SCXI 8-Channel Isolated Frequency Input Module

NI SCXI-1126

- 8 channels
- Programmable gain and filter settings per channel
- Programmable threshold and hysteresis per channel
- 15 Hz to 128 kHz signal ranges up to ±250 V_{rms} (or 1,000 VDC with TBX-1316)
- 333 kS/s maximum sampling rate
- NI-DAQ driver software simplifies configuration and measurement

Operating Systems
- Windows 2000/NT/XP

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

Driver Software
- NI-DAQ 7

Overview

The National Instruments SCXI-1126 is a signal conditioning module with eight isolated frequency input channels. Each channel of the NI SCXI-1126 includes a frequency-to-voltage conversion circuit with programmable input range, threshold, hysteresis, and filtering. The SCXI-1126 can measure the frequency of analog and digital signals with voltage levels as high as 1,000 VDC. The output voltages of the SCXI-1126 module are multiplexed onto a single channel of a DAQ device, so you can scan and acquire multiple frequency and analog input signals within a single high-speed scan operation.

Input Stage

The input stage of the SCXI-1126 consists of eight isolated frequency input channels. You can input signals up to 1,000 V. For example, you can measure the frequency of TTL signals, 24 V signals, or 120/240 VAC power signals. Each channel consists of an analog trigger circuit, which compares the input waveform with a user-programmable threshold and hysteresis. You can program the threshold of each channel from -0.5 to 4.48 V. You can also program the hysteresis window from 0 to 4.98 V. You can extend the input range of the threshold and hysteresis window to 250 V with the SCXI-1327 attenuator terminal block or to 1000 VDC (608 V_{rms}) with the TBX-1316 terminal block. The resolution of the threshold and hysteresis functions of each channel is eight bits. When the input waveform crosses through the threshold and hysteresis window, a trigger occurs.* The frequency of these triggers establishes the frequency of the output signal (a square waveform), which is then coupled across an optical isolation barrier for frequency-to-voltage conversion.

Each channel is individually isolated with a working common-mode voltage of 250 V_{rms} between channels or channel to earth. In addition, the SCXI-1126 has been CE certified as double insulated, Category II, for 250 V_{rms} of working isolation.

Frequency-to-Voltage Converters

The input frequency from each channel is converted to a precise analog voltage by a frequency-to-voltage conversion circuit that includes 10 software programmable frequency ranges and four software programmable output filter cutoffs featuring 4-pole lowpass filters.

Calibration

The SCXI-1126 contains onboard precision, low drift, frequency, and voltage references to guarantee accurate, stable, repeatable frequency-to-voltage conversions. An onboard EEPROM stores the calibration constants for each channel for each input range in a user-modifiable area. The EEPROM also stores a set of factory calibration constants in permanent memory, and cannot be modified. NI-DAQ transparently uses the calibration constants to correct for gain and offset errors.

For more information on threshold voltages and hysteresis, check out the product manuals at ni.com/manuals

	Signal Compatibility	
Module	Frequency Input Range (15 Hz to 128 kHz)	Input Signal Range (± 50 mV to 1,000 V)
SCXI-1126	✓	✓

Table 1. SCXI Module Compatibility

SCXI 8-Channel Isolated Frequency Input Module

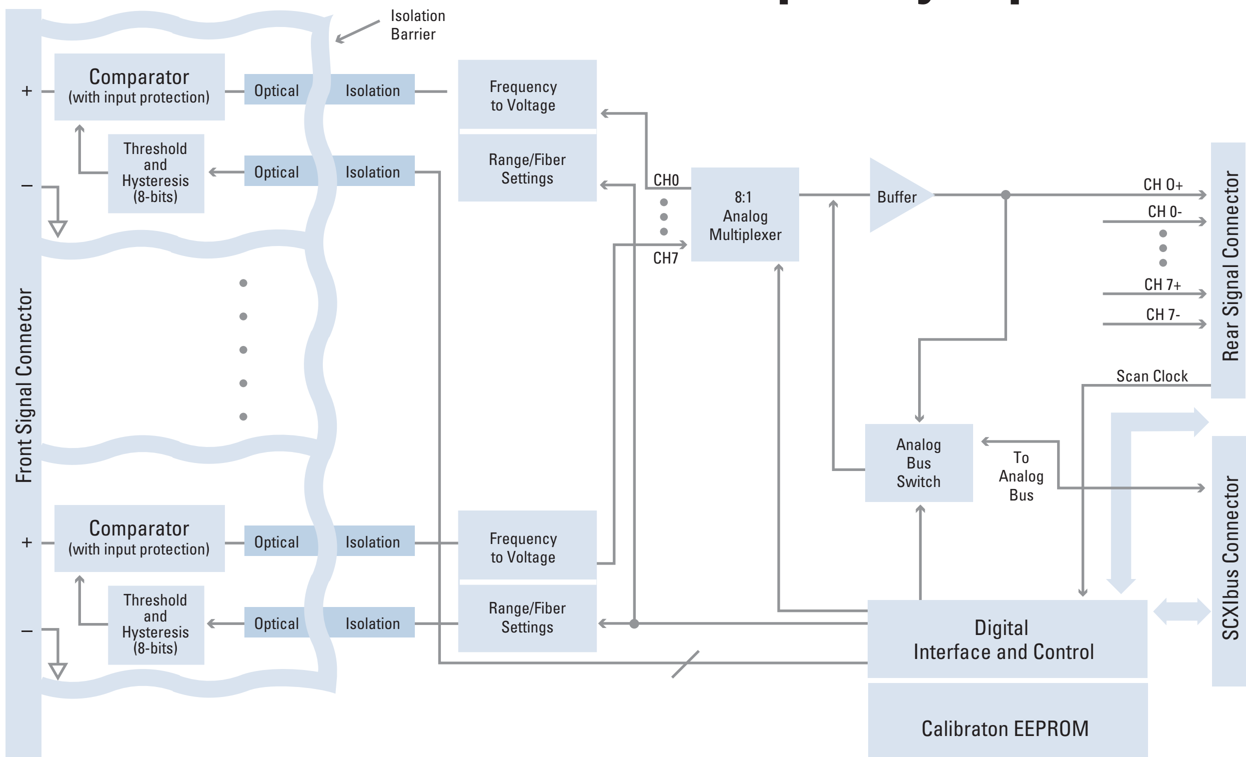

Figure 1. SCXI-1126 Block Diagram

Terminal Block	Part Number	Type	Cabling	Special Functions	Page
SCXI-1320	777687-20	Screw terminals/front-mounting	–	–	329
SCXI-1327	777687-27	Screw terminals/front-mounting	–	Extended voltage input range (to 250 V_{rms})	329
SCXI-1305	777687-05	BNC connectors/front-mounting	–	AC coupling (configurable per channel)	329
TBX-1316	777207-16	Screw terminals	SH-32-32-A (183230-01)	Extends input range to 1000 V DC	331
TBX-1328	777207-28	Screw terminals/DIN-rail mount	SH32-32-A (183230-01)	DIN-rail mount Isothermal construction	331
TBX-1329	777207-29	Screw terminals/DIN-rail mount	SH32-32-A (183230-01)	DIN-rail mount AC/DC coupling with removable screw terminals	331
SCXI-1330	777687-30	Solder pins/front-mounting	–	Low-cost connector and shell assembly	330

Figure 2. Terminal Block Options for SCXI-1126

Ordering Information

NI SCXI-1126 776572-26

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

BUY ONLINE!

Visit ni.com/info and enter scxi1126.

See page 276 to configure your complete SCXI system

SCXI 8-Channel Isolated Frequency Input Module

Specifications

All specifications are for 20 to 30 ˚C and for 1 year unless otherwise noted.
All specifications are relative to calibration standards and require a 15 minute warm-up period.
Specifications do not include transducer error.

Input Characteristics

Number of channels.. 8

Input frequency ranges (software selectable) and corresponding output voltage range[1]

Input Frequency Ranges	Output Voltage Range
250 Hz, 500 Hz, 1 kHz, 2 kHz 4 kHz, 8 kHz, 16 kHz, 32 kHz 64 kHz, 128 kHz	0 to 5 V

Minimum recommended input frequency based on output filter setting

Output Filter Bandwidth Setting	Minimum Input Frequency
1 Hz	15 Hz
40 Hz	600 Hz
320 Hz	5 kHz
1000 Hz	15 kHz

Minimum input pulse width............................ 1.5 µs (5 V pulse train at 128 kHz)
Input signal amplitude range.......................... (1,000 VDC/680 V_{rms} with the TBX-1316) ±50 mV minimum to ±250 V maximnum
Input coupling.. DC (AC with SCXI-1305 or TBX-1329)
Maximum working voltage[2,3].......................... Each input should remain within 250 V_{rms} of chassis ground or any other input terminal (signal + common mode voltage)
Overvoltage protection[3].................................. 250 V_{rms}, powered on or off
Inputs protected .... CH<0..7>
Input impedance
  Powered on... 50 G (-0.5 to 4.5 V)
  Overload... 50 k (-250 to -0.5 V and 4.5 to 250 V)
Powered off... 50 k
Input bias current .... 500 pA maximum (0 to 50˚)
Threshold (software programmable)
  Range.. -0.5 to 4.98 V (-50 to 250 V with SCXI-1327 high-voltage terminal block)
  Resolution... 8 bits
  Hysteresis... 0 to 4.98 V (0 to 250 V with SCXI-1327 high- voltage attenuator terminal block)

Transfer Characteristics[4]

Output Characteristics

Input Frequency Ranges	Percent of Reading + Hz*			Noise (Hz) (DC to 255 kHz)	
	24 hours	90 days	1 year	peak	rms
250 Hz	0.0150% ± 0.011 Hz	0.0217% ± 0.018 Hz	0.0418% ± 0.039 Hz	0.05	0.008
500 Hz	0.0150% ± 0.023 Hz	0.0217% ± 0.036 Hz	0.0418% ± 0.077 Hz	0.10	0.015
1 kHz	0.0150% ± 0.045 Hz	0.0217% ± 0.073 Hz	0.0418% ± 0.154 Hz	0.20	0.030
2 kHz	0.0150% ± 0.091 Hz	0.0217% ± 0.145 Hz	0.0418% ± 0.308 Hz	0.40	0.061
4 kHz	0.0150% ± 0.181 Hz	0.0217% ± 0.290 Hz	0.0418% ± 0.616 Hz	0.8	0.121
8 kHz	0.0150% ± 0.363 Hz	0.0217% ± 0.580 Hz	0.0418% ± 1.231 Hz	1.60	0.242
16 kHz	0.0150% ± 0.726 Hz	0.0217% ± 1.160 Hz	0.0418% ± 2.462 Hz	3.20	0.485
32 kHz	0.0150% ± 1.451 Hz	0.0217% ± 2.319 Hz	0.0418% ± 4.924 Hz	6.40	0.970
64 kHz	0.0150% ± 2.902 Hz	0.0217% ± 4.638 Hz	0.0418% ± 9.848 Hz	12.80	1.939
128 kHz	0.0150% ± 5.803 Hz	0.0217% ± 9.276 Hz	0.0418% ± 16.696 Hz	25.60	3.879

*Accuracy

Module	Scan Interval (Per Channel, Any Frequency Range and Filter Bandwidth)		
	Settle to ±0.012%[5]	Settle to ±0.006%[6]	Settle to ±0.0015%[6]
SCXI-1126	3 µs	10 µs	20 µs

Output impedance
  Multiplexed output mode.......................... 100
  Parallel output mode................................ 330
Output short circuit protection......................... Indefinite duration
Outputs protected .... MCH<0..7>
Filters (software programmable)
Type .... 4-pole, active lowpass

Power-Up and Reset States

Bandwidth and Response Time

Bandwidth (-3 dB) (Hz)	Step Response to ±1%	Settling Time (ms) to ±0.1%	Full Scale Input Step to ±0.024%
1.0	800.0	1,530.0	5,300.0
40.0	30.0	55.0	180.0
320.0	3.2	7.0	30.0
1000.0	0.8	1.0	1.2

Function	Power-Up State	Software Reset State	Hardware Reset State
Scanning mode*	Parallel	Retains last setting prior to software reset	Parallel
DAQ device Connection mode*	DIFF	Retains last setting prior to software reset	DIFF
Input frequency range	0 to128 kHz	0 to128 kHz	0 to128 kHz
Filter setting	1 Hz	1 Hz	1 Hz
Threshold level	-0.5 V	-0.5 V	Retains last setting prior to software reset
Hysteresis level	0 V	0 V	Retains last setting prior to software reset

*Output modes

Stability

Input Frequency Ranges	Temperature Drift Percent of Reading/˚C + Hz/˚C
250 Hz	0.0009% ±0.002 Hz
500 Hz	0.0009% ±0.003 Hz
1 kHz	0.0009% ±0.006 Hz
2 kHz	0.0009% ±0.013 Hz
4 kHz	0.0009% ±0.026 Hz
8 kHz	0.0009% ±0.051 Hz
16 kHz	0.0009% ±0.102 Hz
32 kHz	0.0009% ±0.204 Hz
64 kHz	0.0009% ±0.407 Hz
128 kHz	0.0009% ±0.814 Hz

Recommended warm-up time.......................... 15 minutes
Temperature drift (0 to 20 ˚C; 30 to 50 ˚C)[7]
  In ppm/˚C... ±9 ppm of reading/˚C ±6.4 ppm
  In Hz/˚C of range/˚C
Calibration cycle... 1 year

Physical

Dimensions... 3.0 by 17.2 by 20.3 cm (1.2 by 6.8 by 8.0 in.)
I/O connectors.. 50-pin male ribbon cable rear connector
32-pin male DIN C front I/O connector

Environment

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

Certifications and Compliances

European Compliance CE

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
Safety .... UL Listed to UL 3111-1
CAN/CSA C22.2 No. 1010.1

[1] V_{rms} refers to a sinusoidal waveform; V refers to DC or AC peak
[2] As specified by IEC-1010 for Pollution Degree 2 and Installation Category II
[3] Voltage is limited to 30 V_{rms} (42.4 V) if using the SCXI-1305 terminal block
[4] Accuracy is based on the combination of all errors, including the effects of temperature drift over the range 20 to 30 ˚C
[5] Includes effects of AT-MIO-16E-2 with 1 or 2 m SCXI cable assembly
[6] Includes effects of AT-MIO-16XE-10 with 1 or 2 m SCXI cable assembly
[7] See Transfer Characteristics for temperature drift over the range 20 to 30 ˚C

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	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.