SCXI 8-Channel Isolated Analog Input Modules

NI SCXI-1125, NI SCXI-1120, NI SCXI-1120D

- 8 channels
- 333 kS/s maximum sampling rate
- Gain and lowpass filter settings per channel
- Up to 300 V_{rms} working isolation per channel
- Signal inputs from ±2.5 mV to ±1000 VDC with TBX-1316
- NI-DAQ driver software simplifies configuration, measurement and scaling

SCXI-1125
- Programmable gain and filter settings
- 300 V_{rms} working isolation per channel,

SCXI-1120, SCXI 1120D
- Jumper selectable filter per channel
  - 4 Hz and 10 kHz filter (SCXI-1120)
  - 4.5 kHz and 22.5 kHz (SCXI-1120D)
- 250 V_{rms} working isolation per channel

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.

Overview
The National Instruments SCXI-1125, SCXI-1120, and SCXI-1120D are 8-channel isolated analog input modules. These modules share a common architecture, providing 250 to 300 V_{rms} of working isolation and lowpass filtering for each analog input channel. This architecture is ideal for amplification and isolation of millivolt, volt, 0 to 20 mA, 4 to 20 mA, and thermocouple signals. Each module can multiplex these eight channels into a single channel of the DAQ device, and you can add modules to increase channel count. These modules also offer parallel mode operation for increased scanning rates.

Analog Input
SCXI-1125
The analog inputs of the NI SCXI-1125 consist of eight programmable isolation amplifiers. You can program each channel independently for input ranges from ±2.5 mV to ±5 V. With the SCXI-1313 high-voltage attenuator terminal block, the input range is extended to ±300 V. With the TBX-1316, the input range is extended to ±1000 VDC (680 V_{rms}). Each channel also includes a programmatic lowpass filter that you can configure for 4 Hz or 10 kHz. With the SCXI-1125 you can perform random scanning meaning you can select only the channels from which you want to acquire data as well as scan channels in any order. Each channel is individually isolated with a working common-mode voltage of 300 V_{rms} between channels or channel to earth. In addition, the SCXI-1125 is CE certified as double insulated, Category II, for 300 V_{rms} of operational isolation.

SCXI-1120, SCXI-1120D
The analog inputs of the NI-1120/D consist of eight isolation amplifiers. You can configure each amplifier using jumpers for input ranges from ±2.5 mV to ±5 V (SCXI-1120) or ±5 mV to ±10 V (SCXI-1120D). With the SCXI-1327 high-voltage attenuator terminal block, the input range is extended to ±250 V. With the TBX-1316, the input range is extended to ±1000 VDC (680 V_{rms}). Each channel also includes a lowpass filter that is jumper configurable for 4 Hz or 10 kHz (SCXI-1120), or for 4.5 or 22.5 kHz (SCXI-1120D). 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-1120 and SCXI-1120D are CE certified as double insulated, Category II, for 250 V_{rms} of operational isolation.

Cold-Junction Compensation
Each of these modules can read the cold-junction sensor from the SCXI-1320, SCXI-1321, SCXI-1327, SCXI-1328, and TBX-1328 terminal blocks. The SCXI-1125 can scan the sensor along with other channels, but the SCXI-1120/D must read the cold-junction sensor as a separate analog input operation. This is commonly done once before the start of a continuous acquisition.

Module	±2.5 mV	±5 mV to ±5 V	±10 V	±1000 V	0 to 20 mA	Thermocouple
SCXI-1125	✓	✓	–	✓*	✓	✓
SCXI-1120	✓	✓	–	✓	✓	✓
SCXI-1120D	–	✓	✓	✓	✓	✓

*Using attenuating terminal block.

Table 1. Module Compatibility

SCXI 8-Channel Isolated Analog Input Modules

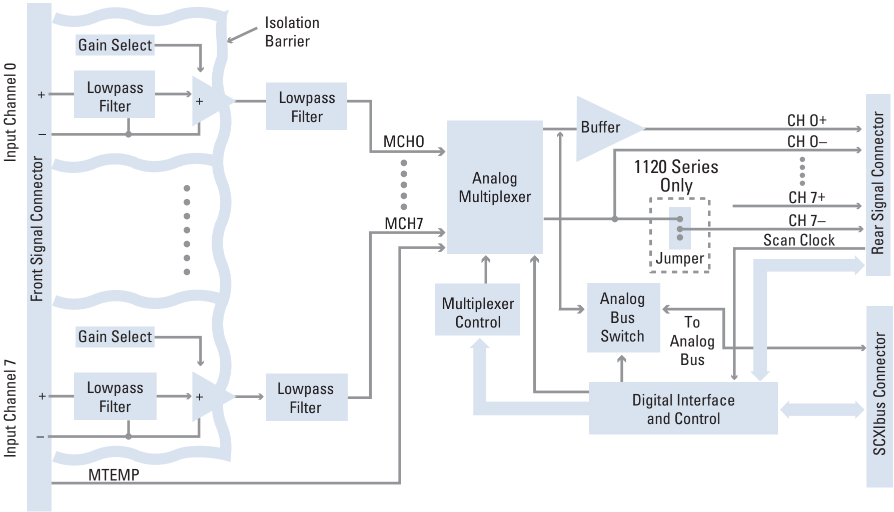

Figure 1. SCXI-1125, SCXI-1120, and SCXI-1120D Block Diagram

Terminal Block	Part Number	Type	CJ Sensor	Compatible Modules	Cabling	Special Functions	Page
SCXI-1313	777687-13	Screw terminals Front-mounting	✓	SCXI-1125	–	Programmable 100:1 attenuator	328
SCXI-1320	777687-20	Screw terminals Front-mounting	✓	SCXI-1125 SCXI-1120 SCXI-1120D	–	IC Sensor for CJC	329
SCXI-1327	777687-27	Screw terminals Front-mounting	✓		–	100:1 attenuator	329
SCXI-1328	777687-28	Screw terminals Front-mounting	✓		–	Isothermal construction Prewired ground referencing	329
SCXI-1338	777687-38	Screw terminals Front-mounting	✓		–	For current inputs	330
SCXI-1305[1]	777687-05	BNC connectors Front-mounting	–		–	AC coupling	328
TBX-1316	777207-16	Screw terminals DIN-rail mount			SH32-32-A (183230-01)	200:1 attenuator	331
TBX-1328	777207-28	Screw terminals DIN-rail mount	✓		SH32-32-A (183230-01)	DIN-rail mount Isothermal construction Prewired ground referencing	331
TBX-1329	777207-29	Screw terminals DIN-rail mount	–		SH32-32-A (183230-01)	DIN-rail mount AC coupling	331
SCXI-1330	777687-30	Solder pins Front-mounting	–		–	Low-cost connector and shell assembly	329

[1]The SCXI-1305 is not intended for high-voltage (>42 V) usage.

Table 2. Terminal block options for SCXI-1125, SCXI-1120, and SCXI-1120D.

Calibration

The SCXI-1125 contains calibration hardware to null out error sources. With programmable offset calibration, software-programmable analog switches ground the inputs of each of the instrumentation amplifiers for offset error calibration. An onboard EEPROM stores the calibration constants for each channel for each input range in a user-defined area. The EEPROM also stores a set of factory calibration constants in permanent memory, and cannot be modified. NI-DAQ driver software transparently uses the calibration constants to correct for gain and offset errors.

Ordering Information

NI SCXI-1125 776572-25
NI SCXI-1120 776572-20
NI SCXI-1120D 776572-20D

Accessories

SCXI current resistors (4-pack) 776582-01

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

BUY ONLINE!

Visit ni.com/info and enter scxi1120, scxi1120d and/or scxi1125.

See page 276 to configure your complete system.

SCXI 8-Channel Isolated Analog Input Modules

Specifications

Absolute Accuracy Table

						System Noise (peak, 3 sigma)*				Temperature Drift	
			Percent of Reading*			Single Point		Average		Percent of	Offset
Module	Nominal Range*	Overall Gain*	Typical	Max	Offset	4 Hz	10 kHz or FBW	4 Hz	10 kHz or FBW	Reading/°C	(µV/°C)
SCXI-1125	±1000 V_{rms}[4]	0.005	0.3996	1.2489	854 mV	115 mV	1.62 V	24.5 mV	401 mV	0.0034	132 mV
	±300 V[3]	0.01	0.2548	0.6498	500 mV	57.7 mV	946 mV	12.7 mV	203 mV	0.0029	44 mV
	±250 V[3]	0.02	0.2548	0.6498	250 mV	29.9 mV	478 mV	6.26 mV	100 mV	0.0029	44 mV
	±100 V[3]	0.05	0.2548	0.6498	100 mV	12.0 mV	183 mV	2.51 mV	40.1 mV	0.0029	22 mV
	±50 V[3]	0.1	0.2548	0.6498	50 mV	5.67 mV	111 mV	1.27 mV	20.3 mV	0.0029	11 mV
	±25 V[3]	0.2	0.2548	0.6498	25 mV	2.82 mV	47.9 mV	641 uV	10.1 mV	0.0029	4.4 mV
	±10 V[3]	0.5	0.2478	0.6478	10 mV	1.05 mV	19.1 mV	238 µV	4.06 mV	0.0029	2.2 mV
	±5 V	1	0.2478	0.6478	5.0 mV	528 µV	8.59 mV	122 µV	2.03 mV	0.0027	1.12 mV
	±2.5 V	2	0.2478	0.6478	2.5 mV	254 µV	4.25 mV	59.7 µV	1.01 mV	0.0027	460 µV
	±1 V	5	0.2478	0.6478	1.0 mV	109 µV	1.68 mV	23.7 µV	403 µV	0.0027	240 µV
	±500 mV	10	0.2478	0.6478	508 µV	68.2 µV	882 µV	12.2 µV	202 µV	0.0027	130 µV
	±250 mV	20	0.2478	0.6478	258 µV	32.0 µV	474 µV	6.26 µV	101 µV	0.0027	64 µV
	±100 mV	50	0.2478	0.6478	108 µV	10.9 µV	180 µV	2.37 µV	40.4 µV	0.0027	42 µV
	±50 mV	100	0.2478	0.6478	58 µV	6.20 µV	88.2 µV	1.24 µV	20.3 µV	0.0027	31 µV
	±25 mV	200	0.2478	0.6478	33 µV	2.58 µV	47.9 µV	0.593 µV	10.4 µV	0.0027	24.4 µV
	±20 mV	250	0.2478	0.6478	28 µV	2.25 µV	37.1 µV	0.499 µV	8.57 µV	0.0027	22.2 µV
	±10 mV	500	0.2478	0.6478	18 µV	1.27 µV	21.8 µV	0.268 µV	4.69 µV	0.0027	21.1 µV
	±5 mV	1000	0.2478	0.6478	13 µV	0.713 µV	14.9 µV	0.170 µV	3.13 µV	0.0027	20.9 µV
	±2.5 mV	2000	0.2478	0.6478	11 µV	0.420 µV	11.2 µV	0.099 µV	2.49 µV	0.0027	20.3 µV
SCXI-1120	±1000 V_{rms}[4]	0.005	0.3996	1.2489	854 mV	162 mV	1.94 V	38.6 mV	488 mV	0.0034	132 mV
	±500 V_{rms}[4]	0.01	0.2548	0.6498	337 mV	86.5 mV	972 mV	18.8 mV	244 mV	0.0029	44 mV
	±250 V[2]	0.02	0.2548	0.6498	250 mV	37.3 mV	503 mV	9.11 mV	122 mV	0.0029	44 mV
	±100 V[2]	0.05	0.2548	0.6498	132 mV	15.3 mV	199 mV	3.68 mV	48.4 mV	0.0029	22 mV
	±50 V[2]	0.1	0.2548	0.6498	65.3 mV	7.73 mV	98.9 mV	1.79 mV	24.4 mV	0.0029	11 mV
	±25 V[2]	0.2	0.2548	0.6498	31.9 mV	4.28 mV	54.6 mV	895 µV	12.3 mV	0.0029	4.4 mV
	±10 V[2]	0.5	0.2478	0.6498	11.9 mV	1.57 mV	26.2 mV	375 µV	4.92 mV	0.0029	2.2 mV
	±5 V	1	0.2478	0.6498	11.3 mV	840 µV	10.8 mV	188 µV	2.41 mV	0.0027	1.12 mV
	±2.5 V	2	0.2478	0.6498	5.13 mV	385 µV	5.00 mV	88.7 µV	1.20 mV	0.0027	460 µV
	±1 V	5	0.2478	0.6478	2.02 mV	157 µV	2.22 mV	36.4 µV	482 µV	0.0027	240 µV
	±500 mV	10	0.2478	0.6478	1.00 mV	80.2 µV	993 µV	18.5 µV	241 µV	0.0027	130 µV
	±250 mV	20	0.2478	0.6478	487 µV	45.0 µV	518 µV	9.18 µV	123 µV	0.0027	64 µV
	±100 mV	50	0.2478	0.6478	193 µV	15.5 µV	221 µV	3.61 µV	49.3 µV	0.0027	42 µV
	±50 mV	100	0.2478	0.6478	93.6 µV	7.74 µV	108 µV	1.82 µV	24.9 µV	0.0027	31 µV
	±25 mV	200	0.2478	0.6478	45.3 µV	4.21 µV	54.9 µV	0.940 µV	13.3 µV	0.0027	24.4 µV
	±20 mV	250	0.2478	0.6478	35.6 µV	3.38 µV	50.6 µV	0.788 µV	11.6 µV	0.0027	22.2 µV
	±10 mV	500	0.2478	0.6478	18.0 µV	1.97 µV	29.3 µV	0.454 µV	7.03 µV	0.0027	21.1 µV
	±5 mV	1000	0.2478	0.6478	13.0 µV	0.962 µV	25.5 µV	0.260 µV	5.58 µV	0.0027	20.9 µV
	±2.5 mV	2000	0.2478	0.6478	11.1 µV	0.908 µV	22.4 µV	0.314 µV	5.07 µV	0.0027	20.3 µV

*Absolute Accuracy (15 to 35 °C). To calculate the absolute accuracy for the SCXI-1125, SCXI-1120, and SCXI-1120D refer to page 194 or visit ***ni.com/accuracy***

						System Noise (peak, 3 sigma)*				Temperature Drift	
			Percent of Reading*			Single Point		Average		Percent of	Offset
Module	Range*	Gain*	Typical	Max	Offset	4.5 kHz	22.5 kHz	4.5 kHz	22.5 kHz	Reading/°C	(V/°C)
SCXI-1120D	±1000 V_{rms}[4]	0.01	0.3533	0.8832	1.04 V	842 mV	4.29 V	206 mV	1.53 V	0.0059	44 mV
	±500 V_{rms}[4]	0.02	0.3533	0.8832	0.52 V	475 mV	3.15 V	103 mV	1.45 V	0.0059	44 mV
	±200 V[2]	0.05	0.3533	0.8832	0.52 V	179 mV	2.46 V	47.3 mV	1.45 V	0.0059	22 mV
	±100 V[2]	0.1	0.3533	0.8832	260 mV	104 mV	2.32 V	30.4 mV	1.45 V	0.0059	11 mV
	±50 V[2]	0.2	0.3533	0.8832	104 mV	71.6 mV	2.23 V	26.1 mV	1.45 V	0.0059	4.4 mV
	±20 V[2]	0.5	0.3533	0.8832	52.2 mV	46.9 mV	1.96 V	21.4 mV	1.33 V	0.0059	2.2 mV
	±10 V[2]	1	0.3525	0.8812	21.0 mV	9.65 mV	40.9 mV	2.11 mV	14.9 mV	0.0059	900 µV
	±5 V	2	0.3525	0.8812	10.6 mV	4.38 mV	30.4 mV	1.04 mV	14.3 mV	0.0057	460 µV
	±2 V	5	0.3525	0.8812	5.4 mV	2.13 mV	23.5 mV	483 µV	14.3 mV	0.0057	240 µV
	±1 V	10	0.3525	0.8812	2.28 mV	1.03 mV	22.2 mV	300 µV	14.3 mV	0.0057	108 µV
	±500 mV	20	0.3525	0.8812	1.25 mV	677 µV	21.5 mV	256 µV	14.3 mV	0.0057	64 µV
	±200 mV	50	0.3525	0.8812	726 µV	448 µV	18.9 mV	208 µV	12.8 mV	0.0057	42 µV
	±100 mV	100	0.3525	0.8812	414 µV	297 µV	13.2 mV	140 µV	9.45 mV	0.0057	28.8 µV
	±50 mV	200	0.4192	1.0480	310 µV	271 µV	13.9 mV	140 µV	9.45 mV	0.0057	24.4 µV
	±20 mV	500	0.7800	1.9500	258 µV	263 µV	9.50 mV	139 µV	6.35 mV	0.0057	22.2 µV
	±10 mV	1000	1.3036	3.2590	227 µV	252 µV	4.81 mV	136 µV	3.21 mV	0.0057	20.9 µV
	±5 mV	2000	2.4008	6.0020	216 µV	243 µV	2.42 mV	131 µV	1.61 mV	0.0057	20.4 µV

*Absolute Accuracy (15 to 35 °C). To calculate the absolute accuracy for the SCXI-1125, SCXI-1120, and SCXI-1120D refer to page 194 or visit ***ni.com/accuracy***

[1]V_{rms} refers to sinusoidal waveform; V refers to DC or AC peak.
[2]With SCXI-1327 high-voltage terminal block.
[3]With SCXI-1313 high-voltage terminal block.
[4]With TBX-1316 high-voltage terminal block.

SCXI 8-Channel Isolated Analog Input Modules

Specifications

Input Characteristics

Number of channels.. 8 differential

Input signal ranges

Module	Signal Ranges
SCXI-1125	±2.5 mV to ±5 V
SCXI-1120	±2.5 mV to ±5 V
SCXI-1120D	±5 mV to ±10 V

Input coupling.. DC (or AC with SCXI-1305 or TBX-1329)

Maximum working voltage (without SCXI-1313, 1327, or TBX-1316)

Module	Signal and Common Mode
SCXI-1125	±300 V_{rms}
SCXI-1120, SCXI-1120D	±250 V_{rms}

Module	Powered On	Powered Off
SCXI-1125	±300 V_{rms}	±300 V_{rms}
SCXI-1120, SCXI-1120D	±250 V_{rms}	±250 V_{rms}

Overvoltage protection

Inputs protected .... CH0..CH7

Transfer Characteristics

Nonlinearity

Module	Percent of Full Scale Range
SCXI-1125	±0.02%
SCXI-1120, SCXI-1120D	±0.04%

Offset error.. See accuracy table

Gain error .... See accuracy table

Amplifier Characteristics

Input impedance

Module	Normal Powered On	Powered Off/Overload
SCXI-1125	> 1 G	4.5 M
SCXI-1120	> 1 G	50 k
SCXI-1120D	> 1 M	500 k

Input bias current

SCXI-1125.. ±100 pA

SCXI-1120.. ±80 pA

SCXI-1120D .... ±15 pA

NMR (Normal Mode Rejection Ratio)

SCXI-1125/1120/1120D .... 60 dB

CMRR (Common Mode Rejection Ratio) (DC to 60 Hz)

Module	Filter	CMRR 50 or 60 Hz
SCXI-1125	4 Hz	160 dB
	10 kHz	100 dB
SCXI-1120	4 Hz	160 dB
	10 kHz	100 dB
SCXI-1120D	4.5 kHz	110 dB
	10 kHz	98 dB

Output range .... ± 5 V

Output impedance

Module	Multiplexed Mode	Parallel Mode
SCXI-1125, SCXI-1120, SCXI-1120D	100	330

[1]V_{rms} refers to sinusoidal waveform; V refers to DC or AC peak.
[2]With SCXI-1327 high-voltage terminal block.
[3]With SCXI-1313 high-voltage terminal block.
[4]With TBX-1316 high-voltage terminal block.
[5]Includes effects of AT-MIO-16E-2 with 1 or 2 m SCXI cable assembly.
[6]Includes effects of AT-MIO-16X or AT-AI-16XE-10 with 1 or 2 m SCXI cable assembly.

Dynamic Characteristics

Input signal bandwidth

Module	Filter	Input Range	Bandwidth
SCXI-1125	4 Hz	All ranges	4 Hz
SCXI-1120	10 kHz	All ranges	10 kHz
SCXI-1125/1120	10 kHz[2, 3]	All ranges	2.6 kHz
SCXI-1125/1120	10 kHz[4]	All ranges	500 Hz
SCXI-1120D	4.5 kHz	± 250 V to ± 50 mV	4.5 kHz
		± 20 mV to ± 10 mV	4 kHz
		± 5 mV	3.5 kHz
	22.5 kHz	± 250 V to ± 1 V	22.5 kHz
		± 50 mV to ± 20 mV	22 kHz
		± 10 V to ± 50 mV	20 kHz
		± 10 mV	17 kHz
		± 5 mV	14 kHz

Multiplexer performance

	Scan Interval (Per Channel, Any Gain and Filter Setting)		
Module	Settle to ±0.012 %[5]	Settle to ±0.006 % [6]	Settle to ±0.0015 % [6]
SCXI-1125 SCXI-1120	3 µs	10 µs	20 µs
SCXI-1120D			

System noise... See accuracy table

Filter type

SCXI-1125.. Third-order Butterworth

SCXI-1120, SCXI-1120D .... Third order RC

Cutoff frequency (-3dB)

SCXI-1125.. 4 Hz, 10 kHz (programmable)

SCXI-1120.. 4 Hz, 10 kHz (jumper selectable)

SCXI-1120D .... 4.5 kHz, 22.5 kHz (jumper selectable)

Stability

Module	Gain Temperature Coefficient	Offset Coefficient
SCXI-1125	20 ppm/°C	± 0.2 ± 220/gain) µV/°C
SCXI-1120	20 ppm/°C	± .42 ± 250/gain) µV/°C
SCXI-1120D	50 ppm/°C	± 20 ± 220/gain) µV/°C

Physical

Dimensions.. 3.1 by 17.3 by 20.3 cm
(12.2 by 6.8 by 8.0 in)

I/O Connector

Rear .... 50-pin male ribbon cable rear connector

Front .... 32-pin male DIN C connector

Environment

Operating temperature.................................... 0 to 50 ˚C

Storage temperature....................................... -20 to 70 ˚C

Relative humidity .... 5 to 90% noncondensing

Certification and Compliance

SCXI-1120/D.. 250 V, Cat II working voltage

SCXI-1125.. 300 V, Cat II working voltage

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

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	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.