

SCC-AI SERIES ISOLATED ANALOG INPUT MODULES

The SCC-AI Series isolated analog input modules (SCC-AIXX) can extract a relatively low-amplitude input signal from a high-common-mode voltage so the E Series DAQ device can measure the input signal. They can also amplify and filter the input signal, resulting in higher measurement resolution and accuracy.

SCC-AIXX modules are available in a range of gains from 0.2 to 200. They contain lowpass filters of either 10 kHz or 4 Hz bandwidth. Table 1 gives the gain and bandwidth for each module.

Table 1. SCC-AIXX Module Input/Output Range, Gain, and Bandwidth

Model	Input Range	Output Range	Gain	Bandwidth
SCC-AI01	±42 V	±8.4 V	0.2	10 kHz
SCC-AI02	±20 V	±10 V	0.5	10 kHz
SCC-AI03	±10 V	±10 V	1	10 kHz
SCC-AI04	±5 V	±10 V	2	10 kHz
SCC-AI05	±1 V	±10 V	10	10 kHz
SCC-AI06	±100 mV	±10 V	100	10 kHz
SCC-AI07	±50 mV	±10 V	200	10 kHz
SCC-AI13	±10 V	±10 V	1	4 Hz
SCC-AI14	±5 V	±10 V	2	4 Hz

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, DBIO<3..0>.



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, see the [Safety Information](#) for precautions to take.

bold

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

italic

Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. 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 configurable connector.

SCC

SCC refers to any SCC Series signal conditioning module.

FCC/Canada Radio Frequency Interference Compliance¹

Determining FCC Class

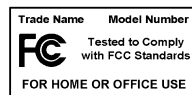
The Federal Communications Commission (FCC) has rules to protect wireless communications from interference. The FCC places digital electronics into two classes. These classes are known as Class A (for use in industrial-commercial locations only) or Class B (for use in residential or commercial locations). Depending on where it is operated, this product could be subject to restrictions in the FCC rules. (In Canada, the Department of Communications [DOC], of Industry Canada, regulates wireless interference in much the same way.)

¹ Certain exemptions may apply in the USA. See FCC Rules §15.103 **Exempted devices**, and §15.105(c). Also available in sections of CFR 47.

Digital electronics emit weak signals during normal operation that can affect radio, television, or other wireless products. By examining the product you purchased, you can determine the FCC Class and therefore which of the two FCC/DOC Warnings apply in the following sections. (Some products may not be labeled at all for FCC; if so, the reader should then assume these are Class A devices.)

FCC Class A products display a simple warning statement of one paragraph in length regarding interference and undesired operation. Most of our products are FCC Class A. The FCC rules have restrictions regarding the locations where FCC Class A products can be operated.

FCC Class B products display either an FCC ID code, starting with the letters **EXN**, or the FCC Class B compliance mark that appears below.



Consult the FCC web site <http://www.fcc.gov> for more information.

FCC/DOC Warnings

This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual and the CE Mark Declaration of Conformity,¹ may cause interference to radio and television reception. Classification requirements are the same for the Federal Communications Commission (FCC) and the Canadian Department of Communications (DOC).

Changes or modifications not expressly approved by National Instruments (NI) could void the user's authority to operate the equipment under the FCC Rules.

Class A

Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may

¹ The CE Mark Declaration of Conformity contains important supplementary information and instructions for the user or installer.

cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Canadian Department of Communications

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Class B

Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Canadian Department of Communications

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Compliance to EU Directives

Readers in the European Union (EU) must refer to the Manufacturer's Declaration of Conformity (DoC) for information pertaining to the CE Mark compliance scheme.¹ The Manufacturer includes a DoC for most every hardware product except for those bought for OEMs, if also available from an original manufacturer that also markets in the EU, or where compliance is not required as for electrically benign apparatus or cables.

To obtain the DoC for this product, click **Declaration of Conformity** at ni.com/hardref.nsf/. This web site lists the DoCs by product family. Select the appropriate product family, followed by your product, and a link to the DoC appears in Adobe Acrobat format. Click the Acrobat icon to download or read the DoC.

Safety Information

The following section contains important safety information that you *must* follow when installing and using the product.

Do *not* operate the product in a manner not specified in this document. Misuse of the product can result in a hazard. You can compromise the safety protection built into the product if the product is damaged in any way. If the product is damaged, return it to NI for repair.

Do *not* substitute parts or modify the product except as described in this guide.

Do *not* operate the product in an explosive atmosphere or where there may be flammable gases or fumes. Operate the product only at or below the pollution degree stated in the *Specifications* section. Pollution is foreign matter in a solid, liquid, or gaseous state that can reduce dielectric strength or surface resistivity. The following is a description of pollution degrees:

- Pollution degree 1 means no pollution or only dry, nonconductive pollution occurs. The pollution has no influence.
- Pollution degree 2 means that only nonconductive pollution occurs in most cases. Occasionally, however, a temporary conductivity caused by condensation must be expected.
- Pollution degree 3 means that conductive pollution occurs, or dry, nonconductive pollution occurs that becomes conductive due to condensation.

¹ The CE Mark Declaration of Conformity contains important supplementary information and instructions for the user or installer.

Clean the product with a soft nonmetallic brush. Make sure the product is completely dry and free from contaminants before returning it to service.

You *must* insulate signal connections for the maximum voltage for which the product is rated. Do *not* exceed the maximum ratings for the product. Remove power from signal lines before connecting them to or disconnecting them from the product.

Operate this product only at or below the installation category stated in the *Specifications* section.

The following is a description of installation categories:

- Installation category I is for measurements performed on circuits not directly connected to MAINS.¹ This category is a signal level such as voltages on a printed wire board (PWB) on the secondary of an isolation transformer.

Examples of installation category I are measurements on circuits not derived from MAINS and specially protected (internal) MAINS-derived circuits.

- Installation category II is for measurements performed on circuits directly connected to the low-voltage installation. This category refers to local-level distribution such as that provided by a standard wall outlet.

Examples of installation category II are measurements on household appliances, portable tools, and similar equipment.

- Installation category III is for measurements performed in the building installation. This category is a distribution level referring to hardwired equipment that does not rely on standard building insulation.

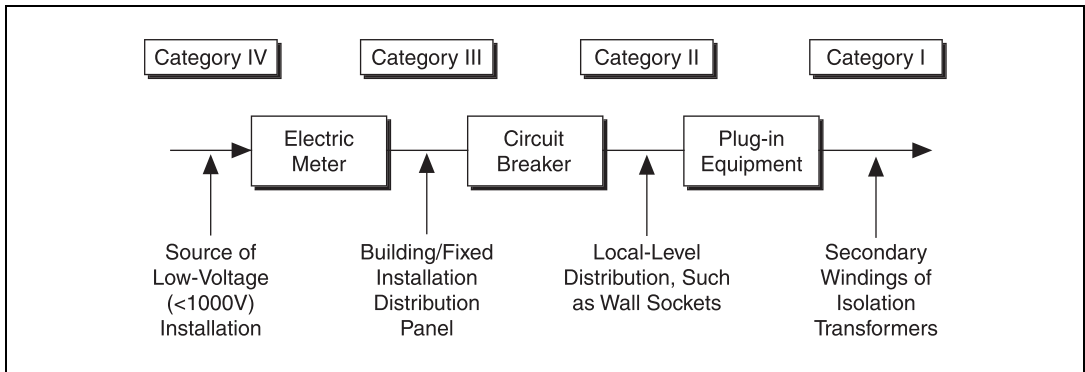
Examples of installation category III include measurements on distribution circuits and circuit breakers. Other examples of installation category III are wiring including cables, bus-bars, junction boxes, switches, socket outlets in the building/fixed installation, and equipment for industrial use, such as stationary motors with a permanent connection to the building/fixed installation.

- Installation category IV is for measurements performed at the source of the low-voltage (<1,000 V) installation.

Examples of category IV are electric meters, and measurements on primary overcurrent protection devices and ripple-control units.

¹ MAINS is defined as the electricity supply system to which the equipment concerned is designed to be connected either for powering the equipment or for measurement purposes.

Below is a diagram of a sample installation.



What You Need to Get Started

To set up and use the SCC-AIXX, 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-AIXX
- SCC-AI Series Isolated Analog Input Modules User Guide*
- SC-2345 User Manual*
- SC-2345 Quick Reference Label
- 68-pin E Series DAQ device, documentation, and 68-pin cable
- 1/8 in. flathead screwdriver
- Numbers 1 and 2 Phillips-head screwdrivers
- Wire insulation strippers
- NI-DAQ (current version) for Windows 2000/NT/9x



Note Software scaling of measurements is not supported on the Macintosh operating system. See the [Scaling Voltage Measurements](#) section of this guide.

Unpacking the Module

SCC modules are shipped in antistatic packaging to prevent electrostatic damage to the modules. Electrostatic discharge can damage several components on these products.



Caution *Never* touch the exposed pins of connectors.

To avoid damage from electrostatic discharge 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 package 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 NI if the module appears damaged in any way. Do *not* install a damaged module.

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

Installing the Module

A blue label stripe identifies the SCC-A1XX as an analog input module. The label also displays the icon shown in Figure 1.

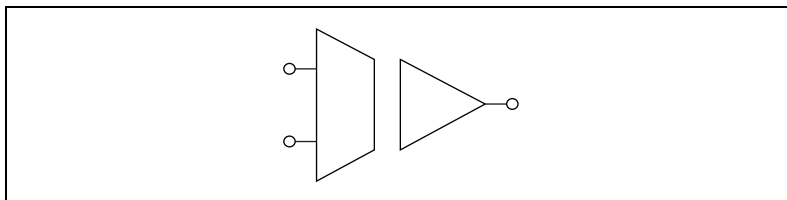


Figure 1. SCC-A1XX icon

You can plug the SCC-A1XX into any analog input socket on the SC-2345. The socket you choose determines which E Series DAQ device channels receive the SCC-A1XX signals.

For single-stage input conditioning, plug the SCC-A1XX into any socket J(X+1), where X is 0 to 7, and connect the input signals to the module as described in the [Connecting the Input Signals](#) section.

If you use the SCC-AIXX in a dual-stage configuration, the SCC-AIXX must be the first-stage module. Plug it into any socket J(X+9) and plug the second-stage SCC into socket J(X+1), where X is 0 to 7. Connect the input signals to the SCC-AIXX as described in the *Connecting the Input Signals* section. The SC-2345 connects the output signals of the first-stage SCC to the inputs of the second-stage SCC. An example of dual-stage conditioning is an SCC-AI02 followed by an SCC-FV01 frequency input module.

Sockets J9 to J16 are also available for digital input/output (DIO) conditioning or control. See the *SC-2345 User Manual* for more information on configuring, connecting, and installing SCC modules.

Connecting the Input Signals

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

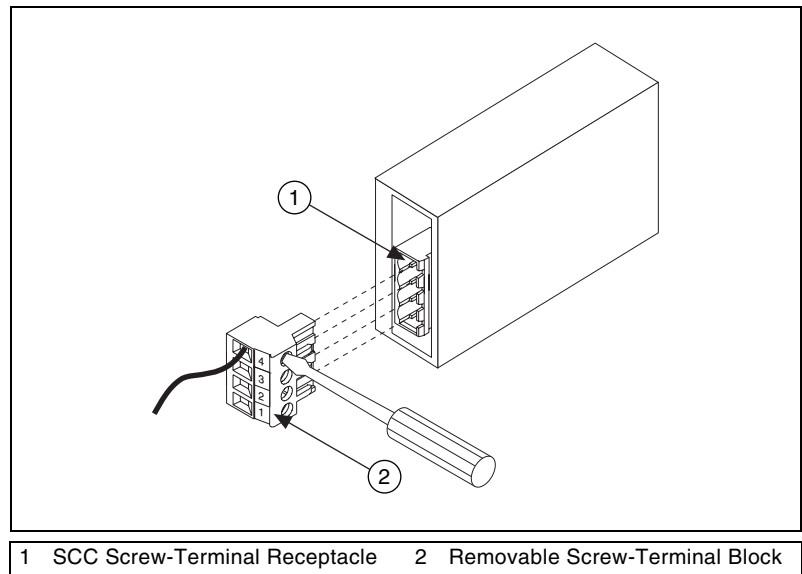


Figure 2. SCC-AIXX Two-Part Screw-Terminal System

After you install the SCC-AIXX, connect the input signals to the removable screw-terminal block of the module.

1. Remove power from the signal lines.
2. Strip 7 mm 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.

Each screw terminal is labeled by pin number <1..4>. Pins 1 and 2 form a channel routed to E Series DAQ device channel X+8, and pins 3 and 4 form a channel routed to E Series DAQ device channel X, where X is 0 to 7 depending on the socket where you plug in the module. The SCC-A1XX provides channel-to-ground and module-to-module isolation only. It does not provide isolation between the two channels of the SCC-A1XX. Because both channels must have the same reference voltage, pins 1 and 3 are connected together internally. Figure 3 shows the SCC-A1XX signal connections.

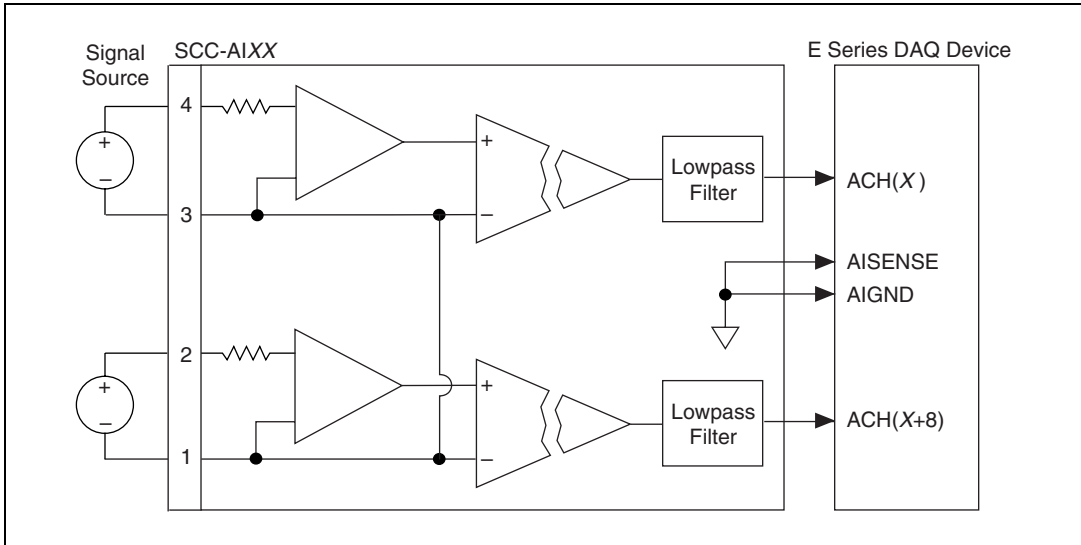


Figure 3. SCC-A1XX Signal Connections

The inputs are designed in a floating (nonreferenced) single-ended configuration. If the measured signals are floating, connect the negative input pins, 1 and 3, to AISENSE on the SC-2345 terminal block through a 10 k Ω to 100 k Ω resistor. Figure 4 shows a floating signal connection on one channel of the SCC-A1XX.

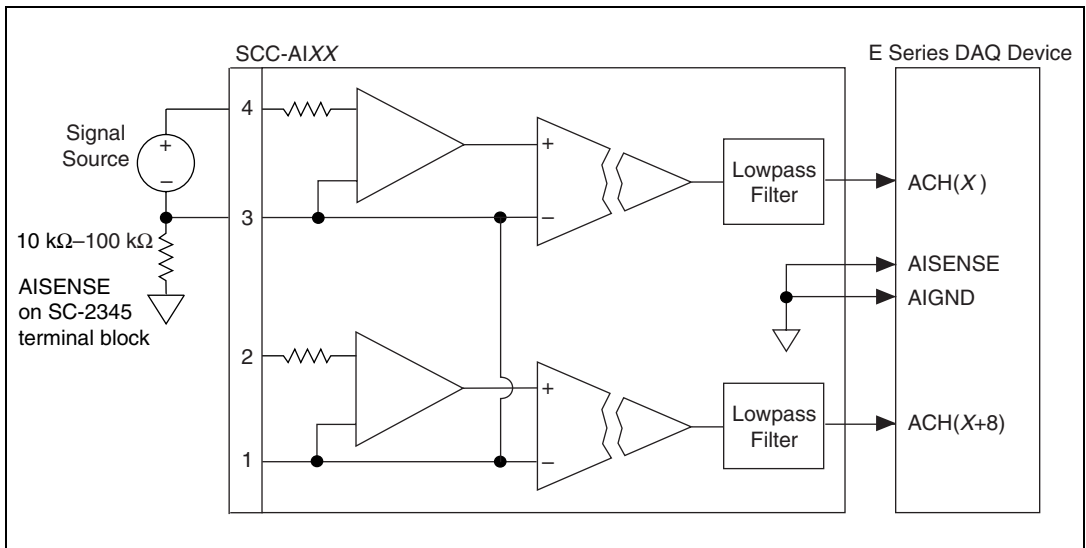


Figure 4. Nonreferenced Signal Connection for the SCC-A1XX (One Channel)

If a high common-mode voltage is present, connect the negative input pins, 1 and 3, to the signal reference. Figure 5 shows a ground-referenced signal connection on one channel of the SCC-A1XX.

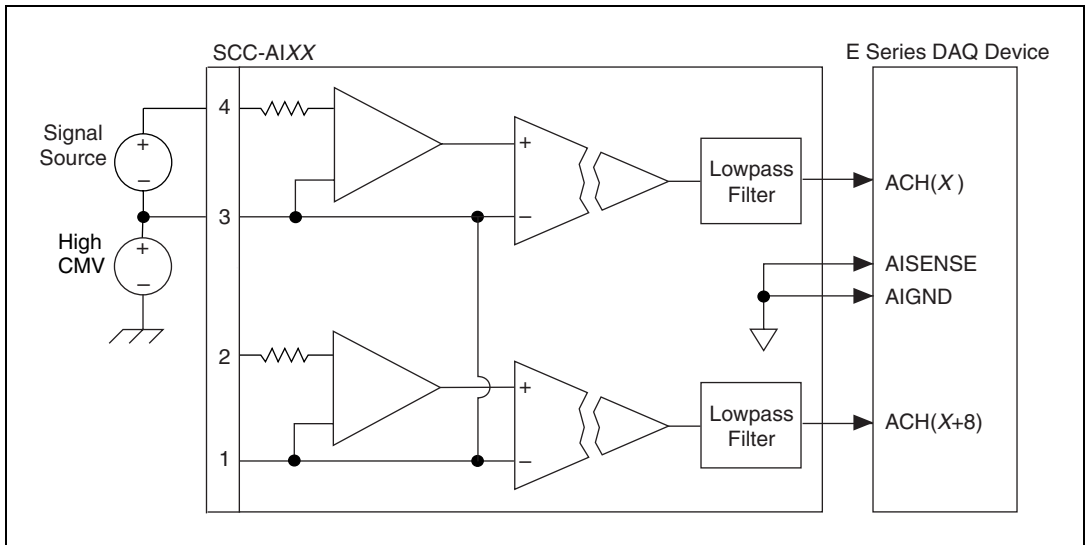


Figure 5. Ground-Referenced Signal Connection for the SCC-A1XX with High Common-Mode Voltage (One Channel)

Configuring the SCC System

Run Measurement & Automation Explorer (MAX) to configure the SCC system. Follow these steps:

1. Launch **Measurement & Automation Explorer**.
2. Expand **Devices and Interfaces**.
3. Right-click the E Series DAQ device connected to the SC-2345 and select **Properties**.
4. Select the **Accessory** tab.
5. Under **Accessory**: select **SC-2345**.
6. Click the **Configure** button. A new window appears listing the sockets (connector reference designators) of the SC-2345.
7. Select the SC-2345 socket where you installed an SCC.
8. 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 the NI Web site, ni.com/support.
9. If you make a selection mistake, select the socket and click **Remove**.
10. Repeat steps 7 and 8 for each newly installed SCC.
11. Click **OK** after completing all SCC entries.
12. Click **OK** to complete the configuration process and close MAX.



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

Scaling Voltage Measurements

If you configured the SCC-AIXX using MAX and you are using NI-DAQ, the voltage reading you get from the E Series DAQ device accounts for the voltage scaling effect of the SCC-AIXX. Otherwise, since the voltage measurement from the E Series DAQ device is scaled by the gain given in Table 1, you must divide the voltage reading returned by the DAQ device by this gain to get the correct input voltage.

Specifications

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

Input Characteristics

Number of input channels	2 NRSE
Isolation.....	Bank isolation (isolation per module) ¹
Input/output signal range, gain, and bandwidth	See Table 1
Input impedance	1 M Ω (SCC-AI01, SCC-AI02) 100 M Ω (all others)
Gain error	4.5% max (trimmable to zero)
Gain stability	150 PPM/°C
Offset error	40 mV max (referred to input ²)
Offset stability	225 μ V/°C
Nonlinearity	0.0128% typ 0.0260% max
Common-mode rejection ratio	100 dB typical at 60 Hz
Output slew rate, dependent on BW (filtering)	0.8 V/ μ s max

Filter Characteristics

Number of poles	3
Rolloff	60 dB/decade
Cutoff frequency (–3 dB)	
AI0X.....	10 kHz
AI1X.....	4 Hz

¹ The SCC-AIXX does not provide isolation between the two channels of the module. For more information on this topic, see the [Connecting the Input Signals](#) section of this guide.

² This specification is calculated relative to the input range of the module.

Power Requirement

Analog power	519 mW max
+15 V	34.6 mA max
-15 V	34.6 mA max
Digital power (+5 V)	625 mW max
	125 mA max

Physical

Dimensions	8.89 by 2.92 by 1.85 cm (3.5 by 1.15 by 0.73 in.)
I/O connectors.....	1, 20-pin right-angle male connector 1, 4-pin screw terminal, removable
Screw terminal wire gauge	24 to 12 AWG

Maximum Working Voltage

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

Channel-to-earth	300 V, Installation Category II
Module-to-module	300 V, Installation Category II
Channel-to-channel.....	Not isolated ¹

Environmental

Operating temperature	0 to 50 °C
Storage temperature	-20 to 70 °C
Humidity	10 to 90% RH, noncondensing
Maximum altitude.....	2000 meters
Pollution degree (indoor use only)	2

¹ The SCC-A1XX does not provide isolation between the two channels of the module. For more information on this topic, see the [Connecting the Input Signals](#) section of this guide.

Safety

The SCC-AIXX meets the requirements of the following standards for safety and electrical equipment for measurement, control, and laboratory use:

- EN 61010-1:1993/A2:1995, IEC 61010-1:1990/A2:1995
- UL 3111-1:1994
- CAN/CSA c22.2 no. 1010.1:1992/A2:1997

Electromagnetic Compatibility

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

Electrical emissions..... EN 55011 Class A at 10 m
FCC Part 15A above 1 GHz

Electrical immunity..... Evaluated to EN 61326:1997/
A1:1998, 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. Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, click **Declaration of Conformity** at ni.com/hardref.nsf/. This web site lists the DoCs by product family. Select the appropriate product family, followed by your product, and a link to the DoC appears in Adobe Acrobat format. Click the Acrobat icon to download or read the DoC.

Calibrating Gain and Offset Errors

The SCC-AIXX is calibrated at the factory before shipment. If you want to adjust the gain of the SCC-AIXX in your system using your E Series DAQ device, you need a voltage source that is several times more accurate than the SCC itself and capable of providing the DC voltage shown in Table 2.

Table 2. SCC-AIXX Input Voltage Requirements

Module	Input Voltage Required
SCC-AI01	40 V
SCC-AI02	16 V
SCC-AI03	8 V
SCC-AI04	4 V
SCC-AI05	800 mV

Table 2. SCC-AIXX Input Voltage Requirements (Continued)

Module	Input Voltage Required
SCC-AI06	80 mV
SCC-AI07	40 mV
SCC-AI13	8 V
SCC-AI14	4 V

To adjust the gain of the SCC-AIXX, use the following procedure:

1. Select the desired SCC-AIXX channel on the E Series DAQ device.
2. Set the gain on the E Series DAQ device so that its input range is ± 10 V.
3. Connect the voltage source to the screw terminals of the desired channel on the SCC-AIXX.
4. Apply the voltage given in Table 2 that corresponds to the SCC-AIXX module. For example, if you have an SCC-AI03, you must apply 8 VDC.
5. Using your software, have the E Series DAQ device read the desired channel on the SCC-AIXX and record the value.
6. Input 0 VDC to the SCC-AIXX.
7. Use the E Series DAQ device to read that channel and record the value.
8. Subtract the values read (*first reading* – *second reading*).
9. Adjust the trimpot labeled *Gain* protruding through the top of the SCC-AIXX. If the value you obtained in step 8 is less than the input voltage, turn the trimpot clockwise to increase the gain. If it is greater than the input voltage, turn the trimpot counterclockwise to decrease the gain.
10. Repeat steps 4 through 9 until the difference you get in step 8 equals the Input Voltage Required value shown in Table 2; the value is 8 V in this example using an SCC-AI03.

For example, assume that you have an SCC-AI03 module. You first connect 8 VDC to the input of CH(X). The E Series DAQ device reads 8.05 V as the SCC output. You then connect 0 VDC to the input of CH(X) and the E Series DAQ device reads -0.01 V as the SCC output. You subtract these readings, $8.05 - (-0.01) = 8.06$, getting a difference of 8.06 V. Because this difference is not equal to 8 V, you must adjust the gain trimpot and repeat the procedure until the difference in outputs equals 8 V.



Note In this example there can be an offset voltage such that the final readings are 8.01 V and 0.01 V for a difference of 8 V. The gain trimpot adjusted in step 9 of the above procedure adjusts only for gain errors and does not compensate for this offset voltage.

Use the following procedure to adjust the offset voltage of the SCC-AIXX:

1. Select the desired SCC-AIXX channel on the E Series DAQ device.
2. Set the gain on the E Series DAQ device so that the E Series input range is ± 10 V.
3. Connect the screw terminals of your desired channel on the SCC-AIXX together.
4. Using your software, have the E Series DAQ device read the channel.
5. If the value read is not equal to 0.00 V, adjust the appropriate trimpot protruding through the top of the SCC-AIXX, labeled *Offset*. Turn the trimpot clockwise to increase the offset.
6. Repeat steps 4 and 5 until the voltage read in step 4 equals 0.00 V.

SCC-AIXX Module Pin Assignments

Figure 6 shows the I/O connector pins on the bottom of the module.

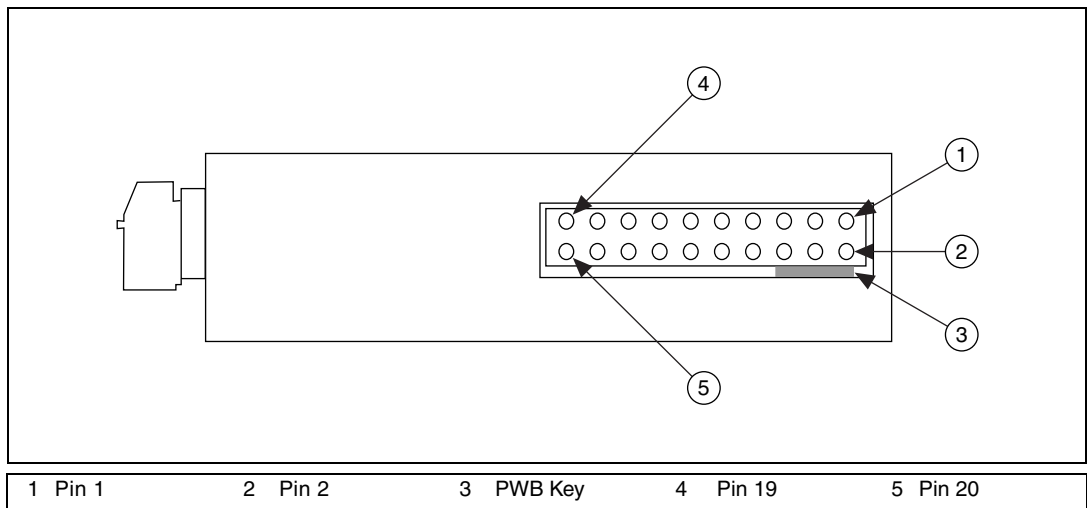


Figure 6. SCC Module Bottom View

Table 3 lists the signal corresponding to each I/O connector pin on the bottom of the SCC-AIXX. ACH(X) and ACH(X+8) are the analog input channels of the E Series DAQ device. AIGND is the analog input ground signal and is the reference for ACH(X) and ACH(X+8). AGND is the reference for the ± 15 V supplies and REF5V. AIGND and AGND connect to the SC-2345 at the SCC-PWR connector. GND is the reference for the +5 V supply.

Table 3. SCC-AIXX Module Pin Assignments

Pin Number	Signal
1	E Series ACH(X)
2	E Series AIGND
3	—
4	E Series ACH(X+8)
5	—
6	E Series AIGND
7	—
8	E Series AIGND
9	+5 V
10	GND
11	AGND
12	REF5V
13	+15 V
14	-15 V
15	—
16	—
17	—
18	—
19	—
20	—

Technical Support Resources

NI Web Support

NI Web support is your first stop for help in solving installation, configuration, and application problems. Online problem-solving and diagnostic resources include frequently asked questions, knowledge bases, product-specific troubleshooting wizards, manuals, drivers, software updates, and more. Web support is available through the Technical Support section of ni.com.

Worldwide Support

NI has offices located around the world to help address your support needs. You can access our branch office Web sites from the Worldwide Offices section of ni.com. Branch office Web sites provide up-to-date contact information, support phone numbers, e-mail addresses, and current events.

If you have searched the technical support resources on our Web site and still cannot find the answers you need, contact your local office or NI corporate. For telephone support in the United States, dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 03 9879 5166, Austria 0662 45 79 90 0, Belgium 02 757 00 20, Brazil 011 284 5011, Canada (Calgary) 403 274 9391, Canada (Montreal) 514 288 5722, Canada (Ottawa) 613 233 5949, Canada (Québec) 514 694 8521, Canada (Toronto) 905 785 0085, China (Shanghai) 021 6555 7838, China (ShenZhen) 0755 3904939, Czech Republic 02 2423 5774, Denmark 45 76 26 00, Finland 09 725 725 11, France 01 48 14 24 24, Germany 089 741 31 30, Greece 30 1 42 96 427, Hong Kong 2645 3186, India 91805275406, Israel 03 6120092, Italy 02 413091, Japan 03 5472 2970, Korea 02 596 7456, Malaysia 603 9596711, Mexico 001 800 010 0793, Netherlands 0348 433466, New Zealand 09 914 0488, Norway 32 27 73 00, Poland 0 22 528 94 06, Portugal 351 1 726 9011, Russia 095 2387139, Singapore 2265886, Slovenia 386 3 425 4200, South Africa 11 805 8197, Spain 91 640 0085, Sweden 08 587 895 00, Switzerland 056 200 51 51, Taiwan 02 2528 7227, United Kingdom 01635 52354