

USER GUIDE

SCC-FT01 Feedthrough Module

The SCC-FT01 is a feedthrough module that connects directly to the analog input (AI) and analog output (AO) channels of a data acquisition (DAQ) device. You can use the breadboard area of the SCC-FT01 to develop custom signal-conditioning circuitry that can connect to and condition any of the analog, digital, and general-purpose counter/timer (GPCTR) channels of E Series DAQ devices.

Conventions

The following conventions are used in this guide:

<>

Angle brackets that contain numbers separated by an ellipsis represent a range of values associated with a bit or signal name—for example, ai<0..7>.

»

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



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



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



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



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

bold

Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.

<i>italic</i>	Italic text denotes variables, emphasis, a cross reference, a hardware label, or an introduction to a key concept. This font also denotes text that is a placeholder for a word or value that you must supply.
monospace	Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames and extensions, and code excerpts.
SC-2345	SC-2345 refers to both the SC-2345 connector block and the SC-2345 with configurable connectors.
SCC	SCC refers to any SCC series signal conditioning module.

What You Need to Get Started

To set up and use the SCC-FT01, you need the following items:

- SC-2345 with one of the following:
 - SCC-PWR01
 - SCC-PWR02 and the PS01 power supply
 - SCC-PWR03 (requires a 7 to 42 VDC power supply, not included)
- One or more SCC-FT01 modules
- SCC-FT01 Feedthrough Module User Guide*
- SC-2345 User Manual*
- Read Me First: Safety and Radio-Frequency Interference*
- SC-2345 Quick Reference Label
- 68-pin E Series DAQ device, documentation, and 68-pin cable of 1 or 2 m length
- 1/8 in. flathead screwdriver
- Numbers 1 and 2 Phillips screwdrivers
- Wire insulation strippers
- NI-DAQ (current version) for Windows 2000/NT/XP/Me

If you do not have the current version of NI-DAQ or one of the documents, you can download them from ni.com, or contact an NI sales representative.



Note Software scaling of measurements is not supported on the Mac OS.

Unpacking the Module

SCC modules are shipped in antistatic envelopes to prevent electrostatic damage (ESD) to the modules. ESD can damage several components on these products.



Caution *Never* touch the exposed pins of connectors.

To avoid damage from ESD when you handle the module, take the following precautions:

- Ground yourself by using a grounding strap or by touching a grounded object.
- Touch the antistatic envelope to a metal part of your computer chassis before removing the module from the packaging.

Remove the module from the package and inspect the module for loose components or any sign of damage. Notify National Instruments if the module appears damaged in any way. Do *not* install a damaged module into the computer.

Store the module in the antistatic envelope when not in use.

Installing the Module



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

Figure 1 shows the icon that appears on the label of the SCC-FT01.

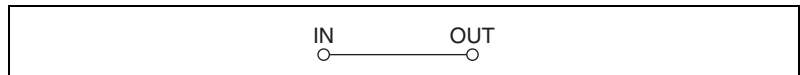


Figure 1. SCC-FT01 icon



Caution If you plug the unmodified SCC-FT01 into any SCC socket other than single - stage AI (sockets J1 through J8) or AO (sockets J17 and J18), you can damage the E Series DAQ device.

You can plug the SCC-FT01, as shipped, into an AI or AO socket on the SC-2345. When used as a prototyping module, the SCC-FT01 plugs into any socket on the SC-2345 except the power socket.

Five $0\ \Omega$ resistors on the printed circuit board (PCB) connect a set of default signals listed on the module label. To modify the SCC-FT01 to perform custom signal conditioning, refer to the [Customizing the SCC-FT01](#) section.

Connecting the Input Signals

The SCC-FT01 has a fixed screw-terminal receptacle and a removable screw-terminal block, as shown in Figure 2.

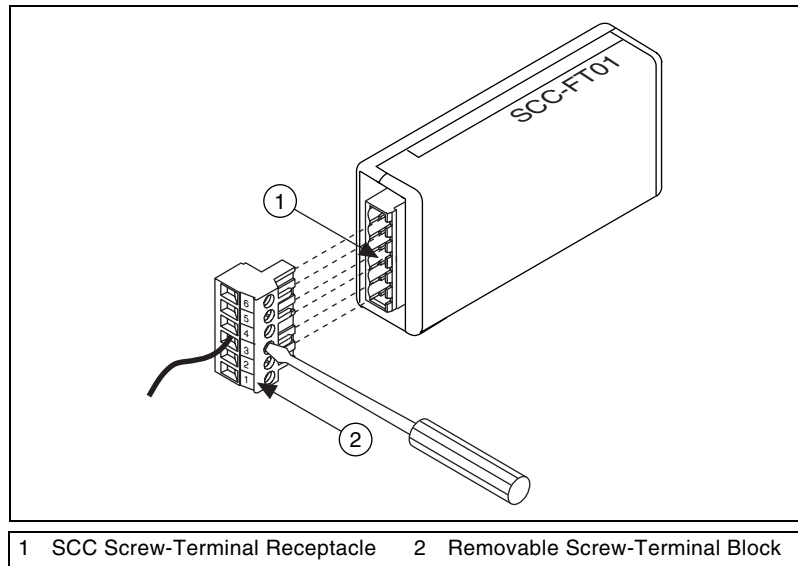


Figure 2. SCC-FT01 Two-Part Screw-Terminal System

After you install the SCC-FT01, complete the following steps to connect the signal lines to the module.

1. Remove power from the signal lines.
2. Strip 7 mm (0.28 in.) of insulation from the ends of the signal wires.
3. Insert the wires into the screw terminals.
4. Tighten the screws to 0.5 to 0.6 N · m (4.4 to 5.3 lb – in.) of torque.

The screw terminals are labeled by pin number <1..6>. The module label lists the signal names beside the pin numbers. Pins 2 through 6 accept the following signals: CH+, CH-, AIGND, AISENSE, and EXTREF. Pin 1 does not connect to anything. Connect the wires accordingly.

Table 1 shows the signals available if you plug the SCC-FT01 into AI single-stage SCC sockets J1–J8 or AO SCC sockets J17 and J18.

Table 1. SCC-FT01 Signals

Screw Terminal Number	Screw Terminal Label	AI Single-Stage SCC Socket J1–J8	AO SCC Socket J17	AO SCC Socket J18
6	CH+	ACH	DAC(A) ¹	DAC(B) ¹
5	CH–	ACH+8	AOGND	AOGND
4	AIGND	AIGND	PFI5	PFI5
3	AISENSE	AISENSE	DAC(B) ¹	DAC(A) ¹
2	EXTREF	—	EXTREF	EXTREF
1	NO CONNECT	—	—	—

¹ DAC(A) and DAC(B) correspond to DAC0 and DAC1 on the E Series DAQ device.

When you plug the SCC-FT01 into a single-stage AI SCC socket, the following conditions are true for the labeled screw terminals:

- CH+ connects to the lower AI channel number CHX, where X is 0 to 7.
- CH– connects to the higher AI channel number CH(X+8) where X is 0 to 7.
- AIGND connects to AI ground.
- AISENSE connects to AISENSE.
- EXTREF does not connect—do not use it.



Note For information on AI modes, refer to the *SC-2345 User Manual*. For information on AI configuration modes, refer to the DAQ device documentation.

When you plug the SCC-FT01 into an AO SCC socket, the following conditions are true for the labeled screw terminals:

- CH+ connects to DAC(A) for AO SCC socket J17, DAC(B) for AO SCC socket J18.
- CH– connects to AO ground.
- AIGND connects to PFI5.

- AISENSE connects to DAC(B) for AO SCC socket J17, DAC(A) for AO SCC socket J18.
- EXTREF connects to EXTREF.

When you configure the SC-2345 as an accessory to the E Series DAQ device in Measurement & Automation Explorer (MAX), the program automatically configures the SC-2345 in nonreferenced single-ended (NRSE) mode. Connect the signal source to single-ended channels on the SCC-FT01 while the SC-2345 is configured in the NRSE AI configuration.

You can configure the E Series DAQ device to read signals from the SCC-FT01 in differential mode. Use a virtual channel in MAX or application software to configure the E Series DAQ device to read the signal in differential mode. When you read a signal in differential mode, you use two channels for one measurement, but you avoid ground loops and get a better signal by rejecting common-mode signal noise.

You can configure the E Series DAQ device on a per channel basis with application software or virtual channels. For example, you can have channels 0 and 8 in differential mode and 1 to 7 and 9 to 15 in NRSE mode. Refer to the *Measurement & Automation Explorer Help* for more information and instructions on configuring channels.

Customizing the SCC-FT01

You can customize the SCC-FT01 to connect to any of the AI, AO, digital input/output (DIO), or GPCTR signals of the E Series DAQ device. After you customize the SCC-FT01, you can plug it into any SCC socket on the SC-2345 except the SCC power socket. The SCC-FT01 PCB contains 2.54 sq cm (1 sq in.) of prototyping breadboard area. This area accommodates as many as four 8-pin integrated circuits and other discrete components such as resistors and capacitors.

Place the SCC-FT01 prototyping module label, which is included in the kit, over the SCC-FT01 feedthrough module label on the SCC enclosure. This label does not contain signal names, so you can customize the assignment of the screw terminals.

Circuit Design

You must disassemble the SCC-FT01 to install custom circuitry. Complete the following steps to open the module.

1. Remove the screw from the back (wide unlabeled side).
2. Turn the front (wide labeled side) toward you.
3. Place the screw terminal receptacle on the left.

4. Slide the top cover to the right.
5. Lift off the cover.

You *must* remove resistors R1 through R5, shown in Figure 3, before you develop custom circuitry.

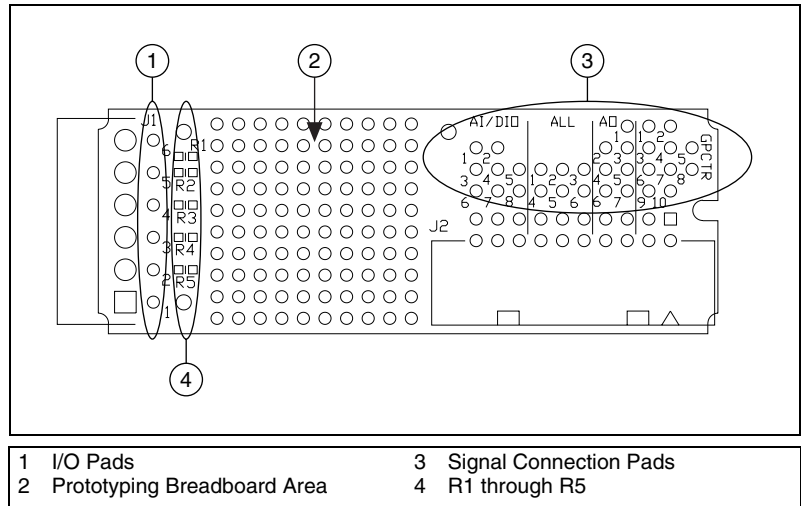


Figure 3. SCC-FT01 Parts Locator Diagram

The signal connection pads above connector J2, represented by item 3 in Figure 3, connect to different signals on the E Series DAQ device, depending on where you install the SCC-FT01 on the SC-2345. Table 2 shows the signals available for circuit design when you plug the SCC-FT01 into each type of SCC socket on the SC-2345. The pad numbers correspond to the number next to each pad on the SCC-FT01.

Table 2. Signals Available by SCC Socket Type

Pad Number	Signal Name				
	AI/DIO	All	AO	GPCTR CH0	GPCTR CH1
1	AISENSE	-15V	EXTREF	PFI8/ GPCTR0_SOURCE	PFI3/ GPCTR1_SOURCE
2	ACH+	REF5V	DAC(B)	PFI6/WFTRIG or ACH- Cascaded REF ¹	EXTSTROBE* or ACH- Cascaded REF ¹
3	AIGND	GND (+5V)	AOGND(B)	N/A or ACH+ Cascaded REF ¹	PFI1/TRIG2 or ACH+ Cascaded REF ¹

Table 2. Signals Available by SCC Socket Type (Continued)

Pad Number	Signal Name				
	AI/DIO	All	AO	GPCTR CH0	GPCTR CH1
4	PFI7/STARTSCAN or DIO(X) ²	+15V	AOGND(A)	FREQ_OUT	FREQ_OUT
5	ACH-	GND (15V and REF5V)	DAC(A)	PFI5/UPDATE*	SCANCLK
6	ACH+ Cascaded ³	+5V	PFI6/WFTRIG	DIO6	DIO7
7	ACH- Cascaded ³	—	PFI5/UPDATE*	PFI0/TRIG1	PFI0/TRIG1
8	AISENSE Cascaded ³	—	—	—	PFI7/STARTSCAN
9	—	—	—	PFI9/ GPCTR0_GATE	PFI4/ GPCTR1_GATE
10	—	—	—	GPCTR0_OUT	GPCTR1_OUT

¹ Not a GPCTR signal name. Available on any AI SCC socket J1 to J8.
² Available on DIO SCC sockets (J9 to J16) only.
³ Available on final-stage AI SCC sockets (J1 to J8) only.



Note DAC(A) and DAC(B) correspond to DAC0 and DAC1 on the E Series DAQ device. AOGND(A) and AOGND(B) are both in the table, but both connect to the one AOGND signal on the E Series DAQ device.

An SCC-FT01 signal connection label, which defines the pad numbers on the SCC-FT01 board, is attached to the inside of the enclosure of the SCC module.

Whether you plug the SCC-FT01 into an SCC socket for AI, AO, DIO, or GPCTR conditioning, the pads listed under the *All* column in Table 2 are connected, and you can use them.

Wiring the SCC-FT01

The signal names in the following sections refer to the signals listed in Table 2.



Note When you plug the SCC-FT01 into the first-stage AI sockets on the SC-2345, you do *not* connect the outputs of the circuitry to the pads labeled *Cascaded*. Use pads labeled *Cascaded* only when you plug the SCC-FT01 into the second-stage (final-stage) socket to get the input signals through the SC-2345 from the first-stage socket. Refer to Figures 4a and 4b.

Analog Input and Digital Input/Output

To use the SCC-FT01 for AI or DIO signal conditioning, use the pads above connector J2 labeled *AI/DIO* for connections to the breadboard area. You then can plug the module into any AI SCC socket J1 to J16 on the SC-2345. The signals available are slightly different when the module is plugged into the first-stage AI (also known as DIO) than when plugged into the second-stage AI (also known as single-stage AI). Use SCC sockets J9 to J16 for first-stage AI. Use SCC sockets J1 to J8 for second-stage AI.

PFI7/STARTSCAN, ACH+ Cascaded, ACH+ Cascaded REF, ACH- Cascaded, ACH- Cascaded REF, and AISENSE Cascaded signals are available for the second-stage AI SCC sockets only. The DIO(X) signal is available for the first-stage AI SCC sockets only. Refer to Table 2 for pad definitions.

When the E Series DAQ device is configured in NRSE AI mode, design your prototype circuitry so that the output of the SCC-FT01 to the E Series DAQ device is referenced single-ended to AIGND on the SC-2345.



Note On the SC-2345, the AIGND and AISENSE signals join at connector J24.

Figures 4a and 4b illustrate example wiring for the SCC-FT01 prototyping module used in dual-stage AI configuration. Figure 4c illustrates single-stage AI configuration.

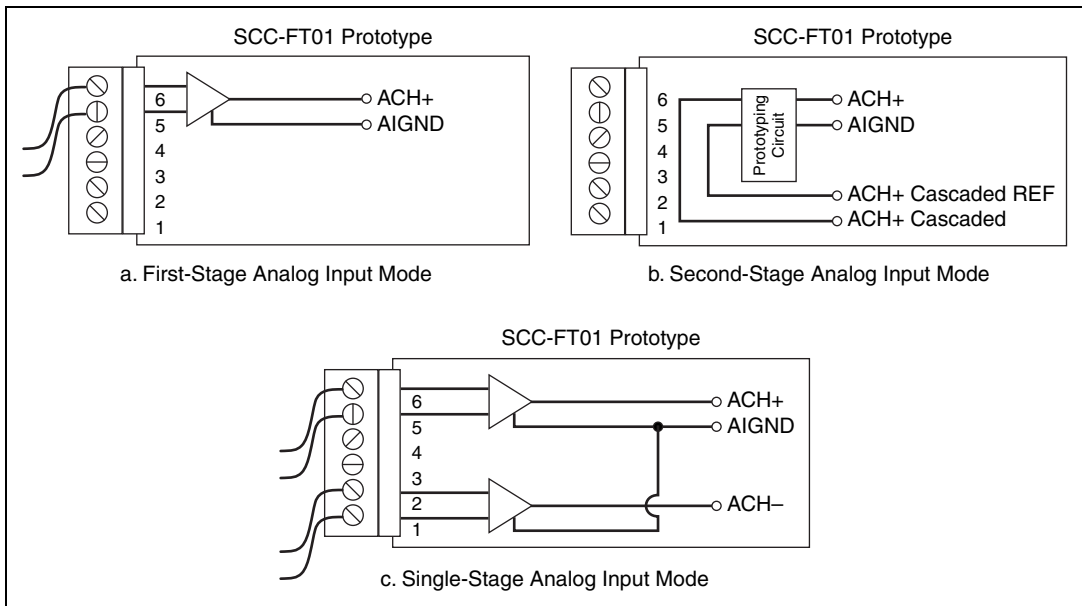


Figure 4. SCC-FT01 Prototyping Module AI Configurations

Analog Output

To use the SCC-FT01 for AO signal conditioning, use the pads above connector J2 labeled *AO* for connections to the breadboard area. The *AO* column in Table 2 lists the signals available to each pad. Plug the SCC-FT01 into any AO socket on the SC-2345.

The DAC(A) and DAC(B) signals depend on which AO SCC socket you use. If you plug the SCC-FT01 into the AO SCC socket J17, the DAC(A) pad connects to DAC0 and the DAC(B) pad to DAC1 on the E Series DAQ device. These pad connections are reversed when the SCC-FT01 is plugged into AO SCC socket J18, and the DAC(A) pad connects to DAC1 and DAC(B) pad to DAC0 on the E Series DAQ device.

GPCTR

To use the SCC-FT01 for GPCTR functions, use the pads above connector J2 labeled *GPCTR* for connections to the breadboard area. The *GPCTR CH0* and *GPCTR CH1* columns in Table 2 list the signals available to each pad. The signals available depend on which SCC socket you use.

If you plug the SCC-FT01 into the GPCTR CH0 socket J19, the pads under GPCTR CH0 on the board connect to signals associated with GPCTR channel 0 and AO of the E Series DAQ device. When the SCC-FT01 is plugged into the GPCTR CH1 socket J20, the pads under GPCTR CH1 on

the board connect to signals associated with GPCTR channel 1 and AI of the E Series DAQ device.

Connecting the Screw Terminals

The pads next to connector J1 connect to each input of the screw terminal connector. Use these pads to connect the external signals to the circuitry you added in the breadboard area. The numbers next to each hole correspond to the screw terminal numbers. Space is available on the SCC-FT01 prototyping module label for custom signal names.

Configuring the SCC System

Measurement & Automation Explorer (MAX) Configuration

Run MAX to configure the SCC system. Complete one of the following sets of steps depending on the version of NI-DAQ used in your application.

NI-DAQmx



Note If you are using SCC-FT01 to perform digital input or output, adding the SCC FT01 module to the SC-2345 produces an error. To avoid this error, read or write directly from the E Series DAQ device physical channels. Such as, use Dev1/di0 or Dev1/do0 to read/write from an SCC-FT01.

Complete the following steps to configure the SCC-FT01 module using NI-DAQmx.

1. Open **Measurement & Automation Explorer**.
2. Right-click **Devices and Interfaces** and select **Create New**.
3. Under **NI-DAQmx SCC Connector Block**, select **SC-2345**. Click **Finish**.
4. In the **SCC Connector Block Configuration** window, configure the SCC system as follows:
 - a. Specify the **SCC Carrier Type**. The location of the SCC sockets change depending on the SCC carrier type.
 - b. Select the **DAQ Device** that is connected to your SC-2345.
 - c. Type the **SCC Connector Block ID**. The default value is SCC1.
 - d. In the J21 drop-down list next to Power, select the correct SC-2345 power configuration. Refer to the *SC-2345 User Manual* for information on power configurations.

- e. For each SCC module physically installed in the SC-2345, add a corresponding entry in the SC-2345 configuration window. To add the SCC, click the socket drop-down list and select the correct module. If the module name does not appear in the list, either the module is not allowed in that location or you do not have the current version of NI-DAQ. If you do not have the current version of NI-DAQ, download it from ni.com.
 - f. Click **OK** after completing all SCC entries to complete the configuration process.
5. Close MAX.



Note Configuring the SCC system using MAX automatically sets the E Series DAQ device analog input mode to nonreferenced single-ended (NRSE).

Traditional NI-DAQ

Complete the following steps to configure the SCC-FT01 module using Traditional NI-DAQ.

1. Open **Measurement & Automation Explorer**.
2. Expand **Devices and Interfaces**.
3. Expand **Traditional NI-DAQ Devices**.
4. Right-click the E Series DAQ device connected to the SC-2345, and select **Properties**.
5. Select the **Accessory** tab.
6. Under **Accessory**, select **SC-2345**.
7. Click the **Configure** button. A new window appears listing the sockets (connector reference designators) of the SC-2345.
8. Select the SC-2345 socket where you installed an SCC.
9. Click **Add** and select the SCC you installed. If the module name does not appear in the list, either the module is not allowed in that location or you do not have the current version of NI-DAQ. If you do not have the current version of NI-DAQ, download it from ni.com.
10. If you make a selection mistake, select the socket and click **Remove**.
11. Repeat steps 8 and 9 for each newly installed SCC.
12. Click **OK** after completing all SCC entries.
13. Click **OK** to complete the configuration process and close MAX.



Note Configuring the SCC system using MAX automatically sets the E Series DAQ device analog input mode to nonreferenced single-ended (NRSE).

Virtual Channels, Physical Channels, and Tasks

After you have installed and configured your SCC hardware you can use software tools within MAX to further configure the module and take measurements.

Creating an NI-DAQmx Task or Global Channel

To create an NI-DAQmx task or global channel, complete the following steps.

1. Open **Measurement & Automation Explorer**.
2. Right-click **Data Neighborhood** and select **Create New**.
3. Select **NI-DAQmx Task** or **NI-DAQmx Global Channel** and click **Next**.
4. Select the appropriate measurement type based upon the hardware functionality of the SCC-FT01 module.
5. If you are creating a task, select the channels to add to the task. You can select blocks of channels by pressing the <Shift> key while making the selections or select individual channels by pressing the <Ctrl> key while making the selections. If you are creating a channel, you can select only one channel. Click **Next**.
6. Enter a name for the task or global channel and click **Finish**.
7. In the **Channel List** box, select the channel(s) you want to configure. You can select blocks of channels by pressing the <Shift> key while making the selections or select individual channels by pressing the <Ctrl> key while making the selections.
8. Enter the specific values for your application in the **Settings** tab. Context help information for each setting is provided on the right side of the screen. Use appropriate values based upon the hardware functionality of the SCC-FT01 module.
9. Click **Test** to test the channel. You should be able to view your measurement in the window that appears.

You have finished configuring the NI-DAQmx task or global channel.

Creating a Virtual Channel in Traditional NI-DAQ

To create a Traditional NI-DAQ virtual channel, complete the following steps.

1. Open **Measurement & Automation Explorer**.
2. Right-click **Data Neighborhood** and select **Create New**.
3. Select **Traditional NI-DAQ Virtual Channel** and click **Finish**.

4. Select the appropriate channel type based upon the hardware functionality of the SCC-FT01 module. Click **Next**.
5. Enter a channel name in the **Channel Name** box and click **Next**. You also can enter a channel description.
6. Enter appropriate values for all the subsequent dialog boxes based upon the hardware functionality of the SCC-FT01 module.
7. To test the channel, click **Test**.

You have finished configuring the Traditional NI-DAQ virtual channel.

Specifications

These ratings are typical at 25 °C unless otherwise stated.

Analog

Number of input channels.....1 DIFF or 2 SE (when plugged into an AI socket on the SC-2345)

Number of output channels.....1 (when plugged into an AO socket on the SC-2345)

Power Requirement

No power required (if unmodified)

Physical

Dimensions8.89 by 2.92 by 1.85 cm
(3.50 by 1.15 by 0.73 in.)

I/O connectors.....20-pin right-angle male connector
6-pin screw terminal system

Screw terminal28 to 16 AWG

Safety

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

- IEC 61010-1, EN 61010-1
- UL 3111-1, UL 61010B-1
- CAN/CSA C22.2 No. 1010.1



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

Electromagnetic Compatibility

CE, C-Tick, and FCC Part 15 (Class A) Compliant

Emissions EN 55011 Class A at 10 m
FCC Part 15A above 1 GHz

Electrical immunity Evaluated to EN 61326:1997/
A2:2001, Table 1



Note For full EMC compliance, you *must* operate this device with shielded cabling. In addition, all covers and filler panels must be installed.

CE Compliance

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

Low-Voltage Directive (safety) 73/23/EEC

Electromagnetic Compatibility
Directive (EMC) 89/336/EEC



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

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