Portable Modular DAQ Systems
SCC Signal Conditioning Overview

NI SCC

- Signal conditioning for DAQ systems
- Up to:
  - 16 analog inputs
  - 8 digital I/O lines
  - 2 unconditioned counter/timers
- Measurement type and connectivity selectable on a per-channel basis
- Low-profile carriers for portable, rack-mount, and desktop applications
- NI-DAQ driver software simplifies configuration, measurement, and scaling

Sensors/Signals

- Thermocouples
- RTDs
- Strain gauges
- Force/load/torque/pressure sensors
- IEPE accelerometers
- Isolated voltage/current input
- Frequency input
- Lowpass filtering
- Isolated voltage/current output
- Isolated digital I/O
- Relay switching

Connectivity Options

- BNC
- Minithermocouple
- Thermocouple
- LEMO (B-series)
- MIL-Spec
- 9-pin D-Sub
- Banana jack
- SMB
- Momentary pushbutton switch
- Toggle switch
- Rocker switch
- LED
- Potentiometer
- Strain relief

Overview

National Instruments SCC provides portable, modular signal conditioning to your DAQ system. SCC conditions a variety of analog I/O and digital I/O signals. With this modular design, you choose your conditioning on a per-channel basis. SCC systems offer custom options for various sensors or signal connection types. While the low-profile carrier is perfect for use with PCMCIA DAQCards and DAQPads for portable applications, you can also use the system for rack-mounted or desktop applications. SCC modules works with all E Series and Basic multifunction DAQ devices.

SCC DAQ Systems

SCC DAQ systems consist of an SC-2345 Series shielded carrier, SCC modules, a DAQ device, and a cable. Each carrier can hold up to 20 SCC modules. Conditioned analog signals are passed directly to the inputs of the DAQ device. SCC modules can also provide up to 300 V of working isolation to voltage and current input/output signals from the DAQ device. Optically isolated digital I/O modules can condition digital lines from the DAQ device or you can access them directly using the 42-pin screw terminal mounted inside the box. Relay modules add switching to your SCC DAQ system, and you can access Analog Input, Analog Output, Digital I/O, Counter/Timer signals as well as timing and triggering signals from the DAQ device using feedthrough modules.

Figure 1. SC-2345 with Configurable Connectors

SCC Features

SCC offers flexibility, customization, and ease of use in a single, low-profile package.

Flexible I/O Options

SCC signal conditioning modules are either single or dual-channel modules that condition analog or digital signals. SCC modules are available for thermocouples, RTDs, strain gauges, force/load/torque/pressure sensors, accelerometers, voltage and current input, isolated voltage and current output frequency-to-voltage conversion, lowpass filtering, isolated digital I/O, relay switching and breadboarding for your custom circuitry (see Table 1 on page 252).

Module Cascading

SCC includes provisions for cascading two SCC analog input modules on a single analog input channel. For example, you can pass an analog input signal through both an attenuator module and a filter module.

Portable Modular DAQ Systems
SCC Signal Conditioning Overview

Removable Connectors

All SCC modules except the SCC-TC01 have removable screw-terminal connectors. This simplifies signal connection and module swapping for quick reconfiguration. The SCC-TC01 has a minithermocouple connector for easy sensor connection and more accurate cold-junction sensing.

Connectivity Options

The SC-2345 with Configurable Connectors is a shielded carrier that offers custom I/O and interface panelettes to match your sensors. With interface panelettes, you can add hardware controls and displays to your system. Blank panelettes are also available to fill unused positions or for customization. See page 267 for complete panelette options.

SCC Module	Input Types	Number of Channels
SCC-AI Series	Isolated analog input	2
SCC-A10	±100 V (10:1 attenuator)	2
SCC-LP Series	Lowpass filters	2
SCC-TC Series	Thermocouples, ±100 mV	1
SCC-RTD01	RTD (2, 3, and 4-wire)	2
SCC-SG Series	Strain gauges and force/load/torque sensors	2
SCC-ACC01	Accelerometers	1
SCC-CI20	0 to 20 mA current input	2
SCC-AO10	Isolated voltage output, ±10 V	1
SCC-CO20	Isolated current output, 0 to 20 mA	1
SCC-FV01	Frequency-to-voltage	2
SCC-DI01	Isolated digital input	1
SCC-DO01	Isolated digital output	1
SCC-SG11	Shunt calibration	2
SCC-FT01	Unconditioned or custom	2
SCC-RLY01	Switch 5 A at 30 VDC or 250 VAC	1

Table 1. SCC Signal Conditioning Modules

Power Options

Each SCC system offers three different power options. Depending on the total power consumption of the SCC modules installed, you can power the SCC system from (1) the 5 VDC line of a DAQ device or an external 5 VDC source, (2) an AC power source, or (3) an external 7 to 42 VDC power supply. To determine which power option is best for your application, see the SC-2345 shielded carrier (page 254) or visit the online SCC Advisor at ***ni.com/advisors***

Signal Routing

Many of the SCC analog input modules are dual-channel modules. When a dual-channel module is installed in the SC-2345, the two output voltages of the module are routed to two input channels of the DAQ device, channels X and X+8, where X is any integer 0 through 7. For example, if a dual-channel module is installed in the J1 socket of the SC-2345, the output voltages are routed to input channels 0 and 8 of the E Series DAQ device.

Digital modules connect directly to individual digital I/O lines of the DAQ device. For example, a digital output module installed in any of J16 slots J9 is controlled by a single DIO line of the DAQ device. The digital I/O lines of a DAQ device are line configurable, so you can choose any combination of eight digital I/O modules and relays.

Accessories

The SC-2345 with configurable connectors offers accessories such as a panel-mount kit, a rack-mount kit for 19 in. cabinets, a stacking kit, and a handle kit for use with multiple carriers and with DAQPad devices.

Software

You can develop your SCC DAQ System applications very quickly and easily with the NI-DAQ driver software or with LabVIEW. NI-DAQ is the robust driver software that makes it easy to access the functionality of your data acquisition and signal conditioning hardware, whether you are a beginner or an advanced user. Helpful features include:

Automatic Code Generation – DAQ Assistant is an interactive guide that steps you through configuring, testing, and programming measurement tasks and generates the necessary code automatically.

Cleaner Code Development – Basic and advanced software functions have been combined into one easy-to-use yet powerful set to help you build cleaner code and move from basic to advanced applications without replacing functions.

High-Performance Driver Engine – Software-timed single-point input (typically used in control loops) with NI-DAQ achieves rates of up to 50 kHz. NI-DAQ also delivers maximum I/O system throughput with a multithreaded driver.

Test Panels – NI-DAQ lets you test all four device functions before you begin development with test panels, accessible either from your development environment, such as LabVIEW, or the configuration utility.

Scaled Channels – Easily scale your voltage data into the proper engineering units using the NI-DAQ Channel Wizard. By choosing from a list of common sensors and signals or creating your own custom scale.

LabVIEW Integration – All NI-DAQ functions offer the waveform data type, which carries acquired data and timing information directly into more than 400 built-in analysis routines in LabVIEW, and displays the results in engineering units on a graph.

Operating System Compatibility

All modules work with Windows 2000/NT/XP

For information on other operating systems such as Linux and Mac OS X see page 187.

Portable, Shielded SCC Module Carriers

NI SC-2345 Series

- Shielded carriers for up to 20 SCC modules
- Portable, low-profile packaging
- Cables directly to an E Series or Basic multifunction DAQ device
- Powered by DAQ device (additional power options available)

SC-2345 Connector Block

- Strain relief for signal wiring
- Hinged lid for easy access

SC-2345 Carrier with Configurable Connectors

- Panelettes for sensor connectivity
- Panelettes for control and display
- Blank panelettes for filler

Operating Systems

- Windows 2000/NT/XP

Recommended Software

- LabVIEW
- LabWindows/CVI
- Measurement Studio
- Lookout
- VI Logger

Other Compatible Software

- Visual Basic
- C/C++, C#

Driver Software (included)

- NI-DAQ 7

Overview

The National Instruments SC-2345 Series consists of two types of carriers, the SC-2345 connector block and the SC-2345 with configurable connectors. These enclosures for SCC signal conditioning modules connect directly to 68-pin DAQ devices. They include sockets for SCC modules, along with screw terminals for convenient connection to digital I/O and counter/timer (GPCTR) signals from the DAQ device. These carriers offer three power options to increase the flexibility of deployment.

SC-2345 Connector Block

The SC-2345 includes 20 SCC sockets, labeled J1 through J20 (see Figure 1). Sockets J1 through J8 accommodate SCC modules for conditioning signals on the analog input channels of the DAQ device. For example, an SCC module plugged into socket J1 conditions signals for channels 0 and 8 of the device.

You can use sockets J9 through J16 for either digital I/O modules or dual-stage analog input conditioning. When using dual-stage conditioning of analog inputs (for applicable modules), wire your input signal to the first-stage module (in sockets J9 through J16). The SC-2345 routes the output signal of the first-stage SCC module to the input of the second stage SCC module internally (see Figure 2). When using sockets J9 through J16 for digital I/O, simply plug in a digital SCC module or the SCC-FT01 for custom digital applications. You can use any combination of SCC digital input or digital output modules. The digital I/O lines of E Series or Basic multifunction DAQ devices are configurable for input and output on a line-by-line basis. You can also access the DIO lines of the DAQ device using the screw terminal block.

Sockets J17 through J20 access the two analog output channels and the GPCTR channels 0 and 1.

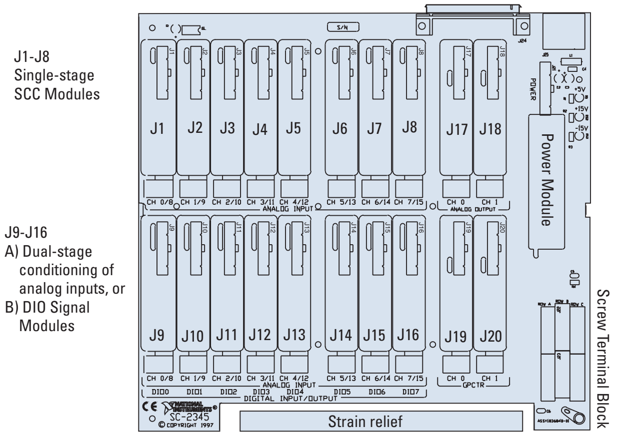
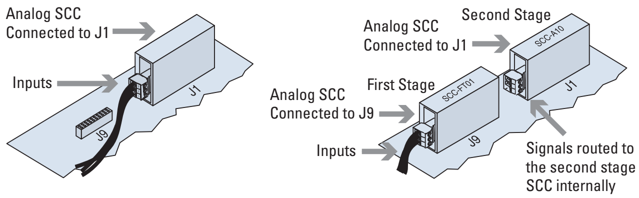


Figure 1. Diagram of Socket Layouts on SC-2345 Connector Block



A. Single-Stage Analog Input SCC Configuration

B. Dual-Stage Analog Input SCC Configuration

Figure 2. Single-Stage and Dual-Stage Analog Input SCC Configuration for the SC-2345 Connector Block

Portable, Shielded SCC Module Carriers

SC-2345 Carrier with Configurable Connectors

The SC-2345 with Configurable Connectors is electrically and functionally identical to the SC-2345 connector block. The only differences are the orientation of some modules and the addition of I/O connector and interface panelettes. This carrier is available with either a side 68-pin connector (recommended for DAQCard products) or a rear 68-pin connector (recommended for DAQPad products).

The SC-2345 with Configurable Connectors handles dual-stage conditioning and digital I/O modules. It also offers custom connectivity by adding panelettes along its front and rear panels. Select up to 18 panelettes for side-mount 68-pin versions, or 15 panelettes for rear-mount 68-pin versions. With I/O panelettes, you can connect your sensor directly to the SCC system. With interface panelettes, you can add hardware controls and displays to your system. Blank panelettes are also available to fill unused positions or for modification to fit your custom application needs.

Panelette	Description	Connectors/Units per Panelette	Slot Width
Minithermocouple jack	J or K-type	2	1
	or uncompensated	2	1
Thermocouple jack	J or K-type	1	1
	or uncompensated	1	1
BNC	BNC connector	2	1
SMB	SMB connector	4	1
Banana jack	Banana jack	2	1
LEMO (B-Series)	2-pin female	2	1
	4, 6-pin female	1	1
MIL-Spec	2, 4, 6-pin female	1	1
9-pin D-Sub	Single (male)	1	2
	Single (female)	1	2
	Dual (male)	2	3
	Dual (female)	2	3
Momentary switch	On – off	2	1
Toggle switch	(On – off – on)	2	1
Rocker switch	(On – off – on)	1	1
LED	Red, green, yellow, and orange LEDs	4	1
Potentiometer	1 turn, 10 Ω	1	1
Strain relief	Small	1	2
Blank	Filler panel	–	–

Table 1. SC-2345 Panelettes Options

Panelettes

If you choose either of the two versions of the SC-2345 with configurable connectors as your carrier, then you can install connectivity and interface panelettes to customize your SCC system. Panelette options include BNC, SMB, LEMO (B-Series), MIL-Spec, banana jack, thermocouple plug, 9-pin D-Sub connectors, rocker switches, toggle switches, momentary switches, potentiometers, and LEDs. Please note, some panelettes occupy more than one panelette slot. All panelettes except for the strain-relief options include lead wires that you connect to the screw terminals of any SCC module or to the 42-pin screw terminal block inside the SC-2345. The thermocouple and minithermocouple jack connector wires are made of the appropriate metals to avoid forming unwanted cold junctions.

Figure 3. SC-2345 Panelettes Options

Portable, Shielded SCC Module Carriers

Screw Terminals

Each SC-2345 shielded carrier includes a 42-position screw terminal block for easy access to digital lines of the E Series or basic multifunction DAQ device, including DIO<0..7>, PFI<0..9>, GPCTR 0,1, +5 V, DGND, AISENSE, FREQ_OUT, EXTSTROBE, and SCANCLK.

Accessories

The SC-2345 with Configurable Connectors offers two optional accessories. For 19 in. rack systems, choose the rack-mount kit. If you are using two SCC systems, or a single SCC system with a DAQPad device, choose the stacking kit to mechanically attach both systems.

Power Options

SC-2345 carriers have three power options:

- SCC-PWR01 – 5 VDC from the DAQ device or an external supply
- SCC-PWR02 – universal AC external supply
- SCC-PWR03 – 7 to 42 VDC external supply module (power supply not included)

One power module is included with your carrier. Power modules are sold separately in case you want to use your SC-2345 in two or more configurations.

If you choose the SCC-PWR01, it is possible to power your SCC system with the internal power source of your DAQ device. NI DAQCards and DAQPads provide 800 mW of total power (490 mW

Ordering Information

NI SC-2345 Connector Block with	
SCC-PWR01	777458-01
SCC-PWR02	777458-02
SCC-PWR03	777458-03
NI SC-2345 with Configurable Connectors (side 68-pin) with	
SCC-PWR01	777722-01
SCC-PWR02	777722-02
SCC-PWR03	777722-03
NI SC-2345 with Configurable Connectors (rear 68-pin) with	
SCC-PWR01	778018-01
SCC-PWR02	778018-02
SCC-PWR03	778018-03

Separate Power Modules

SCC-PWR01	183971-01
SCC-PWR02	183971-02
SCC-PWR03	183971-03

Power Cords for the SCC-PWR-02

U.S. 120 VAC	763000-01
Japan 100 VAC	763000-01
United Kingdom 240 VAC	763064-01
Swiss 220 VAC	763065-01
Australian 240	763066-01
Universal Euro 240 VAC	763067-01
North American 240 VAC	763068-01

Panelettes

Minithermocouple, J-type (2 included)	184736-01
Minithermocouple, K-type (2 included)	184736-02
Minithermocouple, uncompensated (2 included)	184736-03
Thermocouple, J-type	187597-01
Thermocouple, K-type	187597-02
Thermocouple, uncompensated	187597-03
BNC (2 included)	184737-01
Banana jack (2 included)	186405-01
LEMO (B-Series)	
2-pin, female	187585-01
4-pin, female	187585-02
6-pin, female	187585-03
MIL–C–26482 (Series 1)	
MS 3112 E 8-2 S	187591-01
MS 3112 E 8-2 S	187591-02
MS 3112 E 8-4 S	187591-03

Panelettes (continued)

SMB (4 included)	185505-01
9-pin D-Sub	
1 male	184738-01
2 male	184738-02
1 female	184738-03
2 female	184738-04
Strain relief (small)	184721-01
Blank	184483-01
Momentary push-button switches (2 included)	185380-01
Rocker switch (on/off/on)	185379-01
Toggle switches (on/off/on, 2 included)	185378-01
Potentiometer (10 kΩ, single-turn)	185377-01
LEDs (4 included-1 green, 1 red, 1 orange, 1 yellow)	185376-01

Cables

SH6868-EP	
1 m	184749-01
2 m	184749-02
SH68-68R1-EP	187051-01
R6868	182482-01
SH1006868	
1 m	182849-01
2 m	182849-02
PSHR68-68 shielded cable kit	777293-01
SHC6868-EP	186838-01

Accessories

CA-1000 rack-mount kit (1U)	777665-01
CA-1000 stacking kit	777666-01
CA-1000 panel mount kit	187243-01
Strain relief kit[1]	187407-01

[1]You cannot use the strain relief kit in conjunction with the rack-mount, panel-mount, or stacking kits.

For information on extended warranty and value added services, see page 20.

BUY ONLINE!

Visit ***ni.com/info*** *and enter sc2345.*

Portable, Shielded SCC Module Carriers

of analog power) from their internal source. NI PCI and PXI devices provide 4.55 W of total power (1.74 W of analog power) from their internal source. If the power draw from your SCC modules is greater than the power available from your DAQ device, then you must use an external power source. The SCC-PWR02 includes an AC transformer. However, you must purchase an additional power cord to match your country's power requirements.

The SCC-PWR03 does not include a transformer but can be used with an external transformer that provides 7 to 42 VDC. To determine the valid power options for the modules in your SCC DAQ system, use the online SCC Advisor at ***ni.com/advisors***

Cabling

You connect your SC-2345 to your DAQ device using standard cables. To determine the cabling needed for your configuration, see Table 2.

DAQ Device	SC-2345
68-pin E Series or Basic multifunction	SH68-68-EP[1]
100-pin E Series	SH100686[2]
Latching E Series DAQCards: 6062E, 6036E, 6024E	SHC6868-EP

[1]Can also use the SH68-68R1 or R6868 [2]Only the first 68 pins will interface to an SC-2345

Table 2. SC-2345 Cabling Options

Specifications

SCC-PWR01

Input	5 VDC ±5% from an external source, or +5 VDC from E Series or Basic multifunction DAQ device
Output	+5 VDC, 100% efficiency ±15 VDC, 62% efficiency

SCC-PWR02

Input	90 to 264 VAC, 1 A maximum
Output	+5 VDC, 1 A ±15 VDC, ±0.3 A

SCC-PWR03

Input	7 to 42 VDC (from external source)
Output	+5 VDC, 75% efficiency ±15 VDC, 46% efficiency

Physical Dimensions

SCC modules	8.9 by 2.9 by 1.9 cm (3.5 by 1.2 by 0.7 in.)
SC-2345 connector block	24.1 by 26.2 by 3.94 cm (9.5 by 10.3 by 1.6 in.)
SC-2345 with configurable connectors	30.7 by 25.4 by 4.3 cm (12.1 by 10 by 1.7 in.)
External AC adapter (for SCC-PWR02)	15.5 by 8.5 by 4.8 cm (6.1 by 3.3 by 1.9 in.)

Connectors

SC-2345 cable	68-pin male SCSI II
SCC input	Removable screw terminal or minithermocouple connector
SCC output	20-pin right-angle male connector

Multifunction DAQ and SCXI Signal Conditioning Accuracy Specifications Overview

Every Measurement Counts

There is no room for error in your measurements. From sensor to software, your system must deliver accurate results. NI provides detailed specifications for our products so you do not have to guess how they will perform. Along with traditional data acquisition specifications, our E Series multifunction data acquisition (DAQ) devices and SCXI signal conditioning modules include accuracy tables to assist you in selecting the appropriate hardware for your application.

To calculate the accuracy of NI measurement products, visit ni.com/accuracy

Absolute Accuracy

Absolute accuracy is the specification you use to determine the overall maximum tolerance of your measurement. Absolute accuracy specifications apply only to successfully calibrated DAQ devices and SCXI modules. There are four components of an absolute accuracy specification:

- **Percent of Reading** – is a gain uncertainty factor that is multiplied by the actual input voltage for the measurement.
- **Offset** – is a constant value applied to all measurements.
- **System Noise** – is based on random noise and depends on the number of points averaged for each measurement (includes quantization error for DAQ devices).
- **Temperature Drift** – is based on variations in your ambient temperature.
- **Input Voltage** – the absolute magnitude of the voltage input for this calculation. The fullscale voltage is most commonly used.

Based on these components, the formula for calculating absolute accuracy is:

Absolute Accuracy = ±[(Input Voltage X % of Reading) + (Offset + System Noise + Temperature Drift)]

Absolute Accuracy RTI[1] = (Absolute Accuracy Input Voltage)

[1]RTI = relative to input

Temperature drift is already accounted for unless your ambient temperature is outside 15 to 35 °C. For instance, if your ambient temperature is at 45 °C, you must account for 10 °C of drift. This is calculated by:

Temperature Drift = Temperature Difference x % Drift per °C x Input Voltage

Absolute Accuracy for DAQ Devices

Absolute Device Accuracy at Full Scale is a calculation of absolute accuracy for DAQ devices for a specific voltage range using the maximum voltage within that range taken one year after calibration, the Accuracy Drift Reading, and the System Noise averaged value.

Below is the Absolute Accuracy at Full Scale calculation for the NI PCI-6052E DAQ device after one year using the ±10 V input range while averaging 100 samples of a 10 V input signal. In all the Absolute Accuracy at Full Scale calculations, we assume that the ambient temperature is between 15 and 35 °C. Using the Absolute Accuracy table on the next page, we see that that the calculation for the ±10 V input range for Absolute Accuracy at Full Scale yields 4.747 mV. This calculation is done using the parameters in the same row for one year Absolute Accuracy Reading, Offset and Noise + Quantization, as well as a value of 10 V for the input voltage value. You can then see that the calculation is as follows:

Absolute Accuracy = ±[(10 X 0.00037) + 947.0 µV + 87 µV] = ±4.747 mV

In many cases, it is helpful to calculate this value relative to the input (RTI). Therefore, you do not have to account for different input ranges at different stages of your system.

Absolute Acuracy RTI = (±0.004747/10) = ±0.0475%

The following example assumes the same conditions except that the ambient temperature is 40 °C. You can begin with the calculation above and add in the Drift calculation using the % Drift per °C from Table 2 on page 196.

Absolute Accuracy = 4.747 mV + ((40 – 35 °C) x 0.000006 /°C X 10 V) = ±5.047 mV

Absolute Acuracy RTI = (±0.005047/10) = ±0.0505%

Absolute Accuracy for SCXI Modules

Below is an example for calculating the absolute accuracy for the NI SCXI-1102 using the ±100 mV input range while averaging 100 samples of a 14 mV input signal. In this calculation, we assume the ambient temperature is between 15 and 35 °C, so Temperature Drift = 0. Using the accuracy table on page 313, you find the following numbers for the calculation:

Input Voltage = 0.014
% of Reading Max = 0.02% = 0.0002
Offset = 0.000025 V
System Noise = 0.000005 V

Absolute Accuracy = ±[(0.014 x 0.0002) + 0.000025 + 0.000005] V = ±32.8 µV

Absolute Accuracy RTI = ±(0.0000328 / 0.014) = ±0.234 %

The following example assumes the same conditions, except the ambient temperature is 40 °C. You can begin with the Absolute Accuracy calculation above and add in the Temperature Drift.

Absolute Accuracy = 32.8 µV + (0.014 x 0.000005 + 0.000001) x 5 = ±38.15 µV

Absolute Accuracy RTI = ±(0.00003815 / 0.014) = ±0.273 %

Multifunction DAQ and SCXI Signal Conditioning Accuracy Specifications Overview

For both DAQ devices and SCXI modules, you should use the Single-Point System Noise specification from the accuracy tables when you are making single-point measurements. If you are averaging multiple points for each measurement, the value for System Noise changes. The Averaged System Noise in the accuracy tables assumes that you average 100 points per measurement. If you are averaging a different number of points, use the following equation to determine your Noise + Quantization:

$$\text{System Noise} = \text{Average System Noise from table} \times \sqrt{(100/\text{number of points})}$$

For example, if you are averaging 1,000 points per measurement with the PCI-6052E in the ±10 V (±100 mV for the SCXI-1102) input range, System Noise is determined by:

NI PCI-6052E**
System Noise= 87.0 0 μV x $\sqrt{(100/1000)}$ = 27.5 0 μV

NI SCXI-1102
System Noise= 5 μV x SQRT $\sqrt{(100/1000)}$ = 1.58 μV

**The System Noise specifications assume that dithering is disabled for single-point measurements and enabled for averaged measurements.

See page 21 or visit ni.com/calibration for more information on the importance of calibration on DAQ device accuracy.

Absolute System Accuracy

Absolute System Accuracy represents the end-to-end accuracy including the signal conditioning and DAQ device. Because absolute system accuracy includes components set for different input ranges, it is important to use Absolute Accuracy RTI numbers for each component.

Total System Accuracy RTI = ±SQRT [(Module Absolute Accuracy RTI)2 + (DAQ Device Absolute Accuracy RTI)2]

The following example calculates the Absolute System Accuracy for the SCXI-1102 module and PCI-6052E DAQ board described in the first examples:

$$\text{Total System Accuracy RTI} = \pm\sqrt{[(0.00273)2 + (0.000505)2]} = \pm 0.278\%$$

Units of Measure

In many applications, you are measuring some physical phenomenon, such as temperature. To determine the absolute accuracy in terms of your unit of measure, you must perform three steps:

1. Convert a typical expected value from the unit of measure to voltage
2. Calculate absolute accuracy for that voltage
3. Convert absolute accuracy from voltage to the unit of measure

Note: it is important to use a typical measurement value in this process, because many conversion algorithms are not linearized. You may want to perform conversions for several different values in your probable range of inputs, rather than just the maximum and minimum values.

For an example calculation, we want to determine the absolute system accuracy of an NI SCXI-1102 system with a NI PCI-6052E, measuring a J-type thermocouple at 100 °C.

1. A J-type thermocouple at 100 °C generates 5.268 mV (from a standard conversion table or formula)
2. The absolute accuracy for the system at 5.268 mV is ±0.82%. This means the possible voltage reading is anywhere from 5.225 to 5.311 mV.
3. Using the same thermocouple conversion table, these values represent a temperature spread of 99.3 to 100.7 °C.

Therefore, the absolute system accuracy is ±0.7 °C at 100 °C.

Benchmarks

The calculations described above represent the maximum error you should receive from any given component in your system, and a method for determining the overall system error. However, you typically have much better accuracy values than what you obtain from these tables.

If you need an extremely accurate system, you can perform an end-to-end calibration of your system to reduce all system errors. However, you must calibrate this system with your particular input type over the full range of expected use. Accuracy depends on the quality and precision of your source.

We have performed some end-to-end calibrations for some typical configurations and achieved the results in Table 1:

To maintain your measurement accuracy, you must calibrate your measurement system at set intervals over time.

For a current list of SCXI signal conditioning products with calibration services, please visit ni.com/calibration

Multifunction DAQ and SCXI Signal Conditioning Accuracy Specifications Overview

Module	Empirical Accuracy
SCXI-1102	±0.25 °C at 250 °C
	±24 mV at 9.5 V
SCXI-1112	±0.21 °C at 300 °C
SCXI-1125	±2.2 mV at 2 V

Table 1. Possible Empirical Accuracy with System Calibration

		Absolute Accuracy							Relative Accuracy	
Nominal Range (V)		% of Reading			System Noise (mV)		Temp Drift	Absolute Accuracy	Resolution (µV)	
Positive FS	Negative FS	24 Hours	1 Year	Offset (µV)	Single Point	Averaged	(%/°C)	at Full Scale (mV)	Single Point	Averaged
10.0	-10.0	0.0354	0.0371	947.0	981.0	87.0	0.0006	4.747	1145.0	115.0
5.0	-5.0	0.0054	0.0071	476.0	491.0	43.5	0.0001	0.876	573.0	57.3
2.5	-2.5	0.0354	0.0371	241.0	245.0	21.7	0.0006	1.190	286.0	28.6
1.0	-1.0	0.0354	0.0371	99.2	98.1	8.7	0.0006	0.479	115.0	11.5
0.5	-0.5	0.0354	0.0371	52.1	56.2	5.0	0.0006	0.243	66.3	6.6
0.25	-0.25	0.0404	0.0421	28.6	32.8	3.0	0.0006	0.137	39.2	3.9
0.1	-0.1	0.0454	0.0471	14.4	22.4	2.1	0.0006	0.064	27.7	2.8
0.05	-0.05	0.0454	0.0471	9.7	19.9	1.9	0.0006	0.035	25.3	2.5
10.0	0.0	0.0054	0.0071	476.0	491.0	43.5	0.0001	1.232	573.0	57.3
5.0	0.0	0.0354	0.0371	241.0	245.0	21.7	0.0006	2.119	286.0	28.6
2.0	0.0	0.0354	0.0371	99.2	98.1	8.7	0.0006	0.850	115.0	11.5
1.0	0.0	0.0354	0.0371	52.1	56.2	5.0	0.0006	0.428	66.3	6.6
0.5	0.0	0.0404	0.0421	28.6	39.8	3.0	0.0006	0.242	48.2	3.9
0.2	0.0	0.0454	0.0471	14.4	22.4	2.1	0.0006	0.111	27.7	2.8
0.1	0.0	0.0454	0.0471	9.7	19.9	1.9	0.0006	0.059	25.3	2.5

Table 2. NI PCI-6052E Analog Input Accuracy Specifications

Note: Accuracies are valid for measurements following an internal (self) E Series calibration. Averaged numbers assume averaging of 100 single-channel readings. Measurement accuracies are listed for operational temperatures within ±1 °C of internal calibration temperature and ±10 °C of external or factory-calibration temperature. One-year calibration interval recommended. The absolute accuracy at full scale calculations were performed for a maximum range input voltage (for example, 10 V for the ±10 V range) after one year, assuming 100 point averaging of data.