SCXI 32-Channel Analog Input Modules

NI SCXI-1102B/C, NI SCXI-1104/C, NI SCXI-1100

- 32 channels
- Programmable gain settings
- Lowpass filtering
- NI-DAQ simplifies configuration and measurements

SCXI-1102B, SCXI-1102C*

- Programmatic input range from ±100 mV to ±10 V (per channel)
- Per-channel lowpass filter
  - 200 Hz (SCXI-1102B)
  - 10 kHz (SCXI-1102C)

SCXI-1104, SCXI-1104C

- ±60 VDC input range
- Per-channel lowpass filters
  - 2 Hz (SXCI-1104)
  - 10 kHz (SCXI-1104C)

SCXI-1100

- 240 kS/s at full bandwidth, with gain up to 100
- 6.6 kS/s maximum10 kHz filter
- 3 S/s maximum 4 Hz filter

Operating Systems

- Windows 2000/NT/XP

Recommended Software

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

Driver Software

- NI-DAQ 7

Calibration Certificate Included

See page 21

*SCXI-1102, recommended for thermocouple and voltage measurements, is described on page 281

Overview

The National Instruments SCXI-1102B/C, NI SCXI-1104/C, and the SCXI-1100 are an assortment of 32-channel analog input modules. The programmable gain and filter settings are ideal for conditioning a variety of millivolt, volt, and current inputs. Each module multiplexes the 32 channels into a single channel of the DAQ device, and you can add modules to increase channel count.

Analog Input

SCXI-1102B, SCXI-1102C, SCXI-1104, SCXI-1104C

These modules are ideal for accurate measurement of high-channel-count applications, cost-effective and easy to use. Each analog input channel passes through its own programmable gain instrumentation amplifier and lowpass filter before it is multiplexed. With this architecture, you program the input range of each channel independently. Filter settings are preset and specific to each module (1102B – 200 Hz, 1102C – 10 kHz, 1104 – 2 Hz, 1104C – 10 kHz). You can scan channels at full hardware rate (up to 3 µs per channel) at any gain setting. Each channel includes input protection circuitry for up to ±42 V for the SCXI-1102B/C, and ±60 V for the SCXI-1104/C.

SCXI-1100

The SCXI-1100 is a solution for low-speed millivolt, volt, and current inputs. All 32 channels are multiplexed into a single programmable gain instrumentation amplifier (PGIA) and jumper-selectable lowpass filter. For thermocouple and ±100 mV to ±10 V range, and current measurements, the SCXI-1102 offers gain and filter settings on a per-channel basis and provides better performance and higher sampling rates (see page 281).

SCXI-1102B			✔
SCXI-1102C			✔
			–
			–
SCXI-1100			✔

Table 1. Signal Compatibility

SCXI 32-Channel Analog Input Modules

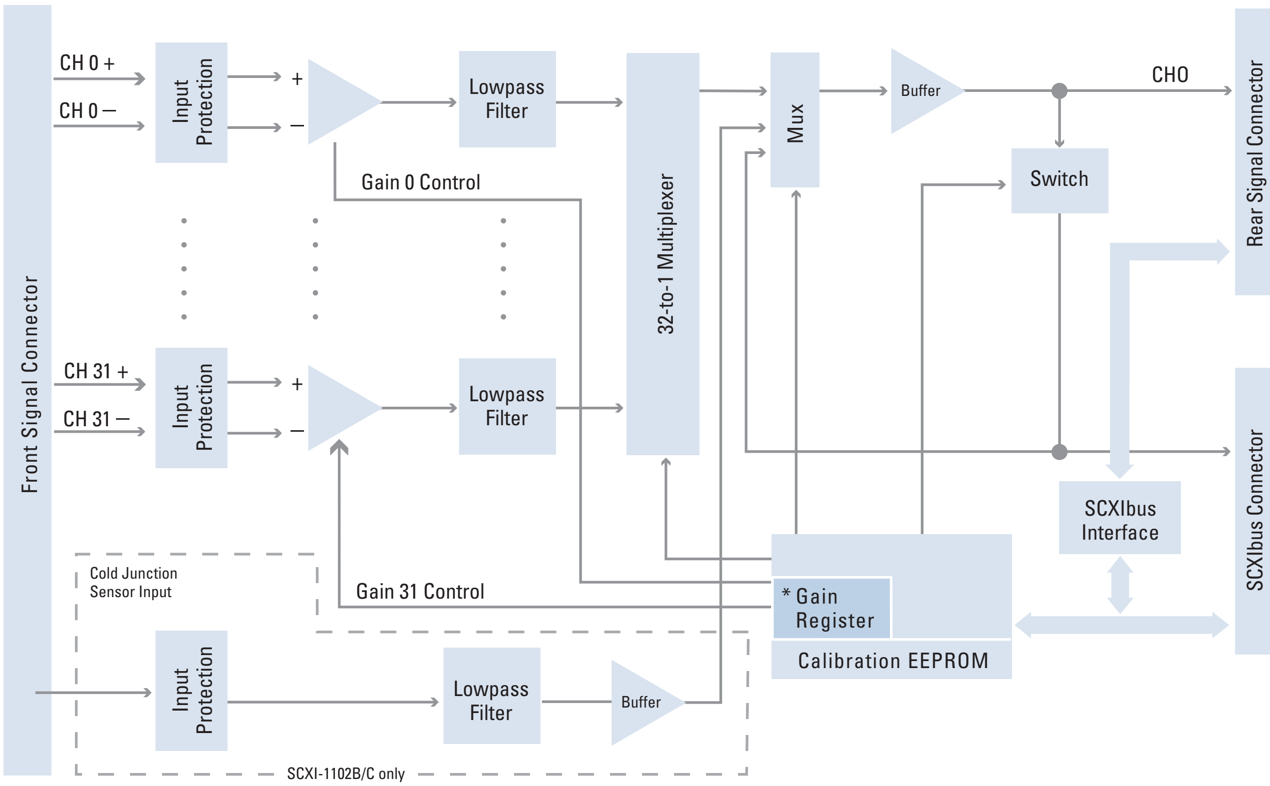

Figure 1. SCXI-1102 Series and SCXI-1104 Series Block Diagram

**Note: Not available on the SCXI-1104 or SCXI-1104C*

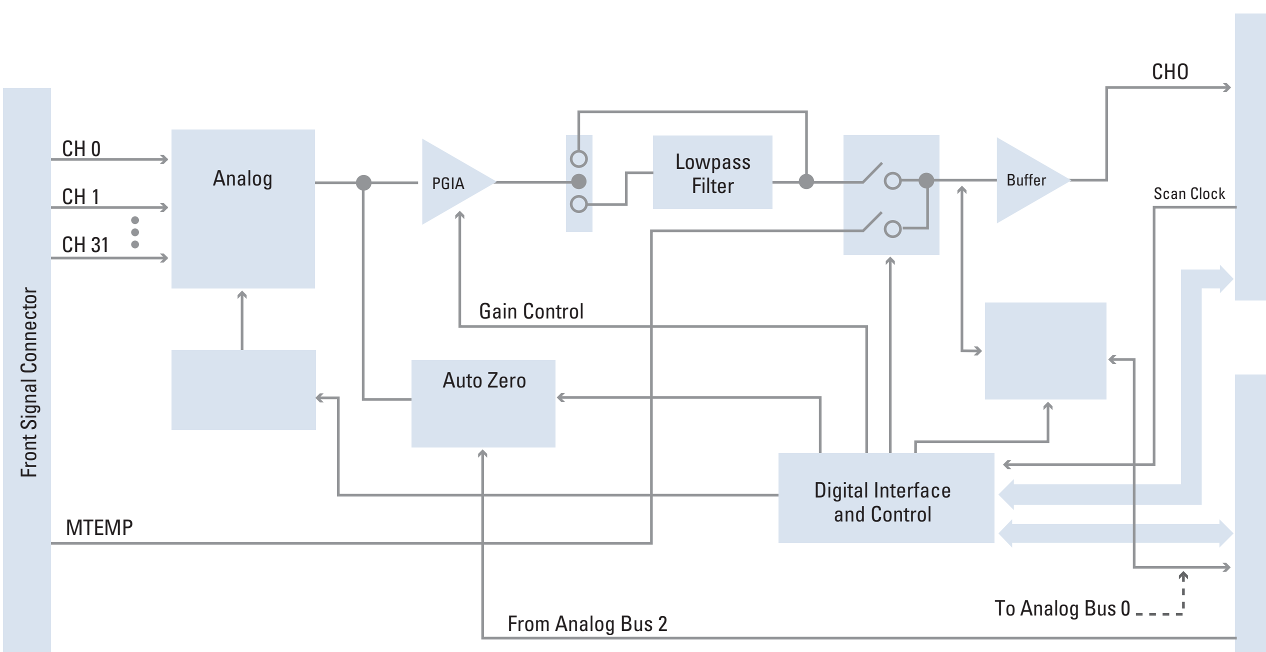

Figure 2. SCXI-1100 Block Diagram

SCXI 32-Channel Analog Input Modules

Te

TBX-96							

[1]You must disable the ground referencing for use with the SCXI-1104C

Table 2. Terminal Block Options for SCXI-1100, SCXI-1102B/C, and SCXI-1104/C

Cold-Junction Compensation

All modules except the SCXI-1104/C read the cold-junction sensor from the SCXI-1300, SCXI-1303, TBX-1303, and TC-2095 terminal blocks. The SCXI-1102 family can read the cold-junction sensor along with other channels, but the SCXI-1100 must read the cold-junction sensor as a separate analog input operation. This is commonly done once, before the start of a continuous acquisition.

Calibration

The SCXI-1102B/C and SCXI-1104/C modules include a calibration EEPROM. You can perform 2-point calibrations and store the results in user-modifiable locations. The NI-DAQ driver software transparently uses these constants to correct for gain and offset errors for each channel. Factory-provided calibration constants are also available by default and are stored in a protected memory location in the EEPROM.

For the SCXI-1100, you programmatically ground the inputs of the instrumentation amplifier, store the readings in application software, and subtract this value from future readings in your application.

Ordering Information

NI SCXI-1102B 776572-02B
NI SCXI-1102C 776572-02C
NI SCXI-1104 776572-04
NI SCXI-1104C 776572-04C
NI SCXI-1100 776572-00

Accessories

SCXI current resistors (4-pack) 776582-01
SH96-96 shielded cable 1m 183228-01
R96-96 ribbon cable 1m 183425-01

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

BUY ONLINE!

Visit ni.com/info and enter scxi1100, scxi1102b, scxi1102c, scxi1104, and/or scxi1104c.

See page 276 to configure your complete SCXI system.

SCXI 32-Channel Analog Input and Thermocouple Input Specifications

Specifications

Complete Accuracy Table

					Offset	System Noise (peak, 3 sigma)*					
											4.0

					Offset				

*Absolute Accuracy (15 to 35 °C). To calculate the absolute accuracy for the SCXI-1100/1102/1102B/1102C/1104/1104C and or 1112 refer to page 194 or visit ***ni.com/accuracy***

Input Characteristics

	No. of channels
SCXI-1100, SCXI-1102, SCXI-1102B SCXI-1102C, SCXI-1104, SCXI-1104C	32 differential
SCXI-1112	8 differential

Input signal ranges.. See accuracy table
Input coupling.. DC
Maximum working voltage

Module	Maximum Working Voltage (Signal + Common Mode)
SCXI-1100, SCXI-1102	±10 V
SCXI-1102B, SCXI-1102C	
SCXI-1104, SCXI-1104C	30 V or ±42 VAC peak or 60 VDC
SCXI-1112	±10 V

Overvoltage protection

Inputs with Overvoltage Protection	
SCXI-1100, SCXI-1104, SCXI-1104C	CH0..CH31
SCXI-1102, SCXI-1102B, SCXI-1102C	CH0..CH31, CJ SENSOR
SCXI-1112	CH0..CH7 CJ SENSOR

Offset error... See accuracy table
Gain error .... See accuracy table

Transfer Characteristics

Module	Percentage of Full Scale Range
SCXI-1100	±0.008%
SCXI-1102, SCXI-1102B, SCXI-1102C	±0.005%
SCXI-1104, SCXI-1104C	±0.01%
SCXI-1112	±0.005%

Nonlinearity

Amplifier Characteristics

Input impedance

Module	Normal Powered On	Powered Off/Overload

SCXI 32-Channel Analog Input and Thermocouple Input Specifications

Specifications

Input bias current

Module	Current
SCXI-1100	± 350 pA
SCXI-1102/1102B/1102C	± 0.5 nA
SCXI-1104/SCXI-1104C/SCXI-1112	

Input offset current

Module	Current
SCXI-1100	± 350 pA
SCXI-1102/1102B/1102C	± 1.0 nA
SCXI-1104/SCXI-1104C/SCXI-1112	

No MMR
CMRR (Common Mode Rejection Ratio) (DC to 60 Hz)

Output range .... See accuracy table
No output impendance

Dynamic Characteristics

Input signal bandwidth

Module	Bandwidth
SCXI-1100	4 Hz, 10 kHz, full bandwidth
SCXI-1102	2 Hz
SCXI-1102B	200 Hz
SCXI-1102C	10 kHz
SCXI-1104	2 Hz
SCXI-1104C	10 kHz
SCXI-1112	2 Hz

Step response (10 V Step)

Module	Filter Setting	Range	Accuracy ±0.012%[1]	±0.006%[2]	±0.0015%[2]

			Accuracy	

			Accuracy	

Multiplexer performance

	Scan Interval [1]	Settle to ±0.006%[2]
SCXI-1104/1104C, SCXI-1112		

Filter Characteristics

		± 10 mV	1.5 µV$_{rms}$
			rms
			rms
			rms
			µV$_{rms}$

Type .... RC

Cutoff Frequency (-3 dB)

SCXI-1100.. 4 Hz, 10 kHz, full bandwidth (jumper selectable)
SCXI-1102/1104/1112..................................... 2 Hz
SCXI-1102B.. 200 Hz
SCXI-1102C, 1104C .... 10 kHz

Stability

Module	Input Range	Gain Temperature Coefficient	Offset Temperature Coefficient
SCXI-1102C			
SCXI-1104C			

Recommended warm-up time......................... 20 minutes

Physical

Dimensions.. 3.0 by 17.3 by 30.3 cm
1.2 by 6.8 by 8.0 in.

I/O Connector

Rear .... 50-pin male ribbon cable rear connector
Front
SCXI-1112 .... 8 uncompensated minithermocouple connectors
Others .... 96-pin male DIN C front connector

Environment

Operating temperature.................................... 0 to 50 ˚C
Storage temperature....................................... -55 to 150 ˚C
Relative humidity .... 5 to 90% noncondensing

Certification and Compliance

European Compliance

EMC .... EN 61326 Group I Class A, 10m, Table 1 Immunity
Safety .... EN 61010-1

North American Compliance

EMC .... FCC Part 15 Class A using CISPR

Australia and New Zealand Compliance

EMC .... AS/NZS 2064.1/2 (CISPR-11)

[1]Includes effects of NI 6052E with 1 or 2m SCXI cable assembly
[2]Includes effects of NI 6030E with 1 or 2m SCXI cable assembly

For a definition of specific terms, please visit *ni.com/glossary*

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:

$$\text{Absolute Accuracy} = \pm[(\text{Input Voltage X \% of Reading}) + (\text{Offset} + \text{System Noise} + \text{Temperature Drift})]$$

$$\text{Absolute Accuracy RTI}^1 = (\text{Absolute Accuracy Input Voltage})$$

[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:

$$\text{Temperature Drift} = \text{Temperature Difference x \% Drift per °C x Input Voltage}$$

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:

$$\text{Absolute Accuracy} = \pm[(10 \text{ X } 0.00037) + 947.0\ \mu V + 87\ \mu V] = \pm 4.747 \text{ mV}$$

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.

$$\text{Absolute Acuracy RTI} = (\pm 0.004747/10) = \pm 0.0475\%$$

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.

$$\text{Absolute Accuracy} = 4.747 \text{ mV} + ((40 - 35\ °C) \text{ x } 0.000006\ /°C \text{ X } 10 \text{ V}) = \pm 5.047 \text{ mV}$$

$$\text{Absolute Acuracy RTI} = (\pm 0.005047/10) = \pm 0.0505\%$$

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

$$\text{Absolute Accuracy} = \pm[(0.014 \text{ x } 0.0002) + 0.000025 + 0.000005] \text{ V} = \pm 32.8\ \mu V$$

$$\text{Absolute Accuracy RTI} = \pm(0.0000328 / 0.014) = \pm 0.234\ \%$$

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.

$$\text{Absolute Accuracy} = 32.8\ \mu V + (0.014 \text{ x } 0.000005 + 0.000001) \text{ x } 5 = \pm 38.15\ \mu V$$

$$\text{Absolute Accuracy RTI} = \pm(0.00003815 / 0.014) = \pm 0.273\ \%$$

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**

$$\text{System Noise} = 87.0\ 0\ \mu V \times \sqrt{(100/1000)} = 27.5\ 0\ \mu V$$

NI SCXI-1102

$$\text{System Noise} = 5\ \mu V \times \text{SQRT} \sqrt{(100/1000)} = 1.58\ \mu V$$

**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

Table 1. Possible Empirical Accuracy with System Calibration

				Offset (µV)			Temp Drift (%/°C)	Absolute Accuracy at Full Scale (mV)		

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.