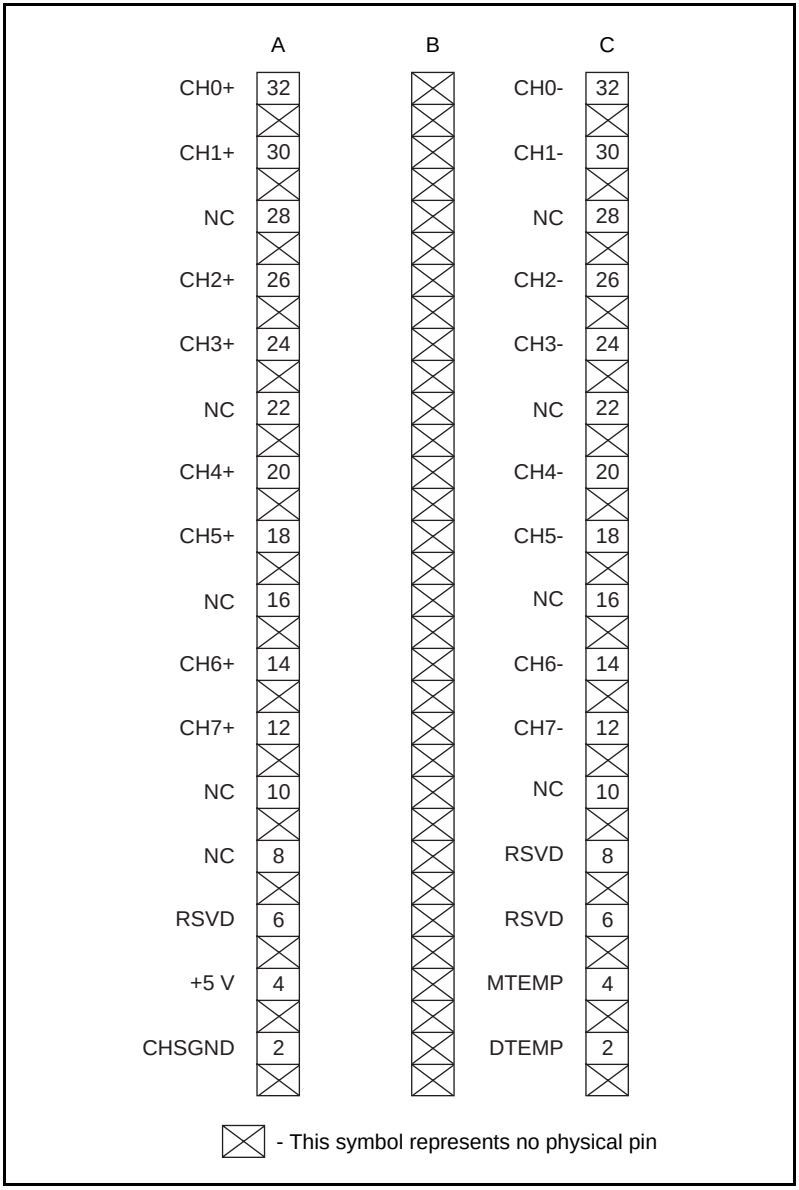


Figure 3-1. SCXI-1120/D Front Connector Pin Assignments

Front Connector Signal Descriptions

SCXI-1120/D front connector signal descriptions are listed in Table 3-1.

Table 3-1. SCXI-1120/D Front Connector Signal Descriptions

Pin	Signal Name	Description
A2	CHSGND	Chassis Ground—Tied to the SCXI chassis.
C2	DTEMP	Direct Temperature Sensor—Connects the temperature sensor to pin 18 of the rear signal connector MCH7- when the terminal block is configured for direct temperature connection and jumper W41 is in position 3.
A4	+5 V	+5 VDC Source—Powers temperature sensor on the terminal block. 0.2 mA of source not protected.
C4	MTEMP	Multiplexed Temperature Sensor—Connects temperature sensor to output multiplexer.
A6, C6, C8	RSVD	Reserved—Reserved for future use. Do not connect any signals to these pins. TTL/CMOS output. They are not protected.
A8, A10, C10, A16, C16, A22, C22, A28, C28	Not Connected	*Do not* connect any signals to these pins.
A12, A14, A18, A20, A24, A26, A30, A32	CH7+ through CH0+	Positive Input Channels—Positive inputs to channels 7 through 0, respectively.
C12, C14, C18, C20, C24, C26, C30, C32	CH7– through CH0–	Negative Input Channels—Negative inputs to channels 7 through 0, respectively.

The signals on the front connector are all analog with the exceptions of pins A6, C6, and C8. The analog signals can be divided into two groups—the analog input channels and the temperature sensor.

Analog Input Channels

The SCXI-1120/D positive input channels are located in Figure 3-1 column A. Their corresponding negative input channels are located in column C. Each input corresponds to a separate amplifier and is fully isolated from the other channels and from earth ground. The inputs are designed in a floating single-ended configuration, thus the measured signal can be referenced to a ground level with common-mode voltage up to 250 V_{rms}. For better noise immunity, connect the negative input channel to the signal reference. If the measured signals are floating, connect the negative input channel to chassis ground on the terminal block. Figure 3-2 shows how to connect a ground-referenced signal on the SCXI-1120/D. Figure 3-3 shows how to connect a floating signal on the SCXI-1120/D. Figures 3-4 through 3-7 show how to connect AC-coupled signals on the SCXI-1120/D.

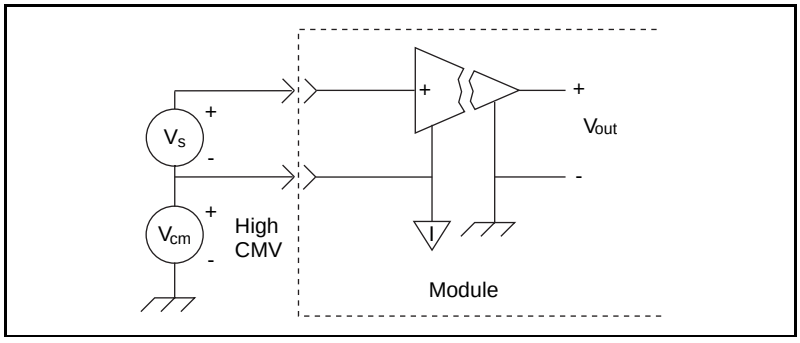


Figure 3-2. Ground-Referenced Signal Connection for the SCXI-1120/D with High Common-Mode Voltage

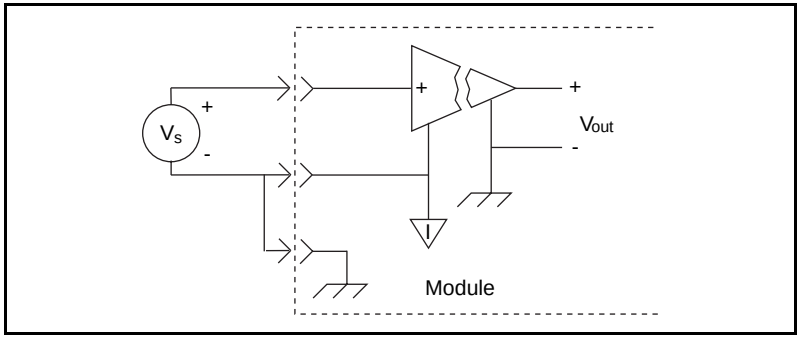


Figure 3-3. Floating Signal Connection for the SCXI-1120/D Referenced to Chassis Ground for Better Signal-to-Noise Ratio

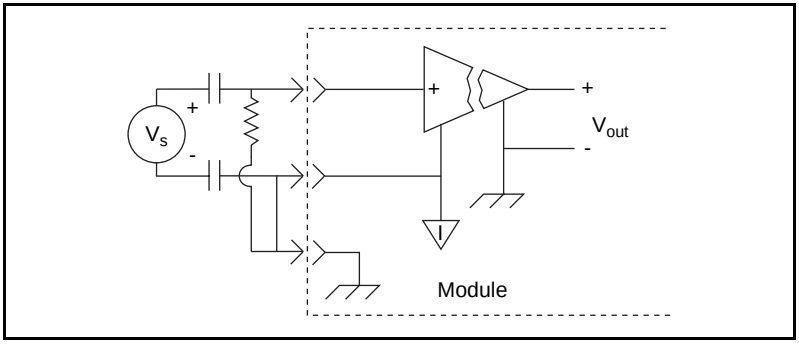


Figure 3-4. Floating AC-Coupled Signal Connection for the SCXI-1120

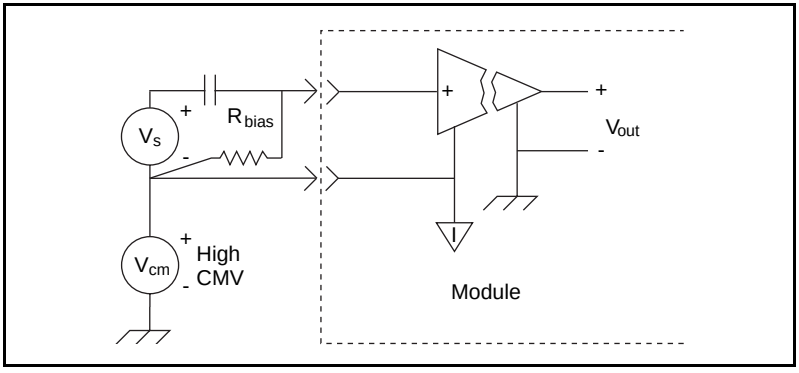


Figure 3-5. AC-Coupled Signal Connection for the SCXI-1120 with High Common-Mode Voltage

- SCXI-1120

When you connect AC-coupled signals to the SCXI-1120, connect an external resistor from the positive input channel to the signal reference to provide the DC path for the positive input bias current. Typical resistor values range from 100 kΩ to 1 MΩ. This solution, although necessary in this case, lowers the input impedance of the input channel amplifier and introduces an additional offset voltage proportional to the input bias current and to the resistor value used. The typical input bias current of the amplifier consists of ±80 pA and a negligible offset drift current. When a 100 kΩ resistor is used, this will result into ±8 µV of offset, which is insignificant in most applications. However, if larger valued bias resistors are used, significant input offset may result. To

determine the maximum offset introduced by the biasing resistor, use the following equation:

$$V_{ofsbias} = I_{bias} \bullet R_{bias}$$

The input signal range of an SCXI-1120 input channel is ±5 V/ G_{total} referenced to its negative input, where G_{total} is equal to the product of the first-stage and second-stage gains. In addition, the input channels are overvoltage protected to 250 V_{rms} with power on or off at a maximum of 4.5 mA_{rms} sink or source.

- SCXI-1120D

When connecting AC-coupled signals to the SCXI-1120D, you do not need to add the external resistor, as the SCXI-1120D provides a DC path internally. Refer to Figures 3-6 and 3-7 for further details.

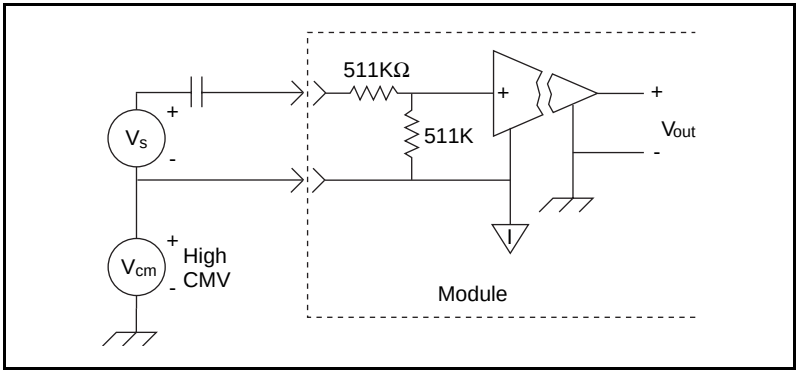


Figure 3-6. AC-Coupled Signal Connection for the SCXI-1120D with High Common Mode Voltage

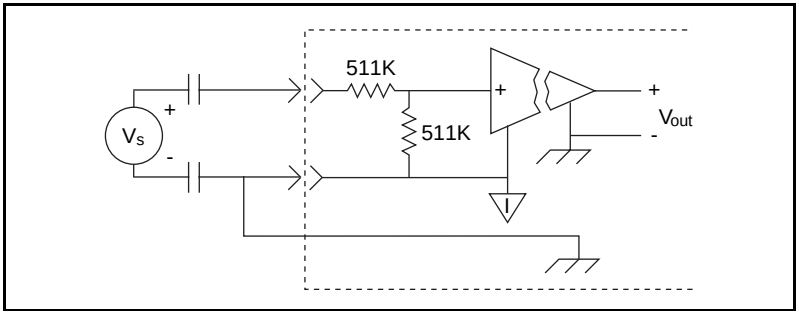


Figure 3-7. Floating AC-Coupled Signal Connection for the SCXI-1120D

Temperature Sensor Connection

Pins C2 and C4 are dedicated for connecting to a terminal block temperature sensor. The temperature sensor is not isolated and is referenced to the chassis ground. The connection is overvoltage protected to ±25 VDC with power on and ±15 VDC with power off.

SCXI-1120/D Rear Connector

☞ **Note:** ***If you will be using the SCXI-1120/D with a National Instruments DAQ board and cable assembly, you do not need to read the remainder of this chapter. If you will also be using the SCXI-1180 feedthrough panel, the SCXI-1343 rear screw terminal adapter, or the SCXI-1351 one-slot cable extender with the SCXI-1120/D, you should read this section.***

Figure 3-8 shows the pin assignments for the SCXI-1120/D rear signal connector.

AOGND	1	2	AOGND
MCH0+	3	4	MCH0-
MCH1+	5	6	MCH1-
MCH2+	7	8	MCH2-
MCH3+	9	10	MCH3-
MCH4+	11	12	MCH4-
MCH5+	13	14	MCH5-
MCH6+	15	16	MCH6-
MCH7+	17	18	MCH7-
OUTREF	19	20	NC
NC	21	22	NC
NC	23	24	DIG GND
SERDATIN	25	26	SERDATOUT
DAQD*/A	27	28	NC
SLOT0SEL*	29	30	NC
NC	31	32	NC
DIG GND	33	34	NC
NC	35	36	SCANCLK
SERCLK	37	38	NC
NC	39	40	NC
NC	41	42	NC
RSVD	43	44	NC
NC	45	46	NC
NC	47	48	NC
NC	49	50	NC

Figure 3-8. SCXI-1120/D Rear Signal Connector Pin Assignments

Rear Connector Signal Descriptions

SCXI-1120/D rear connector signal descriptions are listed in Table 3-2.

Table 3-2. Rear Connector Signal Descriptions

Pin	Signal Name	Description
1–2	AOGND	Analog Output Ground—Connected to the analog reference when jumper W46 is in position AB-R0.
3–18	MCH0± through MCH7±	Analog Output Channels 0 through 7—Connects to the DAQ board differential analog input channels.
19	OUTREF	Output Reference—Serves as the reference node for the analog output channels and the temperature sensor—in the DTS mode—in the NRSE mode. It should be connected to the analog input sense of the NRSE DAQ board.
24, 33	DIG GND	Digital Ground—Supply the reference for DAQ board digital signals and are tied to the module digital ground.
25	SERDATIN	Serial Data In—Taps into the SCXIbus MOSI line to provide serial input data to a module or slot 0.
26	SERDATOUT	Serial Data Out—Taps into the SCXIbus MISO line to accept serial output data from a module.
27	DAQD*/A	DAQ Board Data/Address Line—Taps into the SCXIbus D*/A line to indicate to the module whether the incoming serial stream is data or address information.
29	SLOT0SEL*	Slot 0 Select—Taps into the SCXIbus INTR* line to indicate whether the information on MOSI is being sent to a module or slot 0.
36	SCANCLK	Scan Clock—Indicates to the SCXI-1120/D that a sample has been taken by the DAQ board and causes the SCXI-1120/D to change channels.

Table 3-2. Rear Connector Signal Descriptions (Continued)

Pin	Signal Name	Description
37	SERCLK	Serial Clock—This signal taps into the SCXIbus SPICLK line to clock the data on the MOSI and MISO lines.
43	RSVD	Reserved.

All other pins are not connected.

The signals on the rear connector can be classified as analog output signals, digital I/O signals, or timing I/O signals. Signal connection guidelines for each of these groups are given in the following section.

Analog Output Signal Connections

Pins 1 through 19 of the rear connector are analog output signal pins. Pins 1 and 2 are AOGND signal pins. AOGND is an analog output common signal that is routed through jumper W46 to the analog reference on the SCXI-1120/D. You can use these pins for a general analog power ground tie point to the SCXI-1120/D if necessary. In particular, when using differential input DAQ boards, such as the MIO-16 board, it is preferable to leave jumper W46 in its factory-default setting or in position AB-R1 to avoid ground loops. With DAQ boards that are configured for RSE measurements, jumper W46 should be in position AB-R0 to connect the SCXI-1120/D analog ground reference to the DAQ analog ground. Pin 19 is the OUTREF pin, and is connected internally to the analog reference when jumper W46 is in position AB-R2. Pins 3 through 18 are the analog output channels of the SCXI-1120/D. Pins 3 and 4, or MCH0±, are a multiplexed output of all eight channels and the temperature sensor output. Pins 5 through 18, or MCH1± through MCH7±, are a parallel connection of channels 1 through 7 to the rear connector. Pin 18 is a direct connection to the temperature sensor when jumper W41 is in position 3. Notice that the temperature sensor is located on the terminal block. For further details on configuring the temperature sensor output, refer to the SCXI-1320 and SCXI-1328 terminal block installation guides.

☞ **Note:** ***The SCXI-1120/D analog outputs are short-circuit protected.***

The digital I/O signals of the SCXI-1120/D match the digital I/O lines of the MIO-16 board. When used with an SCXI-1341, SCXI-1342, or SCXI-1344 cable assembly, the SCXI-1120/D signals match the digital

lines of the Lab-NB/Lab-PC+/Lab-LC boards and the PC-LPM-16/PnP board, respectively. Table 3-3 lists the equivalencies. For more information, consult your cable assembly installation guide.

Table 3-3. SCXIbus to SCXI-1120/D Rear Connector to DAQ Board Pin Equivalencies

SCXIbus Line	SCXI-1120/D Rear Signal Connector	MIO E Series Board	Lab and 1200 Series Board	PC-LPM-16/PnP
MOSI	SERDATIN	DIO0	PB4	DOUT4
D*/A	DAQD*/A	DIO1	PB5	DOUT5
INTR*	SLOT0SEL*	DIO2	PB6	DOUT6
SPICLK	SERCLK	EXTSTROBE*	PB7	DOUT7
MISO	SERDATOUT	DIO4	PC1	DIN6

Specifications and ratings for the digital I/O lines are given in Appendix A, *Specifications*.

Chapter 4

Theory of Operation

This chapter contains a functional overview of the SCXI-1120/D module and explains the operation of each functional unit making up the SCXI-1120/D.

Functional Overview

The block diagram in Figure 4-1 illustrates the key functional components of the SCXI-1120/D.

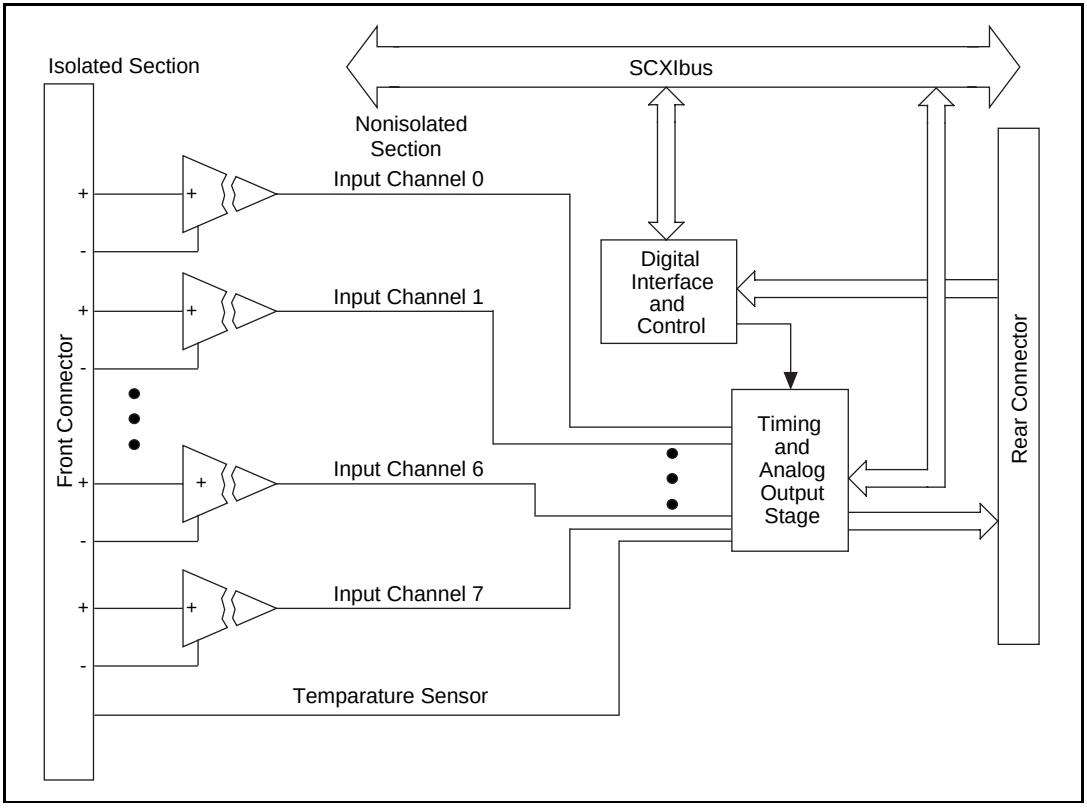


Figure 4-1. SCXI-1120/D Block Diagram

The major components of the SCXI-1120/D are as follows:

- SCXIbus connector
- Digital interface
- Digital control circuitry
- Timing and analog circuitry

The SCXI-1120 consists of eight isolated amplifier channels with gains of 1, 2, 5, 10, 20, 50, 100, 200, 250, 500, 1,000, and 2,000. The SCXI-1120D consists of eight isolated amplifier channels with gains of 0.5, 1, 2.5, 5 10, 25, 50, 100, 125, 250, 500, and 1,000. The SCXI-1120/D also has a digital section for automatic control of channel scanning and temperature selection.

The theory of operation of each of these components is explained in the rest of this chapter.

Power-Up State

The SCXI-1120/D powers up, or resets, in parallel mode.

SCXIbus Connector and Digital Interface

Figure 4-2 shows a diagram of the SCXI-1120/D and SCXIbus digital interface circuitry.

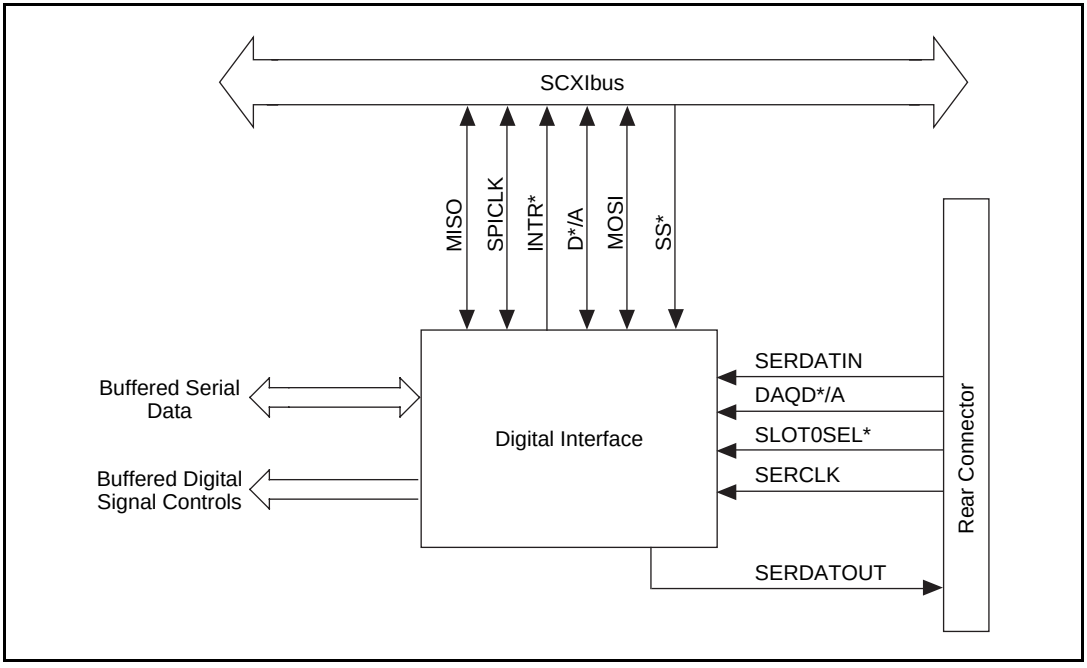


Figure 4-2. Digital Interface Circuitry Block Diagram

The digital interface circuitry is divided into a data acquisition section and an SCXIbus section. The SCXI-1120/D connects to the SCXIbus via a 4 x 24 metral receptacle and to the DAQ board via a 50-pin ribbon-cable header. The digital interface circuitry buffers the digital signals from the DAQ board and the SCXIbus and sends signals back and forth between the DAQ board and the SCXIbus.

Digital Control Circuitry

Figure 4-3 diagrams the SCXI-1120/D digital control.

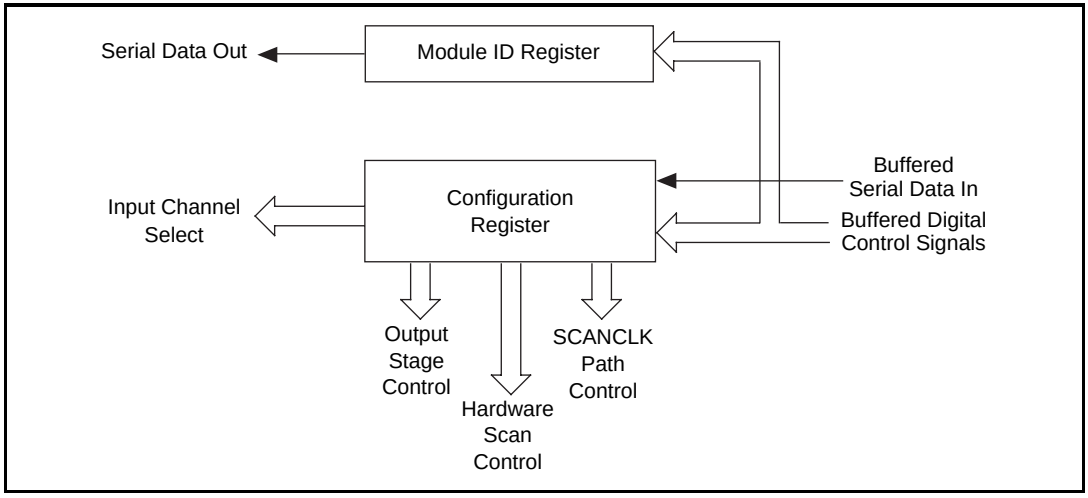


Figure 4-3. SCXI-1120/D Digital Control

The digital control section consists of the Configuration Register and the Module ID Register.

The Configuration Register provides channel selection and configures the SCXI-1120/D for scanning options. All the control bits are fed into a latch before being routed to the rest of the module. The channel-select bits are taken directly from the shift register. Complete descriptions of the register bits are given in the *SCXI-1120/D Register-Level Programmer Manual*.

The Module ID Register contains the module ID 4 hex, a code unique to the SCXI-1120, or 44 hex, a code unique to the SCXI-1120D. You can read this module ID over the SCXIbus to determine the type of module in a particular slot.

Analog and Timing Circuitry

The SCXIbus provides analog power (±18.5 VDC) that is regulated on the SCXI-1120/D to ±15 VDC, a guard, an analog bus (AB0±), and a chassis ground (CHSGND). AB0± buses the SCXI-1120/D output to other modules or receives outputs from other modules via the SCXIbus. The guard guards the analog bus and can be connected via jumper W46 to the analog ground reference or can be left floating (a connection can be made by another board).

The DAQ board analog input and timing is the interface between the SCXI-1120/D output and the DAQ board.

Analog Input Channels

Figure 4-4 shows the analog input block diagram.

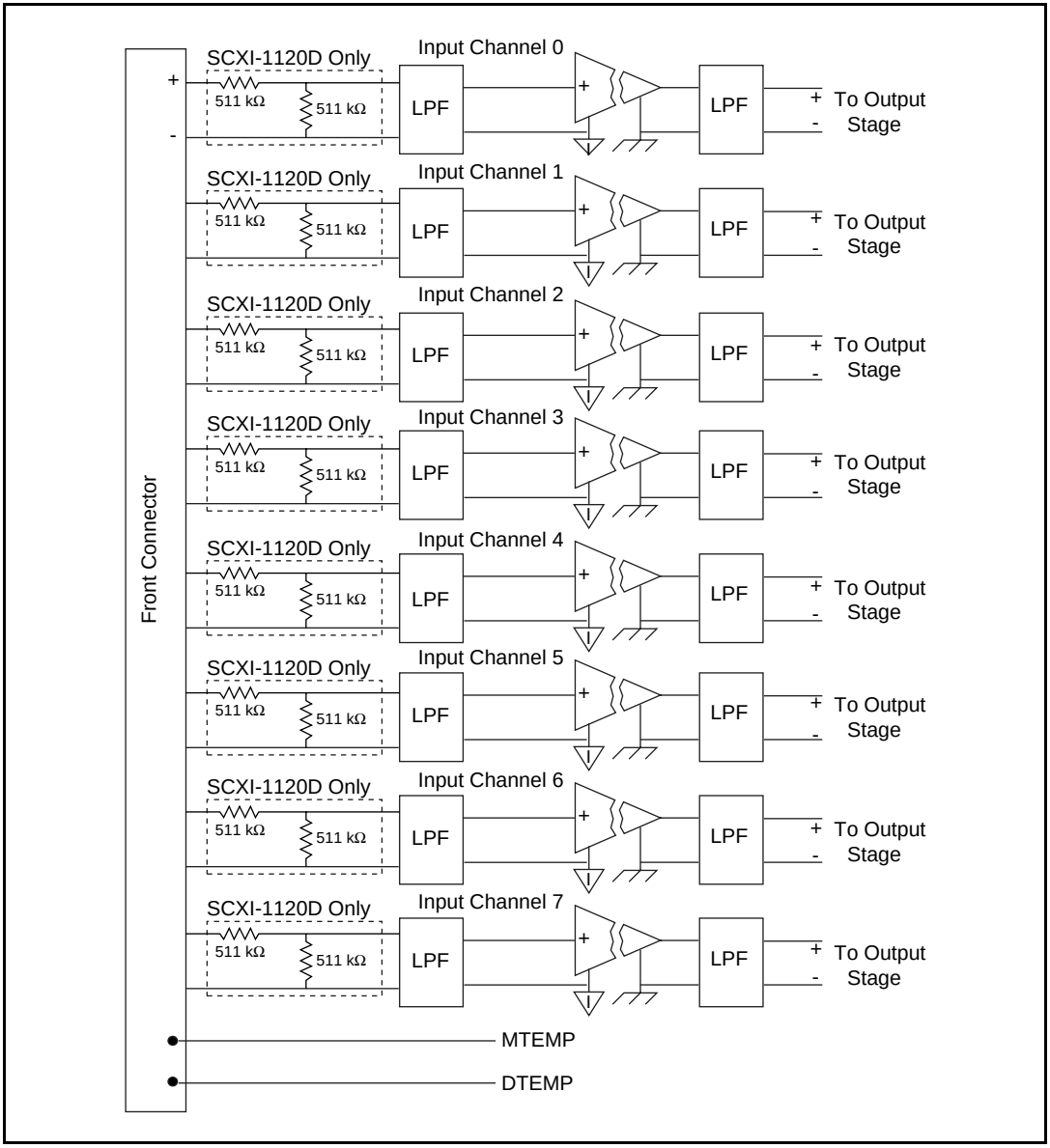


Figure 4-4. Analog Input Block Diagram

The analog input consists of eight isolated single-ended noninverting amplifiers. In addition, lowpass filtering is available at the inputs. You can jumper select one of two bandwidths; 10 kHz or 4 Hz for the SCXI-1120, and 22.5 kHz or 4.5 kHz for the SCXI-1120D. The amplifier gain is divided into two stages; a first stage providing gains of 1, 10, 50, and 100, and a second stage providing gains of 1, 2, 5, 10, and 20. Each channel is configurable to a different bandwidth and gain. In addition to these two stages, the SCXI-1120D has a fixed input gain stage of 0.5.

Use the following formula to determine the overall gain of a given amplifier input channel:

$G_{TOTAL} = G_{1ST} \bullet G_{2ND}$ for the SCXI-1120

$G_{TOTAL} = \frac{1}{2} G_{1ST} \bullet G_{2ND}$ for the SCXI-1120D

where G_{total} is the overall gain and G_{1st} and G_{2nd} are the first- and second-stage gains. Here it is important to note that the choice of gain in each stage will affect the amplifier bandwidth. To determine the bandwidth of a given gain stage use the following formula:

$$BW = \frac{GPWP}{G}$$

where BW is a given amplifier stage bandwidth, GBWP is the gain bandwidth product (typically 800 kHz for the SCXI-1120 and 8 MHz for the SCXI-1120D), and G is the gain at this stage. This BW might be of concern at high first-stage gains such as 50 and 100. In this case, the first-stage amplifier has a BW equal to 16 kHz and 8 kHz, respectively, for the SCXI-1120, and 60 kHz and 80 kHz for the SCXI-1120D. Due to this decrease in the amplifier bandwidth, you will notice a decrease in the channel overall bandwidth, but a better noise immunity. If this bandwidth limitation is unacceptable, you should spread the gains over both stages, thus increasing the BW of each amplifier stage. This will introduce, in most cases, a negligible effect on the channel bandwidth. For example, to achieve a gain of 100 for the SCXI-1120, use $G_{1st} = 10$ and $G_{2nd} = 10$; for a gain of 1,000, use $G_{1st} = 50$ and $G_{2nd} = 20$. However, for the SCXI-1120D, minimal effects are introduced at $G \leq 100$. Refer to Appendix A, *Specifications*, for Gain versus BW for the SCXI-1120D.

All the amplifier input channels are overvoltage protected to 250 V_{rms} with power on or off.

The isolated amplifiers fulfill two purposes on the SCXI-1120/D module. They convert a small signal riding on a high common-mode voltage into a single-ended signal with respect to the SCXI-1120/D chassis ground. With this conversion, the input analog signal can be extracted from a high common-mode voltage or noise before being sampled and converted by the DAQ board. The isolated amplifier also amplifies and conditions an input signal, which results in an increase in measurement resolution and accuracy.

After isolation, further filtering is available to increase the noise immunity of the amplifier channel. It is important to note that the overall amplifier bandwidth is determined by both filtering stages, so to achieve the required bandwidth, both filtering sections should be set the same, as indicated in Chapter 2, *Configuration and Installation*.

Analog Output Circuitry

Figure 4-5 shows the SCXI-1120/D analog output circuitry.

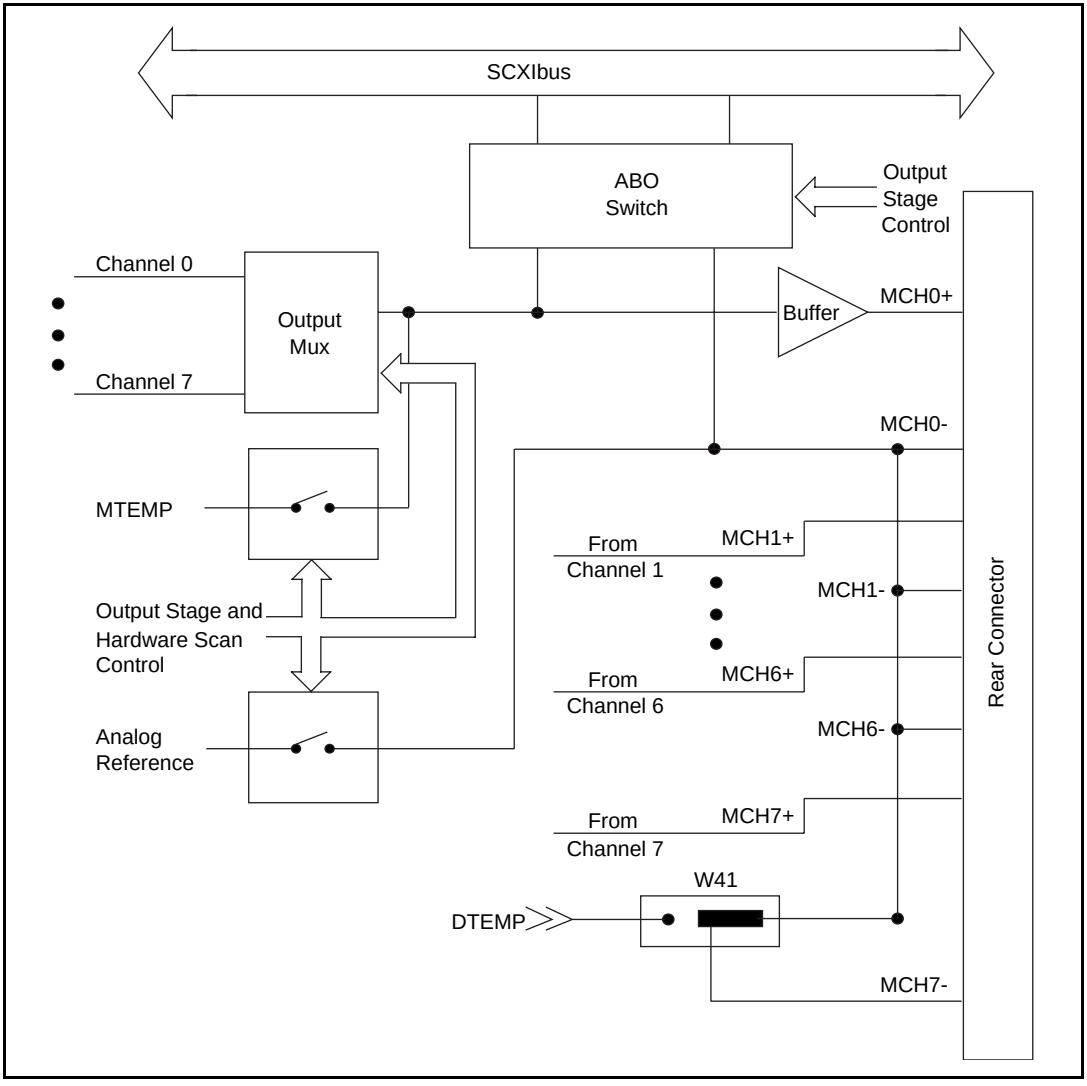


Figure 4-5. Analog Output Circuitry

The SCXI-1120/D output circuitry consists of a buffered-output multiplexer and channel-select hardware. The channel-select hardware consists of a counter. This counter is needed when the board is operating in the multiplexed-output mode.

In the parallel-output mode, the counter is disabled and amplifier channel 0 is selected at the output multiplexer and is connected to MCH0. The seven other channels are hardwired to MCH1 through MCH7 on the rear connector.

The output multiplexer multiplexes all eight amplifier outputs and the temperature-sensor reading provided on the MTEMP line. This measurement is only software controlled. For hardware control of the temperature sensor reading, connect the temperature sensor to pin 18 on the rear connector as described in Chapter 2, *Configuration and Installation*. The multiplexer output connects to the MCH0± and is connected to the DAQ board analog channel input. In the case of the MIO DAQ boards, MCH0± on the rear connector corresponds to ACH0 and ACH8.

Notice that when the multiplexed-output mode is selected, pins 5 through 18 on the rear connector are still driven by the SCXI-1120/D. The SCXI-1120/D outputs on the rear connector are short-circuit protected.

Parallel Mode

When the MCH0 signal is configured to be the output of channel 0, the rear connector simultaneously carries each of the outputs of the SCXI-1120/D on different pins, and the module is in parallel mode. In this mode you can use an SCXI-1180 feedthrough panel to make each of the outputs available at the front of the chassis. A DAQ board cabled to an SCXI-1120/D in parallel mode reads a separate output signal from the module on each of its analog inputs. You cannot multiplex the parallel outputs of a module onto the SCXIbus; only a DAQ board directly cabled to the module has access to the outputs.

Multiplexed Mode (Recommended)

In multiplexed mode, the output signals for channels 1 through 7 are sent to the rear connector but are usually ignored. All reads from the module are from the MCH0 signal of the rear connector, which can be configured as the output of any channel of the SCXI-1120/D or as the output of any other module in multiplexed mode that is sending its output onto the SCXIbus. You can also configure the SCXI-1120/D to send any one of its outputs to the SCXIbus. Thus, in multiplexed mode only, one module in a chassis needs to be connected to a DAQ board; you can pass signals from the other modules to the DAQ board via the SCXIbus.

Multiplexed mode is also useful for performing scanning operations with the SCXI-1120/D. The MIO boards, Lab-PC+, and the 1200 Series DAQ boards all support scanning. The SCXI chassis is programmed with a module scan list that dynamically controls which module sends its output to the SCXIbus during a scan. You can specify this list to scan the modules in any order, with an arbitrary number of channels for each module entry in the list. However, the channels on the SCXI-1120/D must be scanned in a consecutive, ascending order (after channel 7 is scanned the module wraps back to channel 0 and continues). You can program the SCXI-1120/D to start scans with any channel.

☞ **Note:** ***The SCXI-1120/D parallel outputs continuously drive the RSC pins even when the module is configured in multiplexed mode.***

Chapter 5

Calibration

This chapter discusses the SCXI-1120/D calibration procedures.

Calibration Equipment Requirements

For best measurement results, calibrate the SCXI-1120/D so that its offset is adjusted to 0 ± 3 mV RTO and 0 ± 6 µV RTI. No special equipment is needed other than a regular voltmeter with the following specifications:

- Range: 30 mV to 300 mV
- Resolution: 3.5 digits or greater

A multiranging 3.5-digit digital multimeter can provide you with the necessary function as described previously. We will refer to the measuring instrument as a digital multimeter (DMM).

Each channel on the SCXI-1120/D has two potentiometers dedicated for calibration. One potentiometer is used to null the output offset; the other is used to null the input offset.

Re-calibrate your SCXI-1120/D once a year.

Offset Null Adjust

To avoid erroneous results when nulling the amplifier, follow these steps in the order indicated. To null the offset of the amplifier channels, complete the following steps:

1. Set the DMM range to the smallest range that can measure ±3 mV.
2. Short the inputs of the DMM together and then to chassis ground.
3. Record the measurement indicated by the DMM display. This is the DMM inherent offset and it should be subtracted from subsequent measurements.

4. Short the desired channel inputs together and then to chassis ground.
5. Set the amplifier gain to 1.
6. Connect the amplifier output to the DMM. Make sure that the DMM can achieve the accuracy and resolution you need.
7. Adjust the output potentiometer of the desired channel until the output is 0 ± 3 mV.
8. Set the DMM range to the smallest range that can measure ±6 mV.
9. Set the amplifier gain to 1,000.
10. Adjust the input potentiometer of the desired channel until the output is 0 ± 6 mV.
11. Go to the next channel.

You may seal the potentiometers after calibration with antisabotage lacquer to avoid tampering with the calibration.

Table 5-1 lists the potentiometer reference designators that correspond to each channel.

Table 5-1. Calibration Potentiometers Reference Designators

Input Channel Number	Amplifier Channel	
	Input Null	Output Null
0	R08	R24
1	R10	R25
2	R12	R26
3	R14	R27
4	R16	R28
5	R18	R29
6	R20	R30
7	R21	R31

Appendix A

Specifications

This appendix lists the specifications for the SCXI-1120 and SCX-1120D. These are typical at 25° C unless otherwise stated. The operating temperature range is 0° to 50° C.

SCXI-1120

Analog Input

Gain (jumper-selectable).....1, 2, 5, 10, 20, 50, 100, 200, 250, 500, 1,000, 2,000

Output range .....±5 V

Number of channels 8

Gain accuracy .....0.2% of reading typ
0.6% of reading max

Nonlinearity.....0.04% of fullscale range

Offset voltage ..... $\pm\left(6\ \mu V \pm \frac{3\ mV}{Gain}\right)$

Stability versus ambient temperature

Offset drift RTI ..... $\pm\left(0.2\ \mu V/°C \pm \frac{200\ \mu V/°C}{Gain}\right)$

Gain drift .....20 ppm/°C

Input bias current .....±80 pA

Input resistance

Normal .....1 GΩ

Power off .....50 kΩ

Overload .....50 kΩ

Output resistance

Multiplexed-output mode ..... 100 Ω

Parallel-output mode ..... 330 Ω

Filtering (jumper selectable) ..... 4 Hz (–10 dB) or 10 kHz (–3 dB), 3-pole RC

Output selection time

(with 5 V step, all gains)

0.012% accuracy[1] ..... 5.2 µs typ, 7 µs max

0.012% accuracy[2] ..... 3 µs

0.006% accuracy[3] ..... 10 µs

0.0015% accuracy[3] ..... 20 µs

Rise time

4 Hz ..... 0.12 s

10 kHz ..... 70 µs

Slew rate ..... 0.15 V/µs

Noise (400 kHz bandwidth)[1]

Input (gain = 1,000)

4 Hz filter ..... 100 nV_{rms}

10 kHz filter ..... 4 μV_{rms}

Output (gain = 1)

4 Hz ..... 150 μV_{rms}

10 kHz ..... 1 mV_{rms}

Operating common-mode voltage..... 50 or 60 Hz

Channel to channel or channel to earth ..... 250 V_{rms}[4]

1. Includes the combined effects of the SCXI-1120 and the AT-MIO-16F-5
2. Includes the combined effects of the SCXI-1120 and the AT-MIO-16E-2 with 1 m or 2 m cable
3. Includes the combined effects of the SCXI-1120 and the AT-MIO-16X with 1m or 2 m cable
4. Module designed to meet IEC-1010 standard for double or reinforced insulation for category II pollution degree 2

Common-mode rejection ratio, 50 or 60 Hz

1 kΩ in input leads .....160 dB min at 4 Hz bandwidth

NMR (50 or 60 Hz) .....60 dB at 4 Hz bandwidth

Input protection (continuous).....250 V_{rms} max[1]

Output protection.....Continuous short-to-ground

Power consumption.....170 mA at ±18.5 V
50 mA at ±5 V

Digital I/O

Absolute maximum voltage ..... 5.5 V with respect to DIG GND input rating

Digital input specifications (referenced to DIG GND):

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

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

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

Digital output specifications (referenced to DIG GND):

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

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

Physical

Dimensions .....3.1 by 17.3 by 20.3 cm.
(1.2 by 6.8 by 8.0 in.)

Connectors.....50-pin male ribbon-cable rear connector, 32-pin DIN C male front connector(18-screw terminal adapter available)

1. Module designed to meet IEC-1010 standard for double or reinforced insulation for category II pollution degree 2

Environment

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

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

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

SCXI-1120D

Analog Input

Input Characteristics

Number of channels ..... 8 differential

Table A-1. Input Signal Range

Gain	Range	Channel Bandwidth	
		Filter at 22.5 K	Filter at 4.5 K
0.5	±10 V	22.5 K	4.5 K
1	±5 V	22.5 K	4.5 K
2.5	±2 V	22.5 K	4.5 K
5	±1 V	22.5 K	4.5 K
10	±0.5 V	22 K	4.5 K
25	±0.2 V	22 K	4.5 K
50	±0.1 V	22 K	4.5 K
100	±50 mV	20 K	4.5 K
250	±20 mV	20 K	4 K
500	±10 mV	17 K	4 K
1000	±5 mV	14 K	3.5 K

Input coupling.....DC or AC with TBX-1329 or SCXI-1305

Maximum working voltage (Signal + CMV).....250 V_{rms}[1]

Overvoltage protection.....250 V_{rms} on or off

Transfer Characteristics

Nonlinearity.....0.04% FSR

Offset error RTI.....±(6 µV ±3 mV/gain)

Gain error.....0.4% of reading typ
0.6% max

Amplifier Characteristics

Input impedance

Power on.....1 MΩ

Power off and overvoltaged.....500 kΩ

Input bias current.....15 pA

CMRR at DC[2].....≥ 110 dB

CMRR at 50 or 60 Hz[2].....≥ 98 dB

Output range.....± 5 V

Output impedance.....100 Ω in multiplexed mode
330 Ω in parallel mode

1. As specified by IEC-1010 for pollution degree 2 and Installation Category II
2. 0 Ω in low lead

Dynamic Characteristics

Bandwidth (–3 dB) ..... 4.5 kHz or 22.5 kHz jumper selectable

Slew Rate ..... 2 V/µs

Table A-2. System Noise RTI (0.1 Hz to 50 kHz)

Gain	Noise
0.5	10 $\mu V_{rms}/\sqrt{Hz}$
1,000	0.1 $\mu V_{rms}/\sqrt{Hz}$

Table A-3. Switching Supply Noise (approximately at 100 kHz)†

Gain	Noise
0.5	174 μV_{rms}
1,000	4 μV_{rms}
†Earth ground referenced input signal	

Phase shift using TBX-1329 AC coupled

Input to output ..... < 0.5° between 5 Hz and 280 Hz

Channel to channel ..... < 0.5° up to 5 kHz

THD ..... < 0.1% at $7V_{rms}$ f = 1 kHz, G = 0.5
< 1.5% at $3 mV_{rms}$ f = 1 kHz, G = 1,000

Crosstalk ..... 80 dB at 1 kHz
(50 Ω load and source)

Output selection time (with V step, all gains)

to ± 0.012% accuracy ..... 3 µs

Filter

Type .....Second order low-pass RC filter

Cutoff frequency (-3 dB) .....4.5 kHz, 22.5 kHz

Stability

Recommended warm-up .....30 min.

Offset drift RTI..... ± (20 ± 220/gain) µV/°C

Gain drift .....± 50 ppm/°C

Digital I/O

Absolute maximum voltage ..... 5.5 V with respect to DIG GND input rating

Digital input specifications (referenced to DIG GND):

V_{IH} input logic high voltage..... 2 V min
V_{IL} input logic low voltage ..... 0.8 V max
I_I input current leakage..... ±1 µA max

Digital output specifications (referenced to DIG GND):

V_{OH} output logic high voltage..... 3.7 V min at 4 mA max
V_{OL} output logic low voltage ..... 0.4 V max at 4 mA max

Physical

Dimensions .....3.1 by 17.3 by 20.3 cm.
(1.2 by 6.8 by 8.0 in.)

Connectors.....50-pin male ribbon-cable rear connector, 32-pin DIN C male front connector(18-screw terminal adapter available)

Environment

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

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

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

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Customer Communication

Appendix B

For your convenience, this appendix contains forms to help you gather the information necessary to help us solve your technical problems and a form you can use to comment on the product documentation. When you contact us, we need the information on the Technical Support Form and the configuration form, if your manual contains one, about your system configuration to answer your questions as quickly as possible.

National Instruments has technical assistance through electronic, fax, and telephone systems to quickly provide the information you need. Our electronic services include a bulletin board service, an FTP site, a fax-on-demand system, and e-mail support. If you have a hardware or software problem, first try the electronic support systems. If the information available on these systems does not answer your questions, we offer fax and telephone support through our technical support centers, which are staffed by applications engineers.

Electronic Services

Bulletin Board Support

National Instruments has BBS and FTP sites dedicated for 24-hour support with a collection of files and documents to answer most common customer questions. From these sites, you can also download the latest instrument drivers, updates, and example programs. For recorded instructions on how to use the bulletin board and FTP services and for BBS automated information, call (512) 795-6990. You can access these services at:

United States: (512) 794-5422
Up to 14,400 baud, 8 data bits, 1 stop bit, no parity

United Kingdom: 01635 551422
Up to 9,600 baud, 8 data bits, 1 stop bit, no parity

France: 01 48 65 15 59
Up to 9,600 baud, 8 data bits, 1 stop bit, no parity

FTP Support

To access our FTP site, log on to our Internet host, `ftp.natinst.com`, as `anonymous` and use your Internet address, such as `joesmith@anywhere.com`, as your password. The support files and documents are located in the `/support` directories.

Fax-on-Demand Support

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Mouse ___yes ___no Other adapters installed _____

Hard disk capacity _____MB Brand _____

Instruments used _____

_____

National Instruments hardware product model _____ Revision _____

Configuration _____

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Configuration _____

The problem is: _____

_____

_____

_____

_____

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_____

_____

The following steps reproduce the problem:_____

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_____

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- SCXI-1120 Revision Letter _____
- Chassis Slot _____
- Chassis Type _____
- Grounding, Shielding, and Reference Mode Selection (Factory Setting: Parked, W46, AB-R0R1 _____
- Input Channel Gain Configuration

Input Channel	First-Stage Gain		Second-Stage Gain		Total Gain
	Factory Setting	User Setting	Factory Setting	User Setting	Factory Setting, 1,000
0	100, W1, A		10, W9, D		
1	100, W2, A		10, W10, D		
2	100, W3, A		10, W11, D		
3	100, W4, A		10, W12, D		
4	100, W5, A		10, W13, D		
5	100, W6, A		10, W14, D		
6	100, W7, A		10, W15, D		
7	100, W8, A		10, W16, D		

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- Input Channel Filter Configuration

Input Channel	Factory Setting	User Setting
0	W17, A W25, ON, W26, OFF	
1	W18, A W27, ON, W28, OFF	
2	W19, A W29, ON, W30, OFF	
3	W20, A W31, ON, W32, OFF	
4	W21, A W33, ON, W34, OFF	
5	W22, A W35, ON, W36, OFF	
6	W23, A W37, ON, W38, OFF	
7	W24, A W39, ON, W40, OFF	

- Other Modules in System _____
  _____
  _____
  _____
- Data Acquisition Boards Installed _____
  _____
  _____
  _____

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- Chassis Slot _____
- Chassis Type _____
- Grounding, Shielding, and Reference Mode Selection (Factory Setting: Parked, W46, AB-R0R1 _____
- Input Channel Gain Configuration

Input Channel	First-Stage Gain		Second-Stage Gain		Total Gain
	Factory Setting	User Setting	Factory Setting	User Setting	Factory Setting, 1,000
0	100, W1, A		20, W9, E		
1	100, W2, A		20, W10, E		
2	100, W3, A		20, W11, E		
3	100, W4, A		20, W12, E		
4	100, W5, A		20, W13, E		
5	100, W6, A		20, W14, E		
6	100, W7, A		20, W15, E		
7	100, W8, A		20, W16, E		

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- Input Channel Filter Configuration

Input Channel	Factory Setting	User Setting
0	W17, A W25, OFF, W26, ON	
1	W18, A W27, OFF, W28, ON	
2	W19, A W29, OFF, W30, ON	
3	W20, A W31, OFF, W32, ON	
4	W21, A W33, OFF, W34, ON	
5	W22, A W35, OFF, W36, ON	
6	W23, A W37, OFF, W38, ON	
7	W24, A W39, OFF, W40, ON	

- Other Modules in System _____
  _____
  _____
  _____
- Data Acquisition Boards Installed _____
  _____
  _____
  _____

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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}

Numbers/Symbols

°	degrees
Ω	ohms
+5 V (signal)	+5 VDC Source signal

A

A	amperes
AB0+	Positive Analog Bus 0 signal
AB0-	Negative Analog Bus 0 signal
AB0EN	Analog Bus 0 Enable bit
ACH#	data acquisition board Analog Input Channel Number
A/D	analog-to-digital

AOGND	Analog Output Ground signal
A_{rms}	amperes, root mean square
AWG	American Wire Gauge

B

BW	bandwidth

C

C	Celsius
CH#+	Positive Input Channel Number signal
CH#-	Negative Input Channel Number signal
CHAN	Channel Select bit
CHS	Chassis bit
CHSGND	Chassis Ground signal
CJR	cold-junction reference
CLKEN	Clock Enable bit
CLKOUTEN	Scan Clock Output Enable bit
CLKSELECT	Scan Clock Select bit
CNT	Count bit

D

D*/A	Data/Address signal
D/A	digital-to-analog
DAQD*/A	Data Acquisition Board Data/Address Line signal
dB	decibels

DIG GND	Digital Ground signal
DIN	Deutsche Industrie Norme
DMM	digital multimeter
DTEMP	Direct Temperature Sensor signal
DTS	direct temperature sensor

F

F	Fahrenheit
FIFO	first-in-first-out
FOUTEN*	Forced Output Enable bit
FRT	Forced Retransmit bit

G

GBWP	gain bandwidth product
GUARD	Guard signal

H

hex	hexadecimal
HSCR	Hardscan Control Register
HSRS*	Hardscan Reset bit
Hz	hertz

I

II	input current leakage
in.	inches

INTR*	Interrupt signal
I/O	input/output

K

K	kelvin

L

LOAD*	Load bit
LSB	least significant bit

M

m	meters
M	megabytes of memory
MCH#+	Positive Analog Output Channel Number signal
MCH#-	Negative Analog Output Channel Number signal
MIO	multifunction I/O
MISO	Master-In-Slave-Out signal
MOD	Module Number bit
MOSI	Master-Out-Slave-In signal
MSB	most significant bit
MTEMP	Multiplexed Temperature Sensor signal
MTS	multiplexed tempe

N

NRSE	nonreferenced single-ended (input)

O

ONCE	Once bit
OUTREF	Output Reference signal

P

ppm	parts per million

R

RAM	random-access memory
RD	Read bit
RESET*	Reset signal
rms	root mean square
RSC	rear signal connector
RSE	referenced single-ended (input)
RSVD	Reserved bit/signal
RTD	resistance temperature detector
RTEMP	Read Temperature bit
RTI	referred to input
RTO	referred to output
RTSI	Real-Time System Integration

S

SCANCLK	Scan Clock signal
SCANCLKEN	Scan Clock Enable bit

SCANCON	Scanning Control signal
SCANCONEN	Scan Control Enable bit
SCXI	Signal Conditioning eXtensions for Instrumentation (bus)
SDK	Software Developer's Kit
s	seconds
SERCLK	Serial Clock signal
SERDATIN	Serial Data In signal
SERDATOUT	Serial Data Out signal
SL	Slot bit
SLOT0SEL*	Slot 0 Select signal
SPI	Serial Peripheral Interface
SPICLK	Serial Peripheral Interface Clock signal
SS*	Slot Select signal

T

tempco	temperature coefficient
TRIG0	Trigger 0 signal

U

UL	Underwriters Laboratory

V

V	volts
V+	Positive Analog Supply signal
V-	Negative Analog Supply signal

VDC	volts direct current
V_{IH}	input logic high voltage
V_{IL}	input logic low voltage
V_{OH}	output logic high voltage
V_{OL}	output logic low voltage
V_{rms}	volts, root mean square

W

W	watts

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