SCXI Accelerometer Input Modules

NI SCXI-1530, NI SCXI-1531

- Programmable gain per channel (1,10,100)
- Programmable lowpass 4-pole Bessel filter per channel (2.5, 5, 10 and 20 kHz)
- 4 mA current source, 24 V compliance
- IEPE conditioning – software configurable
- Simultaneous sample and hold
- BNC direct connectivity
- Autocalibration
- Multiple inputs
  - 4 channels – SCXI-1530
  - 8 channels – SCXI-1531
- Random scanning
- NI-DAQ driver software simplifies configuration, scaling, and measurement

Operating Systems
- Windows 2000/NT/XP

Recommended Software
- LabVIEW
- LabVIEW Sound and Vibration Toolkit
- LabWindows/CVI
- Measurement Studio
- VI Logger

Driver Software
- NI-DAQ 7

Calibration Certificate Included
See page 21

Overview
The National Instruments SCXI-1530/1531 signal conditioning modules are designed for Integrated Electronic Piezoelectric (IEPE) accelerometers and microphones. These modules share a common architecture in which each input channel includes a programmable AC instrumentation amplifier, 4-pole Bessel lowpass filter, and excitation current source. These modules also offer simultaneous sampling to preserve interchannel phase relationships. Each module can multiplex its signals into a single channel of the DAQ device and you can add modules to increase channel count. With random scanning capabilities, you select only the channels from which you want to acquire data as well as scan channels in any order. These modules also offer parallel-mode operation for faster scanning rates. Each module offers BNC connectors to simplify signal connection.

Analog Input
To simplify configuration and ensure measurement accuracy, the analog inputs of the NI SCXI-1530/1531 consist of programmable instrumentation amplifiers, 4-pole Bessel lowpass filters, and simultaneous sample and hold using track-and-hold (T/H) circuitry. You can program each channel individually for input ranges of ±10, ±1, or ±0.1 V. You can program the lowpass filter of each channel for 2.5, 5, 10, or 20 kHz. The 4-pole Bessel lowpass filters provide a sharp cutoff while maintaining interchannel phase information. Each channel also has a 0.2 Hz highpass filter to block the DC offset of IEPE sensors. All analog inputs offer T/H circuitry to perform simultaneous sampling. To determine the allowable scanning rate, refer to page 795.

Conditioning
Each channel of the SCXI-1530/1531 has a 4 mA, 24 V compliant current source to power IEPE accelerometers/ microphones. By using an active current source, the excitation current of the module remains constant regardless of loading by the sensor. You can programmatically disable the current source for each channel. This is helpful for measuring the system noise of your environment, or using selected input channels for other input signal types.

Module	Accelerometers[1]	Microphones[1]	±0.1 to ±10 V
SCXI-1530	✓	✓	✓
SCXI-1531	✓	✓	✓

[1]Integrated Electronic Piezoelectric (IEPE)

Table 1. Signal Compatibility

SCXI Accelerometer Input Modules

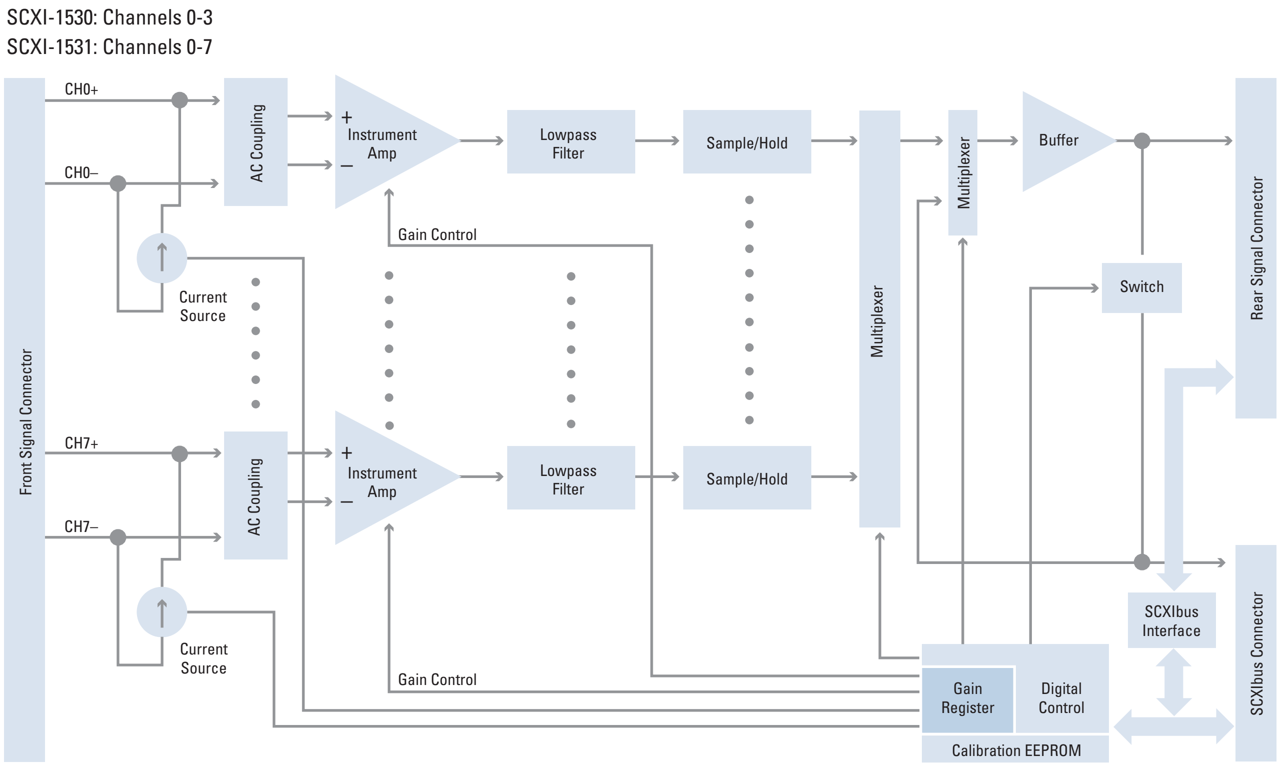

Figure 1. SCXI-1530/1 Block Diagram

Calibration

NI SCXI-1530/1531 modules offer simple yet powerful calibration capabilities. Each module includes a precision onboard calibration source that you can programmatically route to any analog input. By using simple software commands, you can perform calibrations to compensate for environmental changes without connecting external hardware. Each module has an onboard calibration EEPROM that stores the calibration constants for each channel. Factory calibration constants are stored in a protected area of the EEPROM. Additional user-modifiable locations mean calibration can occur under your exact operating conditions. NI-DAQ transparently uses the calibration constants to correct for gain and offset errors of each channel.

Tech Tip

LabVIEW Sound and Vibration Toolkit

For advanced analysis capabilities and automated system (end-to-end) calibration, consider using the LabVIEW Sound and Vibration Tookit.

For more information, visit ni.com/info and enter lvsound.

Ordering Information

NI SCXI-1530 777966-30
NI SCXI-1531 777966-31

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

BUY ONLINE!

Visit ni.com/info and enter scxi1530 and/or scxi1531.

See page 276 to configure your complete system.

SCXI Accelerometer Input Modules

Specifications

Input Accuracy

Module	Nominal Range*	Overall Gain*	Percent of Reading*		Offset	System Noise (peak, 3 sigma)*		Temperature Drift**	
			Typical	Maximum		Single Point	Average	Gain Drift/°C	Offset Drift (µV/°C)
SCXI-1530,	±10 V	1	0.03	0.5	±30 mV	125 µV	25 µV	±10 ppm	±20
SCXI-1531	±1 V	10	0.03	0.5	±3 mV	125 µV	25 µV	±10 ppm	±20
	±100 mV	100	0.03	0.5	±300 µV	125 µV	25 µV	±10 ppm	±20

*Absolute Accuracy (15 to 35 °C). **Added drift outside the range 15 to 35°C). One year specifications. Includes error added by 16-bit E Series MIO immediately after an E Series internal calibration. Absolute accuracy is (reading) x (% of reading) + (offset) + (system noise). If module temperature is beyond the range 15 to 35 °C, include the added term [(reading) x (gain drift) + offset drift] x T, where T is the absolute temperature difference between the module and 15 or 35 °C, whichever is smaller. To calculate the absolute accuracy for the SCXI-1530/1, refer to page 194 or visit ***ni.com/accuracy***

Inputs

Maximum input range .... ±10 V
Number of channels
  SCXI-1530 4
  SCXI-1531 8
Amplifier input impedance .... 1 M
Amplifier coupling .... AC (hard-wired)
Common-mode rejection ratio .... 75 dB minimum, 90 dB typical
Common-mode voltage range .... ±24 V operational
±42 V without damage

Output

Maximum output voltage .... ±10 V
Output impedance 200
Amplifier input noise, RTI .... 25 μV_{rms}, 125 V_{pp} maximum

Transfer Characteristics

Voltage gain
Gain = 1 .... 0 dB
Gain = 10 .... 20 dB
Gain = 100 .... 40 dB
Gain drift .... ±10 ppm/°C maximum
Accuracy .... ±0.5% before calibration
0.03% after calibration
Nonlinearity .... 0.004% of FSR maximum
DC offset .... ±30 mV maximum
DC offset drift .... ±20 µV/°C maximum
Filter type .... 4-pole Bessel lowpass
2-pole 0.2 Hz RC highpass
Bandwidth .... 2.5, 5, 10, 20 kHz (software selectable)

Conditioning

Accelerometer input excitation current .... 4 mA ±10%, 24 V compliant
Current source drift .... -2.5 µA/°C maximum
Current source dynamic impedance .... 400 k minimum
Current source noise, 0.1 to 10 kHz .... 22 μA_{rms}, 80 μA_{pp} maximum

Simultaneous S/H

Tracking time .... 7 µs maximum
Hold step .... 5 mV typical
Droop rate .... 30 mV/s maximum
Interchannel skew .... 100 ns maximum

Physical

Dimensions .... 3.0 by 17.3 by 24.4 cm
(1.2 by 6.8 by 8.0 in.)
Front connectors .... BNC (female)
Rear connectors .... 50-pin male ribbon
96-pin female SCXIbus

Environment

Operating temperature .... 0 to 50 °C
Storage temperature .... -20 to 70 °C
Relative humidity .... 5 to 90% noncondensing

Power Requirements

5 V .... 15 mA
±15 V (max, regulated from ±24 V) .... 150 mA

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 & New Zealand Compliance

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

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:

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:

Total System Accuracy RTI = ± $\sqrt{[(0.00273)2 + (0.000505)2]}$ = ±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 (%/°C)	Absolute Accuracy at Full Scale (mV)	Resolution (µV)	
Positive FS	Negative FS	24 Hours	1 Year	Offset (µV)	Single Point	Averaged			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.