SCXI 8-Channel Simultaneous-Sampling Analog Input

NI SCXI-1140

- 8 simultaneously sampled input channels
- Switch-selectable gains per channel
- ±30 V maximum overvoltage protection, powered on
- Connections for external track-and-hold timing signal
- Cascade with SCXI-1142 for applications requiring filtering
- NI-DAQ driver software simplifies configuration and measurement

Operating Systems
- Windows 2000/NT/XP/Me/9x
- Mac OS 9

Recommended Software
- LabVIEW
- LabWindows/CVI
- Measurement Studio for Visual Basic
- VI Logger

Driver Software
- NI-DAQ

Module	Input Signal Characteristics ±20 mV to ±10 V
SCXI-1140	✔

Table 1. Module Compatibility

Overview
The National Instruments SCXI-1140 is an 8-channel simultaneous-sampling differential amplifier module. Each channel contains a high-input impedance instrumentation amplifier with switch-selectable gain followed by a track-and-hold (T/H) amplifier. The T/H amplifiers track simultaneously, which is useful for preserving interchannel phase relationships. You can run the T/H outputs to eight different input channels on the DAQ device, or you can multiplex the output of one or more modules into one channel of the DAQ device.

Analog Input
Each analog input channel of the NI SCXI-1140 has an instrumentation amplifier with differential inputs. Using DIP switches, you can configure each channel independently for a gain of 1, 10, 100, 200, or 500. Each channel has input overvoltage protection of ±30 V powered on and ±15 V powered off.

Simultaneous Sampling
With the SCXI-1140, you can digitize simultaneous events with negligible skew time between channels. In track mode, the outputs of the T/H amplifiers follow their input. When put into hold mode, the amplifier outputs simultaneously freeze, holding the signal levels constant. You can then digitize these held signals with a sequential sampler, such as a DAQ device. The DAQ device can provide the hold trigger signal, or you can provide an external hold trigger signal through the front connector of the SCXI-1140.

To determine the allowable scanning period, total the following – the SCXI-1140 tracking time (7 μs for 12-bit accuracy) and the allowable SCXI system scan interval (3 μs with a PCI-MIO-16E-1 with SCXI-1140 in multiplexed mode) multiplied by the number of channels minus one. For example, you can scan the 16 channels of two NI SCXI-1140 modules in multiplexed mode with the PCI-MIO-16E-1 in 7 μs + 3 μs(16-1) = 52 μs or a scanning rate of 19.23 kHz.

In parallel mode, you can pass each conditioned channel directly to the analog inputs of the DAQ device. Therefore, you can scan up to eight channels with a PCI-MIO-16E-1 in 7 μs + 1 μs(8-1) = 14 μs or 71.4 kHz. This configuration requires a dedicated DAQ device and cable for each module operating in parallel mode.

Calibration
You can connect the SCXI-1352 to one SCXI-1120, one SCXI-1142, or up to two SCXI-1121 modules configured for parallel mode to an auxiliary 16-pin connector located in the SCXI-1140 module to achieve simultaneous sampling of their parallel outputs. In this configuration, an SCXI terminal block is required only for access to the external hold trigger signal. The SCXI-1140 has offset and gain potentiometers so you can calibrate each channel manually.

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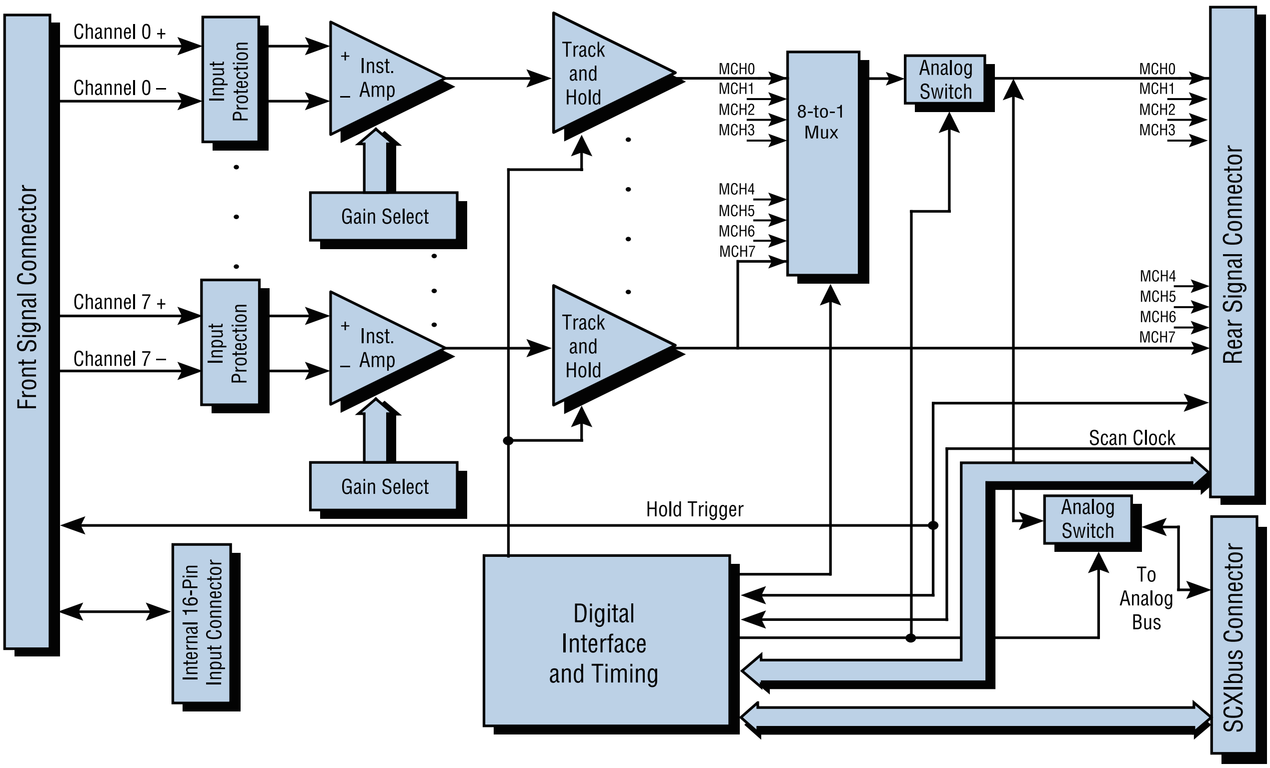


Figure 1. SCXI-1140 Block Diagram

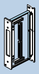
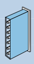
	Terminal Block	Type	Special Functions	Page
	SCXI-1301 (777687-01)	Screw terminals front-mounting	–	310
	SCXI-1304 (777687-04)	Screw terminals front-mounting	AC coupling Signal ground referencing	310
	SCXI-1305 (777687-05)	BNC Connectors front-mounting, Signal ground referencing	BNC connectors AC coupling	310
	SCXI-1310 (777687-10)	Solder pins	Low-cost connector and shell assembly	310

Figure 2. Terminal Block Options for SCXI-1140

Ordering Information

SCXI-1140 776572-40

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

See page 252 for more information on a complete SCXI system.

Accuracy Specifications for Signal Conditioning

Every Measurement Counts

There is little room for error in your measurements. From sensor to software, your system must deliver accurate results. NI provides detailed specifications for our products so that you do not have to guess how they perform. Along with traditional specifications, our signal conditioning products include accuracy tables to assist you in selecting the appropriate hardware for your application. These tables are found on the specification pages for each product.

Absolute Accuracy

Absolute accuracy is the specification you must use to determine the overall maximum possible error of your measurement. Absolute accuracy does assume your signal conditioning equipment has been calibrated within the last year. There are four main components of an absolute accuracy specification:

- % of Reading is an uncertainty factor that is multiplied by the actual imput voltage for the measurement
- Offset is a constant value applied to all measurements
- System Noise is based on noise and depends on the number of points averaged for each measurement
- Temperature Drift is based on variations in your ambient temperature.

Absolute Acuracy RTI stands for relative to the input

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

Absolute Accuracy = (Actual Input Voltage x % of Reading)
+ Offset + System Noise + Temperature Drift

Absolute Accuracy RTI = ±(Absolute Accuracy/Actual Input Voltage)

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

Temperature Drift = ± (Actual Input Voltage x % of Reading/°C + Offset/°C)
x Temperature Difference

Below is an example for calculating the absolute accuracy for the 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 pge 262, you find the following numbers for the calculation:

Actual Input Voltage = 0.014
Percent 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

Accuracy Specifications for Signal Conditioning

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

If you are making single-point measurements, use the Single-Point System Noise specification from the accuracy table. If you are averaging multiple points for each measurement, the value for System Noise changes. The Average System Noise provided in the accuracy table assumes that you average 100 points per measurement. If you are averaging a different number of points, use the following equation to determine your system noise:

System Noise = Average System Noise from table x
SQRT(100/number of points)

For example, if you are averaging 1,000 points per measurement with the SCXI-1102 in the ±100 mV range, the system noise is determined by:

System Noise = 5 μV x SQRT (100/1000) = 1.58 μV

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. See page 194 for information on how to calculate the Absolute Accuracy RTI for your particular DAQ device.

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 described in the first example, and a PCI-MIO-16XE-50 with an Absolute Accuracy RTI of 0.00368%.

Total System Accuracy RTI = ±SQRT [(0.00273)2 + (0.00003682)] = ±0.273%

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.

For an example calculation, we want to determine the absolute system accuracy of an SCXI-1102 system with a PCI-MIO-16XE-50, 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 ±0.59%. This means the possible voltage reading is anywhere from 5.237 to 5.299 mV.
(3) Using the same thermocouple conversion table, these values represent a temperature spread of 99.4 to 100.6 °C.

Therefore, the absolute system accuracy is ±0.6 °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 below:

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

To maintain your measurement accuracy, you must calibrate your measurement device at set intervals. Calibration improves your accuracy and ensures that your end product meets its required specifications. We are continually updating the calibration services available for our products. For a current list of SCXI signal conditioning products with calibration services, please visit ***ni.com/calibration***