

# E Series Multifunction DAQ – 20 kS/s, 16-Bit, 16 Analog Inputs

## NI 601xE

- 20 kS/s, 16-bit resolution, 16 analog inputs
- Two 12-bit analog outputs
- 8 digital I/O lines (5 V/TTL); two 24-bit counter/timers
- Digital triggering
- Available for PCI, PCMCIA, and ISA
- NI-DAQ driver software simplifies configuration and measurements

### Model

- NI 6011E**
- PCI-MIO-16XE-50
  - AT-MIO-16XE-50
- NI 6012E**
- DAQCard-AI-16XE-50

### NI Application Software

- LabVIEW
- Measurement Studio
- VI Logger

### Operating System Compatibility

Windows 2000/NT/Me/9x\*  
Mac OS – not for all hardware

### Accessories

See page 256

### Calibration Certificate Included

See page 24



\*Visit [ni.com/info](http://ni.com/info) and enter winxp for the latest operation system information.

## Ordering Information

NI 6011E	
PCI-MIO-16XE-50 .....	777385-01
AT-MIO-16XE-50* .....	776910-01
NI 6012E	
DAQCard-AI-16XE-50 .....	777231-01

Includes NI-DAQ driver software.

\*Windows only

For information on extended warranty and value-added services, see page 22.

## Recommended Configurations

Family	DAQ Device	Accessory	Cable
NI 6011E	PCI-MIO-16XE-50	SCB-68 (776844-01)	SH6868-EP (184749-01)
	AT-MIO-16XE-50	SCB-68 (776844-01)	SH6868-EP (184749-01)
NI 6012E	DAQCard-AI-16XE-50	SCB-68 (776844-01)	PSHR68-68 (777293-01)

For E Series accessory and cable information, see page 256.

## Overview

The NI 6011E and NI 6012E DAQ devices use E Series technology to deliver reliable data acquisition capabilities to meet a wide range of application requirements. You get up to 20 kS/s, 16-bit performance on 16 analog inputs. Depending on your hard drive, these devices can also stream to disk at rates up to 20 kS/s. The NI 601x devices feature digital triggering capability, as well as two 12-bit analog outputs; two 24-bit, 20 MHz counter/timers; and 8 digital I/O channels. All E Series devices include NI-DAQ driver software.

**For a detailed hardware overview, see the E Series Multifunction DAQ Overview on page 230.**

## INFO CODES

For more information or to order products online, visit [ni.com/info](http://ni.com/info) and enter:

- pcimio16e1
- pxi6070e
- atmio16e1
- daqpad6070e
- pci6071e
- pxi6071e

**BUY ONLINE!**

Family	Bus	Analog Inputs	Resolution	Sampling Rate	Input Range	Analog Outputs	Resolution	Output Rate	Output Range	Digital I/O	Counter/ Timers	Triggers
NI 6011E	PCI, ISA, Parallel	16 SE/8 DI	16 bits	20 kS/s	±0.1 to ±10 V	2	12 bits	20 kS/s	±10 V	8	2, 24-bit	Digital
NI 6012E	PCMCIA	16 SE/8 DI	16 bits	20 kS/s	±0.1 to ±10 V	–	–	–	–	8	2, 24-bit	Digital

Table 1. NI 601xE Channel, Speed, and Resolution Specifications (See page 271 for detailed specifications.)

# E Series Multifunction DAQ – 20 kS/s, 16-Bit, 16 Analog Inputs

	Nominal Range (V)	Absolute Accuracy							Relative Accuracy		
		% of Reading			Offset (µV)	Noise + Quantization (µV)		Temp Drift (%/°C)	Absolute Accuracy at Full Scale (mV)	Resolution (µV)	
		24 Hrs	90 Days	1 Year		Single Pt.	Averaged			Single Pt.	Averaged
PCI, AT, and DAQPad	±10.0	0.0058	0.0078	0.0100	397.2	526.4	45.8	0.0002	1.443	602.7	60.3
	±5.0	0.0208	0.0228	0.0250	200.6	263.2	22.9	0.0007	1.474	301.4	30.1
	±1.0	0.0208	0.0228	0.0250	43.3	52.6	4.6	0.0007	0.298	60.3	6.0
	±0.1	0.0408	0.0428	0.0450	7.9	8.4	0.7	0.0012	0.054	9.6	1.0
	0 to 10	0.0058	0.0078	0.0100	244.6	263.2	22.9	0.0002	1.268	301.4	30.1
	0 to 5	0.0208	0.0228	0.0250	124.3	131.6	11.4	0.0007	1.386	150.7	15.1
	0 to 1	0.0208	0.0228	0.0250	28.1	26.3	2.3	0.0007	0.280	30.1	3.0
	0 to 0.1	0.0408	0.0428	0.0450	6.4	7.0	0.6	0.0012	0.052	8.4	0.8
DAQCard	±10.0	0.0075	0.0095	0.0117	815.4	1029.1	91.6	0.0005	2.077	1205.4	120.5
	±5.0	0.0225	0.0245	0.0267	409.7	514.6	45.8	0.0010	1.791	602.7	60.3
	±1.0	0.0225	0.0245	0.0267	85.1	102.9	9.2	0.0010	0.361	120.5	12.1
	±0.1	0.0425	0.0445	0.0467	12.1	12.2	1.1	0.0015	0.060	14.5	1.4
	0 to 10	0.0075	0.0095	0.0117	591.2	514.6	45.8	0.0005	1.807	602.7	60.3
	0 to 5	0.0225	0.0245	0.0267	297.6	257.3	22.9	0.0010	1.656	301.4	30.1
	0 to 1	0.0225	0.0245	0.0267	62.7	51.5	4.6	0.0010	0.334	60.3	6.0
	0 to 0.1	0.0425	0.0445	0.0467	9.9	8.0	0.7	0.0015	0.057	9.6	1.0

Note: Accuracies are valid for measurements following an internal E Series Calibration. Averaged numbers assume dithering and 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 pt averaging of data. See overview on page 234 for example calculations.

Table 2. NI 601xE Analog Input Accuracy Specifications

Nominal Range (V)	Absolute Accuracy						Absolute Accuracy at Full Scale (mV)
	% of Reading		Offset (mV)	Temp Drift (%/°C)	Absolute Accuracy		
	Positive FS	Negative FS			24 Hrs	90 Days	
10	-10	0.014	0.016	0.018	5.408	0.0002	7.208
10	0	0.014	0.016	0.018	2.966	0.0002	4.766

Note: Temp Drift applies only if ambient is greater than ±10 °C of previous external calibration. See page 234 for example calculations.

Table 3. NI 601xE Analog Output Accuracy Specifications

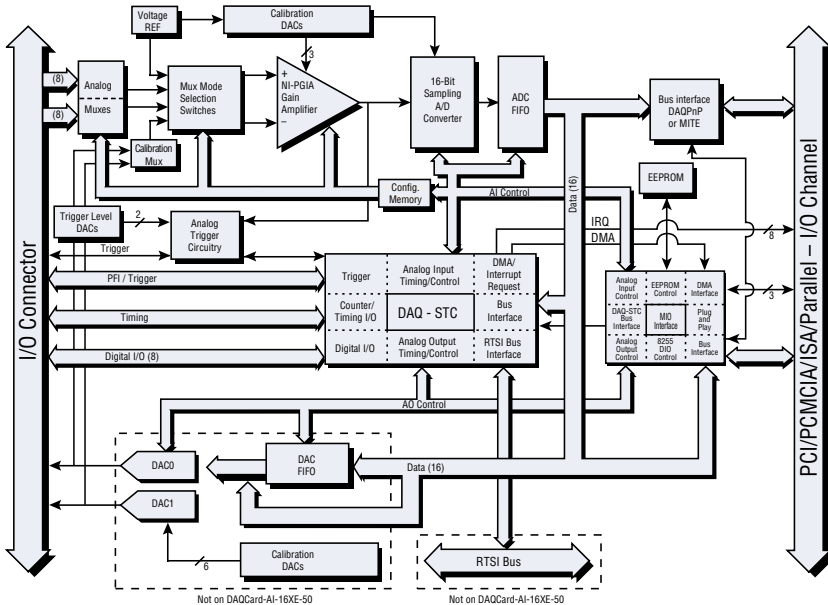


Figure 1. NI 601xE Hardware Block Diagram

See page 233 in the E Series Multifunction DAQ Overview for I/O connector diagrams.

See page 271 for more detailed specifications.

# E Series Multifunction DAQ Accessories

## Selection Guide

**Step 1.** Select your E Series device.

**Step 2.** Using Tables 1 and 2 as a guide, determine which accessories are appropriate for that device. Select an accessory. Table 3 provides descriptions for E Series device accessories.

**Step 3.** Using Tables 1 and 2, determine which cable is required to connect your selected device and accessory.

Device	Accessory			
	TBX-68, CB-68LP, CB-68LPR, DAQ Signal Accessory, CA-1000, BNC-2110, BNC-2120, BNC-2090, SCB-68	TB-2705	SCXI, Signal Conditioning	SCC Modular
	Cables			
68-pin E Series (except DAQCard)	SH68-68-EP (shielded) R6868 (unshielded)	Connects directly to the device (PXI only)	See page 385 for SCXI Signal Conditioning details	See page 461 for SCC Modular Signal Conditioning details
Latching DAQCards NI 6024E, NI 6062E	SHC68-68-EP (shielded) RC68-68 (unshielded)	N/A	See page 385 for SCXI Signal Conditioning details	See page 461 for SCC Modular Signal Conditioning details
Nonlatching DAQCards AI-16E-4, AI-16XE-50	PSHR68-68 (shielded) PR68-68F (unshielded)	N/A	See page 385 for SCXI Signal Conditioning details	See page 461 for SCC Modular Signal Conditioning details

Table 1. Accessories and Cables for 68-Pin and DAQCard E Series Devices

Device	Accessory					
	TBX-68, CB-68LP, CB-68LPR, DAQ Signal Accessory, CA-1000, BNC-2110, BNC-2120, BNC-2090, SCB-68	BNC-2115	TBX-68, CB-68LP CB-68LPR, CA-1000, SCB-68	SCB-100	SCXI Signal Conditioning	SCC Modular Signal Conditioning
	Cables					
100-pin E Series with 64 AI channels NI 6071E, NI 6031E, NI 6033E AT-MIO-64E-3	SH1006868 (shielded); splits into two 68-pin connectors; these accessories are used with the first 68-pin connector. See Figure 16 on page 260.	SH1006868 (shielded); splits into two 68-pin connectors; these accessories are used with the second 68-pin connector.	SH1006868 (shielded); splits into two 68-pin connectors; these accessories are used with the second 68-pin connector.	SH100100 (shielded)	See page 385 for SCXI Signal Conditioning details	See page 461 for SCC Modular Signal Conditioning details
100-pin E Series with 16 AI channels and 32 DIO lines PCI-6025E, AT-6021E	SH1006868 (shielded); splits into two 68-pin connectors; these accessories are used with the first 68-pin connector. See Figure 16 on page 260.	SH1006868 (shielded); splits into two 68-pin connectors; these accessories are used with the second 68-pin connector.	SH1006868 (shielded); splits into two 68-pin connectors; these accessories are used with the second 68-pin connector.	SH100100 (shielded)	See page 385 for SCXI Signal Conditioning details	See page 461 for SCC Modular Signal Conditioning details

Table 2. Accessories and Cables for 100-Pin and DAQCard E Series Devices

Accessory	Description	Page
SCXI Signal Conditioning	High channel-count signal conditioning platform	385
SCC Modular Signal Conditioning	Single or dual channel signal conditioning modules	461
AMUX-64T, 5B, SSR, ER, and SC-204x Signal Conditioning	External signal conditioning accessories	478
BNC-2110	BNC accessory for 68-pin E Series devices	257
BNC-2115	BNC accessory for extended I/O on 100-pin E Series devices	257
BNC-2120	BNC accessory with function generator (for 68-pin E Series devices)	257
BNC-2090	Rack-mountable BNC accessory (for 68-pin E Series devices)	257
CA-1000 enclosure	Configurable connectivity enclosure	257
TB-2705	Latching screw terminal block for PXI E Series modules	258
SCB-100	100-pin, shielded screw terminal block with breadboard areas	258
SCB-68	68-pin, shielded screw terminal block with breadboard areas	258
TBX-68	68-pin, DIN rail-mountable screw terminal block	258
CB-68LP, CB-68LPR	68-pin, low-cost screw terminal block	258
Signal Source and Demo Accessory	DAQ signal accessory to demo and test analog, digital and counter/timer functions	259

For complete and up-to-date information about accessories, visit [ni.com/catalog](http://ni.com/catalog)

Table 3. Overview of E Series DAQ Accessories

# E Series Multifunction DAQ Accessories

## SCXI High-Performance Signal Conditioning (see Figure 1)

SCXI is a modular high-performance signal conditioning platform that you use as a front end to your E Series DAQ device. With the SCXI multiplexing architecture, you can expand your analog inputs to 3,072 channels. Additionally, SCXI offers a variety of modules for connecting to thermocouples, RTDs, strain gauge transducers, LVDT position sensors, ICP-compatible accelerometers/microphones, thermistors, millivolt inputs, voltage inputs up to 1000 V, current inputs (0-20mA), frequency inputs or dynamic signals.

See page 385 for details on SCXI Signal Conditioning.

## SCC Series – Modular Signal Conditioning for Low-Channel Count Applications (see Figure 2)

The SCC Series modular signal conditioning system consists of SCC modules that plug into a low-profile SC-2345 shielded carrier. SCC modules give you single or dual-channel signal conditioning for up to 16 analog input channels and eight digital I/O lines of your plug-in E Series DAQ device. The SCC Series offers signal conditioning for a variety of inputs, including thermocouples, RTDs, strain gauges, ICP-compatible accelerometers, accelerators, analog inputs requiring isolation, high voltage (up to 100 V), current (0-20mA), and optically isolated digital I/O. Lowpass filtering and bread boarding modules are also available.

See page 461 for details on SCC Signal Conditioning.

## Connector Blocks

### BNC-2100 Series Connector Blocks (see Figure 3)

Shielded connector blocks with signal-labeled BNC connectors for easy connectivity of your analog input, analog output, digital I/O and counter/timer signals to your E Series device. The BNC-2110 and BNC-2120 work with all E Series devices. The BNC-2120 also provides a function generator, quadrature encoder, temperature reference, thermocouple connector and LED so that you can test the functionality of your hardware. The BNC-2115 has 24 BNC inputs for connecting to the extended I/O channels of our 100-pin E Series DAQ devices.

BNC-2110.....	777643-01
Dimensions – 20.3 by 11.2 by 5.5 cm (8.0 by 4.4 by 2.2 in.)	
BNC-2115.....	777807-01
Dimensions – 20.3 by 11.2 by 5.5 cm (8.0 by 4.4 by 2.2 in.)	
BNC-2120.....	777960-01
Dimensions – 26.7 by 11.2 by 6.0 cm (10.5 by 4.4 by 2.4 in.)	

### BNC-2090 Shielded BNC Adapter Chassis (see Figure 4)

Shielded, rack-mountable adapter with signal-labeled BNC connectors, spring terminal blocks, and component locations for passive signal conditioning. Consists of 22 BNC connectors and 28 spring terminals to simplify connection to your analog, digital, trigger and counter/timer signals. The BNC-2090 has silk-screened component locations that you use to develop simple signal conditioning circuits. For added flexibility, you can connect any E Series DAQ device to the BNC-2090 from the front or rear through dual 68-pin connectors.

BNC-2090 .....	777270-01
Dimensions – 48.3 by 4.4 by 18.8 cm (19.0 by 1.7 by 7.4 in.)	



Figure 1. SCXI High-Performance Signal Conditioning



Figure 2. SCC Portable, Modular Signal Conditioning



Figure 3. BNC-2100 Series Connector Blocks



Figure 4. BNC-2090 Shielded BNC Adapter Chassis



Figure 5. CA-1000 Configurable Signal Conditioning Enclosure



Figure 6. TB-2705 Terminal Block



Figure 7. SCB-68 and SCB-100 Shielded I/O Connector Blocks

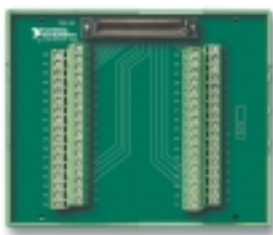


Figure 8. TBX-68 I/O Connector Block



Figure 9. CB-68LP and CB-68LPR I/O Connector Blocks



Figure 10. DAQ Signal Accessory

# E Series Multifunction DAQ Accessories

## CA-1000 Configurable Signal Conditioning Enclosure (see Figure 5)

Configurable enclosure that gives you maximum user-defined connectivity and flexibility through customized panelettes. Each enclosure can accommodate up to 9 panelettes.

Dimensions – 30.7 by 25.4 by 4.3 cm (21.1 by 10 by 1.7 in.)

*See page 263 for more information about the CA-1000.*

## TB-2705 Terminal Block for 68-pin PXI E Series Devices (see Figure 6)

Screw terminal block for PXI that works with your PXI E Series DAQ devices. Latches to the front of your PXI module with locking screws and provides strain relief as well as easy access to your analog, digital, trigger and counter/timer signals through screw terminals.

TB-2705 .....778241-01

Dimensions – 8.43 by 10.41 by 2.03 cm (3.32 by 4.1 by 0.8 in.)

## SCB-68 and SCB-100 Shielded I/O Connector Blocks (see Figure 7)

Shielded I/O connector blocks for rugged, very low-noise signal termination for connecting to 68-pin or 100-pin E Series DAQ devices, respectively. Silk-screened component locations for easy addition of simple signal-conditioning circuitry for your analog input channels. They also include general-purpose breadboard areas (two on the SCB-68; three on the SCB-100) as well as an IC temperature sensor for cold-junction compensation in temperature measurements.

SCB-68 .....776844-01

Dimensions – 19.5 by 15.2 by 4.5 cm (7.7 by 6.0 by 1.8 in.)

SCB-100 .....776990-01

Dimensions – 19.5 by 15.2 by 4.5 cm (7.7 by 6.0 by 1.8 in.)

## TBX-68 I/O Connector Block with DIN-Rail Mounting (see Figure 8)

Termination accessory with 68 screw terminals for easy connection of field I/O signals to 68-pin DAQ devices. Includes one 68-pin male connector for direct connection to 68-pin cables. The TBX-68 is mounted in a protective plastic base with hardware for mounting on a standard DIN rail.

TBX-68 .....777141-01

Dimensions – 12.50 by 10.74 cm (4.92 by 4.23 in.)

## CB-68LP and CB-68LPR I/O Connector Blocks (see Figure 9)

Low-cost termination accessory with 68 screw terminals for easy connection of field I/O signals to 68-pin E Series DAQ devices. Includes one 68-pin male connector for direct connection to 68-pin cables. The connector blocks include standoffs for use on a desktop or for mounting in a custom panel. The CB-68LP has a vertical-mounted 68-pin connector. The CB-68LPR has a right-angle mounted connector, and is used with the CA-1000 (see page 263).

CB-68LP .....777145-01

Dimensions – 14.35 by 10.74 cm (5.65 by 4.23 in.)

CB-68LPR .....777145-02

Dimensions – 7.62 by 16.19 cm (3.00 by 6.36 in.)

# E Series Multifunction DAQ Accessories and Cables

## Signal Source and Demo Accessory (see Figure 10)

The DAQ Signal Accessory demonstrates and tests the use of analog, digital, and counter/timer functions of DAQ devices. You can connect the DAQ Signal Accessory directly to your DAQ device. It features a built-in function generator, quadrature encoder, solid-state relay, IC temperature sensor, noise generator, microphone jack, thermocouple jack, four LEDs, and a digital trigger button. The DAQ Signal Accessory works with all E Series DAQ devices.

DAQ Signal Accessory.....777382-01  
 Dimensions – 12.7 by 12.7 cm (5.0 by 5.0 in.)

## RTSI Bus Cables (see Figures 11 and 12)

Use RTSI bus cables to connect timing and synchronization signals among Measurement, Vision, Motion, and Controller Area Network (CAN) boards for PCI and ISA and DAQPad 6070E boards. For systems using long and short boards order the extended RTSI cable.

2 boards .....776249-02  
 3 boards .....776249-03  
 4 boards .....776249-04  
 5 boards .....776249-05  
 Extended, 5 boards .....777562-05  
 3 external boards .....186464-01

## Shielded I/O Cables

### SH68-68-EP Shielded Cable (see Figure 13)

Shielded 68-conductor cable terminated with two 68-pin female 0.050 series D-type connectors. Features individually-shielded analog twisted pairs for reduced crosstalk with high-speed devices. This cable works with all 68-pin E Series devices (except latching DAQCards). If you need a right-angle connector, the SH68-68R1-EP shielded cable is fully compatible.

1 m.....184749-01  
 2 m.....184749-02

### SH68-68R1-EP Shielded Cable (see Figure 14)

Shielded 68-conductor cable; one end terminates with a 68-pin female 0.050 series D-type connector and the other end terminates with a right-angle 68-pin female 0.050 series D-type connector.

1 m.....187051-01

### SH100100 Shielded Cable (see Figure 15)

Shielded 100-conductor cable terminated with 100-pin male 0.050 series D-type connectors. This cable connects the 100-pin E Series devices to 100-pin accessories.

1 m.....182853-01  
 2 m.....182853-02

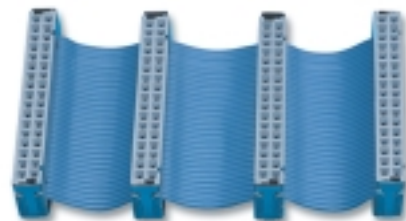


Figure 11. RTSI Bus Cable



Figure 12. Extended RTSI Bus Cable



Figure 13. SH68-68-EP Shielded Cable



Figure 14. SH68-68R1-EP Shielded Cable



Figure 15. SH100100 Shielded Cable

# E Series Multifunction DAQ Accessories and Cables



Figure 16. SH1006868 Shielded Cable



Figure 17. SHC68-68-EP Shielded Cable



Figure 18. PSHR68-68 Shielded Cable Kit



Figure 19. PSHR68-68M Shielded Cable



Figure 20. R6868 Ribbon Cable

## SH1006868 Shielded Cable (see Figure 16)

Shielded cable that connects to 100-pin E Series devices and terminates with two female 68-pin 0.050 series D-type connectors. See Table 2 on page 256 for accessories compatible with each 68-pin connector.

1 m .....	182849-01
2 m .....	182849-02

## SHC68-68-EP and SHC68U-68-EP Shielded Cables for Latching E Series DAQCards (see Figure 17)

These cables connect a latching E Series DAQCard (NI 6062E and NI 6024E) to standard 68-pin accessories. Latching screws secure the shielded connector to the PCMCIA DAQCard. The SHC68-68-EP is a shielded 68-conductor cable terminated with a VHDCl 68-pin male connector at one end and a 68-pin female 0.050 series D-type connector at the other. The SHC68U-68-EP is identical to the SHC68-68-EP except it uses an inverted VHDCl 68-pin male connector. Use the SH68U-68-EP for a DAQCard located in the bottom PCMCIA slot in your laptop. Use the SHC68-68-EP cable with a DAQCard inserted in the upper PCMCIA slot in your laptop. When using two E Series DAQCard PCMCIA devices in adjacent slots, you must use one SHC68-68-EP and one SHC68U-68-EP.

### SHC68-68-EP

0.5 m .....	186838-0R5
1 m .....	186838-01

### SHC68U-68-EP

0.5 m .....	187406-0R5
1 m .....	187406-01

## PSHR68-68 Shielded Cable Kit for Nonlatching DAQCards (see Figure 18)

Shielded cable for use in connecting non-latching E Series DAQCards (AI-16E-4 and AI-16XE-50) with 68-pin accessories. The kit contains the PSHR68-68M, the PCMCIA Strain-Relief Adapter and a 1 m SH68-68-EP cable.

1 m .....	777293-01
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## PSHR68-68M Shielded Cable for Nonlatching DAQCards (see Figure 19)

Shielded cable for use in connecting non-latching E Series DAQCards (AI-16E-4 and AI-16XE-50) with custom cables and other 68-pin cable assemblies.

0.1 m .....	183569-01
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# E Series Multifunction DAQ Accessories and Cables

## Ribbon I/O Cables

### RC688 Ribbon Cable for E Series Devices (see Figure 20)

68-conductor flat ribbon cable terminated with two 68-pin connectors. Use this cable to connect a 68-pin E Series device to 68-pin accessories.

1 m .....182482-01

### RC68-68 Ribbon Cable for Latching DAQCards (see Figure 21)

Ribbon cable that connects to a latching E Series DAQCard (NI 6062E, NI 6024E) and is terminated with a 68-pin female connector that attaches directly to 68-pin accessories. Two RC68-68 cables can be used together in adjacent PCMCIA slots.

0.25 m .....187252-0R25

1 m .....187252-01

### PR68-68F for Non-Latching DAQCards (see Figure 22)

Ribbon cable that connects to a non-latching E Series DAQCard (AI-16E-4, AI-16XE-50) and is terminated with a 68-pin female connector that attaches directly to 68-pin accessories.

0.2 m .....183646-0R2

1 m .....183646-01

## Custom Connectivity Components

### 68-Pin Custom Cable Connector/Backshell Kit (see Figure 23)

68-pin female mating connector and backshell kit for use in making custom cables. Solder-cup contacts are available for soldering of cable wires to the connector.

68-pin connector/backshell kit .....776832-01

### PCB Mounting Connectors for Custom Accessories (see Figure 24)

PCB connectors for use in building custom accessories that connect to 68-conductor or 100-conductor shielded and ribbon cables. Two connectors are available, one for right-angle and one for vertical mounting onto a PCB.

68-position, male, right-angle mounting .....777600-01

68-position, male, vertical mounting .....777601-01

100-position, female, right-angle mounting .....777778-01

100-position, female, vertical mounting.....777779-01

### PCMCIA Strain-Relief Accessory (see Figure 25)

Accessory that attaches to the bottom of your notebook computer and provides adjustable strain relief for one or two PCMCIA cables attached to the installed PCMCIA card(s). Used with non-latching E Series DAQCards (AI-16E-4, AI-16XE-50).

PCMCIA Strain-Relief Accessory .....777550-01

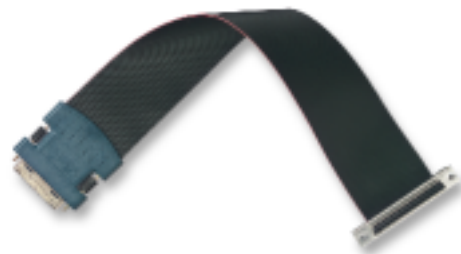


Figure 21. RC68-68 Ribbon Cable



Figure 22. PR68-68F Ribbon Cable

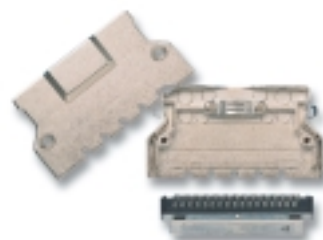


Figure 23. 68-Pin Custom Cable Connector/Backshell Kit

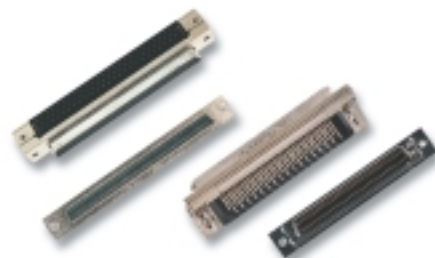


Figure 24. PCB Mounting Connectors for Custom Accessories



Figure 25. PCMCIA Strain-Relief Accessory

# E Series Multifunction DAQ Accessories and Cables



Figure 26. USB Cable



Figure 27. IEEE 1394 Cable

## USB Cable (see Figure 26)

Cable that connects DAQPad devices for the Universal Serial Bus (USB) to a USB port. The USB cables have a USB B-type connector and a USB A-type connector.

1 m .....	184125-01
2 m .....	184125-02

## IEEE 1394 Cable (see Figure 27)

Cable that connects DAQPad devices for IEEE 1394 (FireWire) to an IEEE 1394 port.

1 m (latching) .....	185798-01
2 m (latching) .....	185798-02

## Use Interactive Online Catalog Configurator for Quick Product Selection

You can now easily configure NI multifunction data acquisition (DAQ) measurement systems using a new, interactive feature of our online catalog. The interactive online catalog offers a better, easier way to select and purchase measurement solutions from National Instruments. Based on user input, the interactive online catalog suggests products and then suggests the appropriate cables and accessories for those products. This new automated tool helps eliminate ordering mistakes and product-compatibility errors.

To take advantage of the online catalog for multifunction DAQ devices, visit [ni.com/catalog](http://ni.com/catalog)

From the Products and Services menu, select Data Acquisition, then select Multifunction I/O. The online catalog prompts you with a series of questions regarding preferences for operating system, computer bus, number of channels, and maximum sampling rate. The online catalog then recommends several appropriate DAQ devices. You can review specifications on each device and select your preferred product. Next, the catalog suggests the preferred accessory and cable solution designed to work with the selected DAQ device. You have the option of choosing the preferred configuration or choosing from a separate list of accessories and cables that also work with the selected DAQ device. You can purchase the selected items online.



Figure 28. Use the interactive configuration tool in the NI online catalog to select and purchase multifunction DAQ solutions.

# Configurable Signal Conditioning Enclosure

## CA-1000

- Versatile connector/enclosure system
- Houses signal conditioning and connector block accessories
- Wide variety of I/O connectivity and panelette options
- Holds maximum of 18 connectivity/interface panelettes
- Low profile enclosure
- Rack-mount and stacking kits available

### I/O Connectivity

- BNC
- Thermocouple
- Banana jack
- LEMO® connector (B-Series)
- MIL-Spec
- SMB
- Dual 9-pin D-Sub
- Strain relief

### Interface Panelettes

- Momentary pushbutton switch
- Potentiometer
- Toggle switch
- Rocker switch
- LED



## Overview

The National Instruments CA-1000 is a configurable signal conditioning enclosure designed for maximum user-defined I/O connectivity and flexibility. The CA-1000 is a portable enclosure for laptop, desktop, and rack-mount applications. In the CA-1000, you can install many NI signal conditioning accessories, such as the SC-204x signal conditioning products, and the SCB-68, CB-68LPR, and CB-50LP terminal blocks. The result is a compact, portable, flexible, and comprehensive signal conditioning/interconnection system. The CA-1000 also facilitates quick connection and disconnection with standard I/O connectors for easy system integration and reconfiguration. By adding interface panelettes, such as toggle switches, potentiometers, and LEDs, you can locally control and verify system operation.

## Description

The CA-1000 system includes four components: 1) CA-1000 enclosure, 2) I/O and interface panelettes, 3) signal conditioning or measurement accessories installed in the CA-1000, and 4) for 50-pin accessories, an internal cable adapter to connect the signal conditioning accessory to the cable attached to the CA-1000.

### CA-1000 Enclosure

The metal enclosure provides a low-profile, portable housing for signal conditioning and connector accessories. You can place the enclosure under a laptop PC, on a benchtop, or in a 19 in. rack. You can also stack two or more enclosures with the stacking kit. The CA-1000 enclosure includes five cable entry locations, so you can place the 68-pin or 50-pin connector that you cable to your measurement device on either the side or the rear of the CA-1000

enclosure. Please note, the CA-1000 is shipped without any panelettes, signal conditioning accessories, connector blocks, or cables. Order all of these components separately.

### Internal Accessories

The CA-1000 houses a variety of signal conditioning and data acquisition accessories, including the SC-204x, SCB-68, CB-68LPR, and CB-50LP (Table 1 on page 264). You mount these accessories to the bottom panel of the CA-1000 enclosure.

### I/O Panelettes

The CA-1000 includes a user-configurable signal connection scheme. This connectivity flexibility is achieved with interchangeable panelettes. The panelettes, which come with standard signal connectors – for example, BNC, SMB, banana jack, thermocouple plugs, and LEMO, MIL-Spec, and 9-pin D-Sub connectors – mount in the front of the CA-1000 enclosure. The CA-1000 front panel offers nine panelette slots. The rear panel can also be removed offering nine more panelette slots. However, this option is not available if you are using the SCB-68 inside the CA-1000. You can mix and match different types of panelettes. Each panelette (except for the strain-relief panel) includes lead wires that you connect to the screw terminals of the accessory mounted inside the CA-1000. You can therefore connect the panelettes to any I/O signal available on the accessory.

### INFO CODES

For more information or to order products online, visit [ni.com/info](http://ni.com/info) and enter:

ca1000

**BUY ONLINE!**

# Configurable Signal Conditioning Enclosure

## Interface Panelettes

National Instruments also offers interface panelettes, which expand the functionality of the CA-1000. Interface panelettes include traditional interface controls and displays, such as rocker switches, toggle switches, momentary switches, potentiometers, and LEDs. Using interface panelettes, which are mounted alongside I/O panelettes, you can change hardware inputs, trigger events, or verify operational status. Each interface panelette includes lead wires for connection to the screw terminals of the accessory mounted inside the CA-1000.

## Cabling

The cabling needed to connect the CA-1000 to the measurement device depends on the accessories installed in the CA-1000 and the

measurement device used. Some accessories installed in the CA-1000 require internal cabling to connect the accessory to the CA-1000 wall. Use Table 1 to determine what cabling components you need, including the cable to your measurement device.

The CA-1000 also provides the flexibility of five external interconnection locations, giving convenient cabling for laptop applications by aligning the I/O connector with the location of the PCMCIA slots on laptop computers. With the five external interconnection locations, you can also customize desktop and rack-mount applications for added convenience.

Device	Connector Blocks		
	SC-204x Series	CB-50LP	CB-68LPR or SCB-68
68-pin E Series DAQ Devices (except DAQCards)	R68M-50F and SH68-68-EP <sup>1</sup>	N/A	SH68-68-EP <sup>1</sup>
100-pin E Series DAQ Devices <sup>3</sup>	Applicable for one leg	N/A	SH1006868
Latching E Series DAQCards:	R68M-50F and SHC68-68-EP	N/A	SHC68-68-EP
DAQCard-6062E, DAQCard-6024E	–	–	–
Nonlatching E Series DAQCards:	R68M-50F and PSHR68-68 Shielded Cable Kit <sup>2</sup>	N/A	PSHR68-68 Shielded Cable Kit <sup>2</sup>
DAQCard-AI-16E-4, DAQCard-AI-16XE-50	–	–	–
68-pin Digital I/O and Counter/Timer Devices (except DAQCards)	N/A	N/A	SH68-68-D1
PCI-DIO-32HS, PXI-6533, AT-DIO-32HS,	–	–	–
NI 6534, NI 660x	–	–	–
Nonlatching 68-pin Digital I/O DAQCards:	N/A	N/A	PSHR68-68-D1 Shielded Cable Kit
DAQCard-6533	–	–	–
Simultaneous Sampling Multifunction DAQ Devices	N/A	N/A	SH68-68-EP <sup>1</sup>
PCI-6503	N/A	R50M-50F and SH50-50	N/A
PC-DIO-24	–	–	–
DAQCard-DIO-24	N/A	R50M-50F and PSH27-50F-D1	N/A
NI 6527 <sup>3</sup> , PCI-DIO-96 <sup>3</sup> , PXI-6508 <sup>3</sup> , DAQPad-6508 <sup>3</sup>	N/A	Two R50M-50F and R1005050 <sup>4</sup>	N/A
PC-DIO-96 <sup>3</sup>	N/A	Two R50M-50F and NB5 <sup>4</sup>	N/A

<sup>1</sup>You can also use the SH68-68R1-EP or R6868. <sup>2</sup>You can also use the PR68-68F. <sup>3</sup>You can use two CA-1000 enclosures with one of these devices. Please note: If you are using a NI 435x series data logger, please see Figure 1 on page 298 for information on cabling to a CB-68T and CA-1000. <sup>4</sup>Splits into two 50-pin connectors. See page 319 for information on using the CA-1000 with signal source products.

Table 1. CA-1000 Cabling



Table 2. CA-1000 Panelette Options

# Configurable Signal Conditioning Enclosure

Panelette	Description	Connectors/Units per Panelette	Slot Width
Minithermocouple Jack	J-type	2	1
	K-type	2	1
	Uncompensated	2	1
Thermocouple Jack	J-type	1	1
	K-type	1	1
	Uncompensated	1	1
BNC	BNC connector	2	1
SMB	SMB connector	4	1
Banana Jack	Banana Jack	2	1
LEMO	2-pin female	2	1
	4, 6-pin female	1	1
MIL-Spec	2, 4, 6-pin female	1	1
9-pin D-sub	Single (male)	1	2
	Single (female)	1	2
	Dual (male)	2	3
	Dual (female)	2	3
Momentary Pushbutton Switch	On – off	2	1
Toggle Switch	(On – off – on)	2	1
Rocker Switch	(On – off – on)	1	1
LED	A red, green, yellow, and orange LED	4	1
Potentiometer	1 turn, 10 kW	1	1
Strain Relief	Screw clamp	1	2
Blank	Filler panel	–	1

Table 3. CA-1000 Panelette descriptions

## Ordering Information

CA-1000 (enclosure only) .....777664-01  
 Dimensions – 30.7 by 25.4 by 4.3 cm (21.1 by 10.3 by 1.7 in.)

## I/O Connector Panelettes

Minithermocouple, J-type (2 included) .....184736-01  
 Minithermocouple, K-type (2 included) .....184736-02  
 Minithermocouple, uncompensated (2 included) .....184736-03  
 Thermocouple, J-type .....187597-01  
 Thermocouple, K-type .....187597-02  
 Thermocouple, uncompensated .....187597-03  
 BNC (2 included) .....184737-01  
 Banana jack (2 included) .....186405-01  
 LEMO connector (B-Series)  
     Dual 2-pin, female .....187585-01  
     4-pin, female .....187585-02  
     6-pin, female .....187585-03  
 MIL-C-26482 (Series 1)  
     MS3112E8-2 S.....187591-01  
     MS3112E8-4 S.....187591-02  
     MS3112E10-6 S.....187591-03  
 SMB (4 included) .....185505-01

## Ordering Information (continued)

Strain relief.....184721-01  
 9-Pin D-Sub  
     Single male.....184738-01  
     Dual male.....184738-02  
     Single female.....184738-03  
     Dual female.....184738-04  
 Blank .....184483-01

## Interface Panelettes

Momentary pushbutton switch (2 included) .....185380-01  
 Rocker switch (on/off/on).....185379-01  
 Toggle switch (on/off/on – 2 included) .....185378-01  
 Potentiometer (10 kΩ, single turn) .....185377-01  
 LED 4 – (Includes: 1 green,  
     1 red, 1 orange, 1 yellow) .....185376-01

## External Cables

SH68-68-EP, 1 m .....182419-01  
 SH68-68-D1, 1 m.....183432-01  
 SH68-68R1-EP, 1 m .....187051-01  
 SH50-50, 1 m .....777720-01  
 R6868, 1 m .....182482-01  
 R1005050, 1 m .....182762-01  
 NB5, 1 m .....181304-10  
 SH1006868, 1 m .....182849-01  
 PSHR68-68 Shielded Cable Kit .....777293-01  
 PSHR68-68-D1 Shielded Cable Kit .....777420-01  
 PR68-68F, 1 m .....183646-01  
 PSH27-50F-D1, 1 m.....776989-01  
 SHC68-68-EP, 1 m .....186838-01

## Internal Cables

R50M-50F ribbon cable.....184526-0R3  
 R68M-50F MIO bulkhead ribbon cable.....777660-0R3

## Accessories

CA-1000 Rack-Mount Kit (1U) .....777665-01  
 CA-1000 Stacking Kit.....777666-01  
 CA-1000 Panel Mount Kit .....187243-01  
 Strain Relief Kit<sup>1</sup>.....187407-01  
<sup>1</sup>You cannot use the Strain Relief Kit in conjunction with the rack-mount, panel-mount, or stacking kits.

For information on extended warranty and value added services, see page 22.

# E Series Multifunction DAQ Overview

## Self-Calibration Using an Internal Reference

The E Series analog inputs and outputs have calibration circuitry to correct gain and offset errors. You can calibrate the device in software to avoid analog I/O errors caused by time and temperature drift at run time. No external circuitry is necessary; an internal reference ensures high accuracy and stability over time and temperature. Factory-calibration constants are permanently stored in an onboard EEPROM and cannot be modified. A modifiable section of the EEPROM stores user-modifiable constants. You can return the devices to their initial factory calibration by accessing the unmodified factory constants. Included with all E Series devices is an NIST-traceable and ISO-9002 certified calibration certificate. Visit [ni.com/calibration](http://ni.com/calibration) for more information.

## I/O Interface – MITE and DAQ-PnP

All of the PCI and PXI E Series use the MITE ASIC as a bus master interface to the PCI bus. The E Series products for ISA use an ASIC that fully implements the Plug and Play ISA Specification, so that the DMA level, interrupt channels, and base I/O address are all software configurable. All other E Series devices are inherently Plug and Play compatible. Visit [ni.com/info](http://ni.com/info) and enter *exniev* to download a technical paper on bus mastering.

## RTSI Bus Interface

All E Series devices except DAQCards, USB DAQ Pads, and PXI modules are interfaced to the National Instruments RTSI bus with an embedded cross-matrix switch in the DAQ-STC. This switch synchronizes several DAQ devices by sending timing signals to them on the RTSI bus. Using RTSI bus, a single master device can control one or more slave devices for both single and multiple A/D conversions. The PXI Trigger bus serves the same purpose for PXI systems as RTSI bus.

## E Series Multifunction DAQ Software NI-DAQ

NI-DAQ, our driver software bundled with every E Series multifunction DAQ device, provides access to the features of your DAQ hardware, so that you can easily develop powerful measurement solutions.

You can use NI-DAQ to perform single-point and buffered analog I/O, digital I/O, and counter/timer input operations. You can perform those operations individually, or program your device to perform multiple operations simultaneously. To facilitate integration of signal conditioning in your system, NI-DAQ provides you with a single interface for programming both the E Series device and signal conditioning modules. Using NI-DAQ, you can also synchronize your E Series multifunction DAQ device with other measurement devices, to build measurement systems customized to your particular needs.

## Measurement & Automation Explorer

NI Measurement & Automation Explorer (MAX) software, which is

bundled with every E Series multifunction DAQ device, guides you through hardware configuration, channel scaling, and sensor set-up. You can also test the basic operation of your E Series device and signal connections using a test panel.

## What About Signal Conditioning?

Signal conditioning is one of the most important, and most overlooked, components of a data acquisition system. Many sensors require special signal conditioning technology, and no DAQ device has the capability to provide all types of signal conditioning to all sensors. Using NI signal conditioning products, you can measure a wide variety of signals and sensors. These modular conditioning devices come in a range of sizes, from rack-mountable SCXI systems to portable SCC systems.

**See page 383 for more information on Signal Conditioning.**

ACH8	34	68	ACH0
ACH1	33	67	AIGND
AIGND	32	66	ACH9
ACH10	31	65	ACH2
ACH3	30	64	AIGND
AIGND	29	63	ACH11
ACH4	28	62	AISENSE
AIGND	27	61	ACH12
ACH13	26	60	ACH5
ACH6	25	59	AIGND
AIGND	24	58	ACH14
ACH15	23	57	ACH7
DAC0OUT <sup>†</sup>	22	56	AIGND
DAC1OUT <sup>†</sup>	21	55	ADGND <sup>1</sup>
EXTREF <sup>†</sup>	20	54	ADGND <sup>1</sup>
DIO4	19	53	DGND
DIO1	18	52	DIO0
DIO5	17	51	DIO5
DIO6	16	50	DGND
DGND	15	49	DIO2
+5 V	14	48	DIO7
DGND	13	47	DIO3
DGND	12	46	SCANCLK
PF10/TRIG1	11	45	EXTSTROBE*
PF11/TRIG2	10	44	DGND
DGND	9	43	PF12/CONVERT*
+5 V	8	42	PF13/GPCTRI_SOURCE
DGND	7	41	PF14/GPCTRI_GATE
PF15/UPDATE*	6	40	GPCTRI_OUT
PF16/WFTRIG	5	39	DGND
DGND	4	38	PF17/STARTSCAN
PF13/GPCTRI_GATE	3	37	PF18/GPCTRI_SOURCE
GPCTRI_OUT	2	36	DGND
FREQ_OUT	1	35	DGND

<sup>†</sup> Not available on AT-AI-16XE-10, PCI-6032E, DAQCard-AI-16E-4, DAQCard-AI-16XE-50

Figure 3. 68-Pin I/O Connector for NI 6070E, NI 6060E, NI 6062E, NI 6052E, NI 6041E, NI 6040E, NI 6036E, NI 6035E, NI 6034E, NI 6032E, NI 6030E, NI 6024E, NI 6023E, NI 6020E, NI 6012E and NI 6011E Devices

AIGND	1	51	ACH16
AIGND	2	52	ACH24
ACH0	3	53	ACH17
ACH8	4	54	ACH25
ACH1	5	55	ACH18
ACH9	6	56	ACH26
ACH2	7	57	ACH19
ACH10	8	58	ACH27
ACH3	9	59	ACH20
ACH11	10	60	ACH28
ACH4	11	61	ACH21
ACH12	12	62	ACH29
ACH5	13	63	ACH22
ACH13	14	64	ACH30
ACH6	15	65	ACH23
ACH14	16	66	ACH31
ACH7	17	67	ACH32
ACH15	18	68	ACH40
AISENSE	19	69	ACH33
DAC0OUT <sup>†</sup>	20	70	ACH41
DAC1OUT <sup>†</sup>	21	71	ACH34
EXTREF <sup>†</sup>	22	72	ACH42
ADGND <sup>1</sup>	23	73	ACH35
DGND	24	74	ACH37
DIO0	25	75	ACH38
DIO4	26	76	AIGND
DIO1	27	77	ACH36
DIO5	28	78	ACH44
DIO2	29	79	ACH37
DIO6	30	80	ACH45
DIO3	31	81	ACH38
DIO7	32	82	ACH46
DGND	33	83	ACH39
+5 V	34	84	ACH47
+5 V	35	85	ACH48
SCANCLK	36	86	ACH56
EXTSTROBE*	37	87	ACH49
PF10/TRIG1	38	88	ACH57
PF11/TRIG2	39	89	ACH50
PF12/CONVERT*	40	90	ACH58
PF13/GPCTRI_SOURCE	41	91	ACH51
PF14/GPCTRI_GATE	42	92	ACH59
GPCTRI_OUT	43	93	ACH52
PF15/UPDATE*	44	94	ACH60
PF16/WFTRIG	45	95	ACH53
PF17/STARTSCAN	46	96	ACH61
PF18/GPCTRI_SOURCE	47	97	ACH54
PF19/GPCTRI_GATE	48	98	ACH62
GPCTRI_OUT	49	99	ACH55
FREQ_OUT	50	100	ACH63

<sup>†</sup> Not available on PCI-6033E

Figure 2. 100-Pin I/O Connector for NI 6071E, NI 6061E, NI 6031E, NI 6033E Devices

AIGND	1	51	PC7
AIGND	2	52	GND
ACH0	3	53	PC6
ACH8	4	54	GND
ACH1	5	55	PC5
ACH9	6	56	GND
ACH2	7	57	PC4
ACH10	8	58	GND
ACH3	9	59	PC3
ACH11	10	60	GND
ACH4	11	61	PC2
ACH12	12	62	GND
ACH5	13	63	PC1
ACH13	14	64	GND
ACH6	15	65	PC0
ACH14	16	66	GND
ACH7	17	67	PB7
ACH15	18	68	GND
AISENSE	19	69	PB6
DAC0OUT <sup>†</sup>	20	70	GND
DAC1OUT <sup>†</sup>	21	71	PB5
RESERVED	22	72	GND
ADGND	23	73	PB4
DGND	24	74	GND
DIO4	25	75	PB3
DIO1	26	76	GND
DIO5	27	77	PB2
DIO2	28	78	GND
DIO6	29	79	PB1
DIO3	30	80	PC2
DIO7	31	81	PB0
DGND	32	82	GND
DGND	33	83	PA7
+5 V	34	84	GND
+5 V	35	85	PA6
SCANCLK	36	86	GND
EXTSTROBE*	37	87	PA5
PF10/TRIG1	38	88	GND
PF11/TRIG2	39	89	PA4
PF12/CONVERT*	40	90	GND
PF13/GPCTRI_SOURCE	41	91	PA3
PF14/GPCTRI_GATE	42	92	GND
GPCTRI_OUT	43	93	PA2
PF15/UPDATE*	44	94	GND
PF16/WFTRIG	45	95	PA1
PF17/STARTSCAN	46	96	GND
GPCTRI_SOURCE	47	97	PA0
GPCTRI_GATE	48	98	GND
GPCTRI_OUT	49	99	+5 V
FREQ_OUT	50	100	GND

Figure 4. 100-Pin I/O Connector for NI 6021E and NI 6025E Devices

# E Series Multifunction DAQ Specifications

## Specifications – 16-Bit E Series NI 6052E, NI 603xE, and NI 601xE

These specifications are typical for 25 °C unless otherwise noted.

### Analog Input

Accuracy specifications ..... See tables in E Series product pages

### Input Characteristics

Number of channels

6052E	16 single-ended or 8 differential (software selectable per channel)
6030E	
6032E	
6034E	
6035E	
6036E	
601xE	64 single-ended or 32 differential (software selectable per channel)
6031E	
6033E	

Type of ADC ..... Successive approximation

Resolution ..... 16 bits, 1 in 65,536

Maximum sampling rate

6052E	333 kS/s
6034E	200 kS/s
6035E	
6036E	
6030E	100 kS/s
6031E	
6032E	
6033E	
601xE	20 kS/s; 200 kS/s single-channel sampling with the DAQCard™-AI-16XE-50

Streaming-to-disk rate (system dependent)<sup>1</sup>

6052E	333 kS/s
6034E	200 kS/s
6035E	
6036E	
6030E	100 kS/s
6031E	
6032E	
6033E	
601xE	20 kS/s

<sup>1</sup>Streaming-to-disk rates do not apply to RT Series devices

Input signal ranges

Device	Range Software Selectable	Bipolar Input Range	Unipolar Input Range	
6052E	20 V	±10 V	–	
	10 V	±5 V	0 to 10 V	
	5 V	±2.5 V	0 to 5 V	
	2 V	±1 V	0 to 2 V	
	1 V	±500 mV	0 to 1 V	
	500 mV	±250 mV	0 to 500 mV	
6030E	200 mV	±100 mV	0 to 200 mV	
	100 mV	±50 mV	0 to 100 mV	
	6031E	20 V	±10 V	–
		10 V	±5 V	0 to 10 V
		5 V	–	0 to 5 V
		6032E	4 V	±2 V
2 V			±1 V	0 to 2 V
1 V			±500 mV	0 to 1 V
6033E	500 mV	–	0 to 500 mV	
	400 mV	±200 mV	–	
	200 mV	±100 mV	0 to 200 mV	
	100 mV	–	0 to 100 mV	
	6034E	20 V	±10 V	–
		10 V	±5 V	–
1 V		±500 mV	–	
6035E	100 mV	±50 mV	–	
	6036E	20 V	±10 V	–
		10 V	±5 V	0 to 10 V
5 V		–	0 to 5 V	
601xE	2 V	±1 V	–	
	1 V	–	0 to 1 V	
	200 mV	±100 mV	–	
100 mV	–	0 to 100 mV		

Input coupling ..... DC

Maximum working voltage

(signal + common mode) ..... Each input should remain within  
±11 V of ground

Overvoltage protection

Powered on ..... ±25 V

Powered off ..... ±15 V

Inputs protected

6052E	ACH<0..15>, AISENSE
6030E	
6032E	
6034E	
6035E	
6036E	
601xE	ACH<0..63>, AISENSE, AISENSE2
6031E	
6033E	

FIFO buffer size ..... 512 samples, (1024 samples for  
DAQCard; 2048 for PCI-MIO-16XE-50)

Data transfers

PCI, PXI, AT ..... DMA, interrupts, programmed I/O

DAQCard ..... Interrupts, programmed I/O

DMA modes

PCI, PXI ..... Scatter-gather (single transfer,  
demand transfer)

AT ..... Single transfer, demand transfer

Configuration memory size ..... 512 words

# E Series Multifunction DAQ Specifications

## 16-Bit E Series NI 6052E, NI 603xE, and NI 601xE (continued)

### Transfer Characteristics

Relative accuracy (dithered)

Device	Typical	Maximum
6052E 6034E 6035E 6036E	±1.5 LSB	±3 LSB
6030E 6031E 6032E 6033E	±0.75 LSB	±1 LSB
6011E 6012E	±0.5 LSB ±1.5 LSB	±1 LSB ±2 LSB

DNL

Device	Typical	Maximum
6052E 603xE 6011E	±0.5 LSB	±1 LSB
6012E	+1.5 to -0.75 LSB	+2.25 to -1.0 LSB

No missing codes ..... 16 bits, guaranteed

### Amplifier Characteristics

Input impedance

Device	Normal Powered On	Powered Off	Overload
6052E 603xE	100 GΩ in parallel with 100 pF	820 Ω	820 Ω
601xE	7 GΩ in parallel with 100 pF	820 Ω; 1 kΩ for DAQCard	820 Ω; 1 kΩ for DAQCard

Input bias and offset current

Device	Bias Current	Offset Current
6052E 6034E 6035E 6036E	±200 pA	±100 pA
6030E 6031E 6032E 6033E	±1 nA	±2 nA
6011E 6012E	±10 nA ±10 nA	±20 nA ±14 nA

CMRR, DC to 60 Hz

Device	Range	CMRR		
		Bipolar	Unipolar	
6052E	20 V	92 dB	–	
	10 V	97 dB	97 dB	
	5 V	101 dB	101 dB	
	2 V	104 dB	104 dB	
	100 mV to 1 V	105 dB	105 dB	
6030E	20 V	92 dB	–	
	10 V	97 dB	92 dB	
	5 V	–	97 dB	
	6032E	4 V	101 dB	–
	6033E	2 V	104 dB	101 dB
6034E	10 V	–	–	
	5 V	–	–	
	6035E	1 V	105 dB	104 dB
	6036E	100 mV to 500 mV	105 dB	105 dB
	601xE	20 V	80 dB	–
10 V		86 dB	80 dB	
5 V		–	86 dB	
2 V		100 dB	–	
1 V		–	100 dB	
200 mV		120 dB	–	
100 mV		–	120 dB	
–		–	–	
–		–	–	
–		–	–	

### Dynamic Characteristics

Bandwidth

Device	Range	Small Signal (-3 dB)
6052E	All ranges	480 kHz
6030E 6031E 6032E 6033E	All ranges	255 kHz
6034E 6035E 6036E	All ranges	413 kHz
6011E	5 to 20 V	63 kHz
	1 to 2 V	57 kHz
	100 to 200 mV	33 kHz
6012E	5 to 20 V	69 kHz
	1 to 2 V	66 kHz
	100 to 200 mV	39 kHz

System noise (LSB<sub>rms</sub>, including quantization)

Device	Range	Bipolar	Unipolar	
6052E	2 to 20 V	0.95	0.95	
	1 V	1.1	1.1	
	500 mV	1.3	1.3	
	200 mV	2.3	2.3	
	100 mV	4.2	4.2	
6030E	2 to 20 V	0.6	0.8	
	6031E	1 V	0.7	0.8
	6032E	400 to 500 mV	1.1	1.1
	6033E	200 mV	2.0	2.0
	100 mV	–	3.8	
6034E	10 to 20 V	0.8	–	
6035E	1 V	1.0	–	
6036E	100 mV	5.6	–	
6010E	1 to 20 V	0.5	0.5	
	100 to 200 mV	0.8	1.4	
6011E	1 to 20 V	1.0	1.0	
	100 to 200 mV	1.2	1.6	

Settling time to full-scale step

Device	Range	Accuracy					
		±0.00076% (±0.5 LSB)	±0.0015% (±1 LSB)	±0.0031% (±2 LSB)	±0.0061% (±4 LSB)	±0.024% (±16 LSB)	
6052E	2 to 20 V	20 μs typical	10 μs max	5 μs max	4 μs max	3 μs typical	
	1 V	20 μs typical	15 μs max	5 μs max	4 μs max	3 μs typical	
	200 to 500 mV	20 μs typical	15 μs max	8 μs max	4 μs max	3 μs typical	
6030E	All	40 μs max	20 μs max	–	10 μs max	–	
		6032E	–	–	–	–	
6031E	All	50 μs max	25 μs max	–	10 μs max	–	
		6033E	–	–	–	–	
6034E	1 to 20 V	–	–	5 μs max	–	–	
		6035E	–	–	–	5 μs typical	–
		6036E	–	–	–	–	–
6011E	1 to 20 V	–	50 μs max	–	50 μs max	–	
		200 mV (bipolar), 100 mV (unipolar)	75 μs max	–	50 μs max	–	
		–	75 μs max	–	50 μs max	–	
6012E	1 to 20 V	–	–	50 μs max	50 μs max	–	
		200 mV (bipolar), 100 mV (unipolar)	–	60 μs max	50 μs typical	–	
		–	–	60 μs max	50 μs typical	–	

Crosstalk

Device	Adjacent Channels	All Other Channels
6052E 603xE	-75 dB	-90 dB
601xE	-85 dB	-100 dB

# E Series Multifunction DAQ Specifications

## 16-Bit E Series NI 6052E, NI 603xE, and NI 601xE (continued)

### Analog Output

#### Output Characteristics

Number of channels

6052E	2 voltage outputs
6030E	
6031E	
6035E	
6036E	
6011E	
6032E	None
6033E	
6034E	
6012E	

Resolution

6052E	16 bits, 1 in 65,536
6036E	
6030E	
6031E	
6035E	12 bits, 1 in 4,096
6011E	

Maximum update rate

6052E	333 kS/s
6035E	10 kS/s, system dependent
6036E	
6030E	100 kS/s
6031E	
6011E	20 kS/s, system dependent

Type of DAC..... Double buffered, multiplying

FIFO buffer size

6052E	2,048 samples
6030E	
6031E	
6035E	None
6036E	
6011E	

Data transfers

PCI, PXI, AT ..... DMA, interrupts, programmed I/O  
DAQCard ..... Interrupts, programmed I/O

DMA modes

PCI, PXI ..... Scatter-gather (single transfer, demand transfer)  
AT ..... Single transfer, demand transfer

### Transfer Characteristics

Relative accuracy

6052E	±0.35 LSB typical, ±1 LSB max
6030E	±0.5 LSB typical, ±1 LSB max
6031E	
6035E	±0.3 LSB typical, ±0.5 LSB max
6036E	±2 LSB max
6011E	±0.5 LSB max

DNL..... ±1.0 LSB max

Monotonicity

6052E	16 bits, guaranteed
6036E	
6030E	
6031E	
6035E	12 bits, guaranteed
6011E	

### Voltage Output

Ranges

6052E	±10 V, 0 to 10 V, ±EXTREF, 0 to EXTREF; software selectable
6030E	±10 V, 0 to 10 V; software selectable
6031E	
6035E	±10 V
6036E	
6011E	

Output coupling ..... DC  
Output impedance ..... 0.1 Ω max  
Current drive ..... ±5 mA max  
Protection ..... Short-circuit to ground

Power-on state

6052E	0 V (±20 mV)
6030E	
6031E	
6035E	0 V (±200 mV)
6036E	0 V (±21 mV)
6011E	0 V (±85 mV)

External reference input (6052E only)

Range ..... ±11 V  
Overvoltage protection ..... ±25 V powered on, ±15 V powered off  
Input impedance ..... 10 kΩ  
Bandwidth (-3 dB) ..... 3 kHz  
Slew rate ..... 0.3 V/μs

### Dynamic Characteristics

Settling time and slew rate

Device	Settling Time for Full-Scale Step	Slew Rate
6052E	3.5 μs to ±1 LSB accuracy	15 V/μs
6030E	10 μs to ±1 LSB accuracy	5 V/μs
6031E		
6035E	10 μs to ±0.5 LSB accuracy	10 V/μs
6036E	5 μs to ±1 LSB accuracy	15 V/μs
6011E	50 μs to ±0.5 LSB accuracy	2 V/μs

Noise

6052E	60 μV <sub>rms</sub> , DC to 1 MHz
6030E	
6031E	
6035E	200 μV <sub>rms</sub> , DC to 1 MHz
6036E	110 μV <sub>rms</sub> , DC to 400 kHz
6011E	40 μV <sub>rms</sub> , DC to 1 MHz

Glitch energy (at mid-scale transition)

### Digital I/O

Number of channels ..... 8 input/output  
Compatibility ..... 5 V/TTL

Device	Magnitude	Duration
6052E	±10 mV	1 μs
6030E	N/A	N/A
6031E		
6035E	±12 mV	2 μs
6036E	±10 mV	1 μs
6011E	±30 mV	10 μs

Power-on state ..... Input (high impedance)

Data transfers ..... Programmed I/O

Digital logic levels

Level	Minimum	Maximum
Input low voltage	0 V	0.8 V
Input high voltage	2 V	5 V
Output low voltage (I <sub>out</sub> = 24 mA)	–	0.4 V
Output high voltage (I <sub>out</sub> = 13 mA)	4.35 V	–

# E Series Multifunction DAQ Specifications

## Specifications – 16-Bit E Series NI 6052E, NI 603xE, and NI 601xE (continued)

### Timing I/O

#### General-Purpose Up/Down Counter/Timers

Number of channels .....	2
Resolution .....	24 bits (1 in 16, 777, 216)
Compatibility .....	5 V/TTL

#### Digital logic levels

Level	Minimum	Max
Input low voltage	0.0 V	0.8 V
Input high voltage	2.0 V	5.0 V
Output low voltage (I <sub>out</sub> = 5 mA)	–	0.4 V
Output high voltage (I <sub>out</sub> = 3.5 mA)	4.35 V	–

Base clocks available .....	20 MHz and 100 kHz
Base clock accuracy.....	±0.01%
Maximum source frequency.....	20 MHz
External source selections.....	PF10..PF19, RTS10..RTS16, analog trigger; software selectable
External gate selections.....	PF10..PF19, RTS10..RTS16, analog trigger; software selectable
Minimum source pulse duration.....	10 ns
Minimum gate pulse duration.....	10 ns, edge-detect mode
Data transfers	
PCI, PXI, AT .....	DMA, interrupts, programmed I/O
DAQCard .....	Interrupts, programmed I/O
DMA modes	
PCI, PXI .....	Scatter-gather (single transfer, demand transfer)
AT .....	Single transfer, demand transfer

#### Frequency Scaler

Number of channels .....	1
Resolution .....	4 bits
Compatibility .....	5 V/TTL

#### Digital logic levels

Level	Minimum	Max
Input low voltage	0.0 V	0.8 V
Input high voltage	2.0 V	5.0 V
Output low voltage (I <sub>out</sub> = 5 mA)	–	0.4 V
Output high voltage (I <sub>out</sub> = 3.5 mA)	4.35 V	–

Base clocks available .....	10 MHz, 100 kHz
Base clock accuracy.....	±0.01%
Data transfers .....	Programmed I/O

### Triggers

#### Analog Triggers

Number of triggers

6052E	1
6030E	
6031E	
6032E	
6033E	
6034E	None
6035E	
6036E	
601xE	

#### Purpose

Analog input .....	Start and stop trigger, gate, clock
Analog output .....	Start trigger, gate, clock
General-purpose counter/timers.....	Source, gate

#### Source

6052E	ACH<0..15>, PF10/TRIG1
6030E	
6032E	
6031E	ACH<0..63>, PF10/TRIG1
6033E	

#### Level

Internal source, ACH<0..15/63> .....	±Full-scale
External source, PF10/TRIG1 .....	±10 V

Slope .....	Positive or negative; software selectable
Resolution .....	12 bits, 1 in 4,096
Hysteresis .....	Programmable
Bandwidth (-3 dB)	
Accuracy .....	±1% of full-scale range max

Device	Internal source ACH<0..15/63>	External Source PF10/TRIG1
6052E	700 kHz	700 kHz
6030E, 6031E, 6032E, 6033E	255 kHz	4 MHz

#### Digital Triggers (all devices)

Number of triggers .....

#### Purpose

Analog input .....	Start and stop trigger, gate, clock
Analog output .....	Start trigger, gate, clock
General-purpose counter/timers.....	Source, gate

#### Source

Source .....	PF10..PF19, RTS10..RTS16
Slope .....	Positive or negative; software selectable
Compatibility .....	5 V/TTL
Response .....	Rising or falling edge
Pulse width .....	10 ns minimum

# E Series Multifunction DAQ Specifications

## 16-Bit E Series NI 6052E, NI 603xE, and NI 601xE (continued)

### External Input for Digital or Analog Trigger (PFIO/TRIG1)

Impedance .....	10 k $\Omega$
Coupling .....	DC
Protection	
Digital trigger .....	-0.5 to (V <sub>cc</sub> + 0.5) V
Analog trigger	
On/Off/Disabled .....	$\pm$ 35 V

### Calibration

Recommended warm-up time .....	15 minutes; 30 minutes for DAQCard
Calibration Interval .....	1 year
Onboard calibration reference	
DC Level	

6052E 6030E 6031E 6032E 6033E 6012E	5.000 V ( $\pm$ 1.0 mV)	Over full operating temperature, actual value stored in EEPROM
6034E 6035E 6036E	5.000 V ( $\pm$ 3.5 mV)	
6011E	5.000 V ( $\pm$ 3.0 mV)	

### Temperature coefficient

6052E 6030E 6031E 6032E 6033E	$\pm$ 0.6 ppm/ $^{\circ}$ C max
6012E 6034E 6035E 6036E	$\pm$ 5.0 ppm/ $^{\circ}$ C max
6011E	$\pm$ 2.0 ppm/ $^{\circ}$ C max

### Long-term stability

6052E 6030E 6031E 6032E 6033E	$\pm$ 6.0 ppm/ $\sqrt{1000 \text{ h}}$
6034E 6035E 6036E 601xE	$\pm$ 15.0 ppm/ $\sqrt{1000 \text{ h}}$

### RTSI (PCI and ISA only)

Trigger lines .....	7
---------------------	---

### PXI Trigger Bus (PXI only)

Trigger lines .....	6
Star Trigger .....	1

### Bus Interface

PCI, PXI .....	Master, slave
AT, DAQCard .....	Slave

### Power Requirements<sup>1</sup>

Device	+5 VDC ( $\pm$ 5%)	Power Available at I/O Connector
6052E	1.3 A	+4.65 to +5.25 VDC, 1 A
603xE (PCI, PXI); except 6034E/6035E	1.5 A	+4.65 to +5.25 VDC, 1 A
6034E 6035E 6036E	0.9 A	+4.65 to +5.25 VDC, 1 A
603xE (AT)	1.2 A	+4.65 to +5.25 VDC, 1 A
PCI-MIO-16XE-50	1.1 A	+4.65 to +5.25 VDC, 1 A
DAQCard-A1-16XE-50	230 mA	+4.65 to +5.25 VDC, 250 mA
AT-MIO-16XE-50	750 mA	+4.65 to +5.25 VDC, 1 A

### Physical<sup>1</sup>

#### Dimensions (not including connectors)<sup>1</sup>

PCI .....	17.5 by 10.6 cm (6.9 by 4.2 in.)
PXI .....	16.0 by 10.0 cm (6.3 by 3.9 in.)
ISA (long) .....	33.8 by 9.9 cm (13.3 by 3.9 in.)
ISA (short) .....	17.5 by 9.9 cm (6.9 by 4.2 in.)
DAQCard .....	Type II PC Card

#### I/O connectors

6052E 6030E 6032E 6034E 6035E 6036E 6011E	68-pin male SCSI-II type
6031E 6033E	100-pin female 0.050 D-type
6012E	68-pin female PCMCIA

### Environment

Operating temperature .....	0 to 55 $^{\circ}$ C; DAQCards should not exceed 55 $^{\circ}$ C while in PCMCIA slot
Storage temperature .....	-20 to 70 $^{\circ}$ C
Relative humidity .....	10 to 90%, noncondensing

### Certifications and Compliances

#### CE Mark Compliance $\text{CE}$

<sup>1</sup>See page 148 for RT Series devices power requirements and physical parameters.

# E Series DAQ Accuracy Specifications



## 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 that you do not have to guess how they will perform. Along with traditional data acquisition specifications, our E Series multifunction data acquisition (DAQ) devices also include accuracy tables to assist you in selecting the appropriate hardware for your application. These tables are found on the product pages and include specifications for both absolute and relative accuracy.

## Absolute Accuracy

Absolute accuracy is the specification you use to determine the overall maximum error of your measurement. Absolute accuracy specifications apply only to a successfully calibrated DAQ device. There are four components of an absolute accuracy specification:

**Percent of Reading** is a percent of the actual input voltage.

**Offset** is a constant offset applied to all measurements.

**Noise + Quantization** is based on noise and depends on the number of points averaged for each measurement.

**Drift** is based on variations in your ambient temperature.

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

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

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:

$$\text{Drift} = \text{Temperature Difference} \times \% \text{ Drift per } ^\circ\text{C} \times \text{Input Voltage}$$

**Absolute Accuracy at Full Scale** is a calculation of absolute accuracy for a specific voltage range using the maximum voltage within that range taken one year after calibration, the Accuracy Drift Reading, and the Noise + Quantization averaged value.

Below is the **Absolute Accuracy at Full Scale** calculation for the PCI-MIO-16XE-50 after one year using the  $\pm 10$  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. You can see on the next page that the calculation for the  $\pm 10$  V input range for Absolute Accuracy at Full Scale yields 1.443 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:

$$\text{Absolute Accuracy} = \pm[(10 \times 0.0001) + 397.2 \mu\text{V} + 45.8 \mu\text{V}] = \pm 1.443 \text{ mV}$$

The following example assumes the same conditions except that the ambient temperature is 45 °C. You can begin with the calculation above and add in the Drift calculation using the % Drift per °C from the table on the next page (see Table 1).

$$\text{Absolute Accuracy} = 1.443 \text{ mV} + ((45 ^\circ\text{C} - 35 ^\circ\text{C}) \times 0.000002 / ^\circ\text{C} \times 10 \text{ V}) = \pm 1.643 \text{ mV}$$

If you are making single-point measurements, use the Single-Point Noise + Quantization specification from the accuracy tables. If you are averaging multiple points for each measurement, the value for Noise + Quantization changes. The Averaged Noise + Quantization 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:

$$\text{Noise} + \text{Quantization for } x \text{ averaged points} = \frac{\text{Averaged Noise} + \text{Quantization from table} \times \sqrt{100/X}}$$

For example, if you are averaging 1000 points per measurement with the PCI-MIO-16XE-50 in the  $\pm 10$  V input range, the Noise + Quantization is determined by:

$$\text{Noise} + \text{Quantization} = 45.7 \mu\text{V} \times \sqrt{100/1000} = 14.5 \mu\text{V}$$

The Noise + Quantization specifications assume that dithering is disabled for single-point measurements and enabled for averaged measurements.

**See page 24 or visit [ni.com/calibration](http://ni.com/calibration) for more information on the importance of calibration on DAQ device accuracy.**

To calculate the accuracy of NI measurement products, visit [ni.com/measurements/accuracy](http://ni.com/measurements/accuracy)

# E Series DAQ Accuracy Specifications

## Relative Accuracy

Relative accuracy is the specification that compares the difference between two or more measurements. It indicates the degree to which two or more measurements can be distinguished from each other. The two major contributors to relative accuracy are the resolution of the device's analog-to-digital Converter (ADC) and the system noise. The accuracy tables show both single-point and averaged relative accuracy, which include both ADC resolution and system noise effects. Averaging will improve your relative accuracy for DC measurements.

As an example, assume you are monitoring a voltage once per second using the  $\pm 10$  V range on the PCI-MIO-16XE-50 and averaging 100 points for each measurement. Using the accuracy table on page 255 (reprinted below for your convenience), we find:

$$\text{Averaged Relative Accuracy} = 60.3 \mu\text{V}$$

This means that a measurement taken at time  $t_2$  would have to be 60.3  $\mu\text{V}$  greater or less than the measurement taken at time  $t_1$  in order to detect a difference in the input voltage. Relative accuracy does not depend on DAQ device calibration.

## Detailed Specifications

The pages starting at page 266 contain detailed specifications for all National Instruments E Series multifunction devices. Devices can be identified by their family number. For instance, if you want to determine the common-mode rejection ratio (CMRR) in the 10 V range for the PCI-6052E in unipolar range, you would look at the 16-bit E Series Multifunction DAQ specification on page 272. For the 10 V range, the CMRR specification for the NI 6052E devices is 97 dB.

Nominal Range (V)	Absolute Accuracy								Relative Accuracy		
	% of Reading			Offset ( $\mu\text{V}$ )	Noise + Quantization ( $\mu\text{V}$ )		Temp Drift (%/ $^{\circ}\text{C}$ )	Absolute Accuracy at Full Scale (mV)	Resolution ( $\mu\text{V}$ )		
	24 Hrs	90 Days	1 Year		Single Pt.	Averaged			Single Pt.	Averaged	
PCI, AT, and DAQPad	$\pm 10$	0.0058%	0.0078%	0.0100%	397.2	526.4	45.8	0.0002	1.443	602.7	60.3
	$\pm 5$	0.0208%	0.0228%	0.0250%	200.6	263.2	22.9	0.0007	1.474	301.4	30.1
	$\pm 1$	0.0208%	0.0228%	0.0250%	43.3	52.6	4.6	0.0007	0.298	60.3	6.0
	$\pm 0.1$	0.0408%	0.0428%	0.0450%	7.9	8.4	0.7	0.0012	0.054	9.6	1.0
	0 to 10	0.0058%	0.0078%	0.0100%	244.6	263.2	22.9	0.0002	1.268	301.4	30.1
	0 to 5	0.0208%	0.0228%	0.0250%	124.3	131.6	11.4	0.0007	1.386	150.7	15.1
	0 to 1	0.0208%	0.0228%	0.0250%	28.1	26.3	2.3	0.0007	0.280	30.1	3.0
	0 to 0.1	0.0408%	0.0428%	0.0450%	6.4	7.0	0.6	0.0012	0.052	8.4	0.8
DAQCard	$\pm 10$	0.0075%	0.0095%	0.0117%	815.4	1029.1	91.6	0.0005	2.077	1205.4	120.5
	$\pm 5$	0.0225%	0.0245%	0.0267%	409.7	514.6	45.8	0.0010	1.791	602.7	60.3
	$\pm 1$	0.0225%	0.0245%	0.0267%	85.1	102.9	9.2	0.0010	0.361	120.5	12.1
	$\pm 0.1$	0.0425%	0.0445%	0.0467%	12.1	12.2	1.1	0.0015	0.060	14.5	1.4
	0 to 10	0.0075%	0.0095%	0.0117%	591.2	514.6	45.8	0.0005	1.807	602.7	60.3
	0 to 5	0.0225%	0.0245%	0.0267%	297.6	257.3	22.9	0.0010	1.656	301.4	30.1
	0 to 1	0.0225%	0.0245%	0.0267%	62.7	51.5	4.6	0.0010	0.334	60.3	6.0
	0 to 0.1	0.0425%	0.0445%	0.0467%	9.9	8.0	0.7	0.0015	0.057	9.6	1.0

Note: Accuracies are valid for measurements following an internal E Series Calibration. Averaged numbers assume dithering and averaging of 100 single-channel readings. Measurement accuracies are listed for operational temperatures within  $\pm 1$   $^{\circ}\text{C}$  of internal calibration temperature and  $\pm 10$   $^{\circ}\text{C}$  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  $\pm 10$  V range) after one year, assuming 100 pt averaging of data. See Overview on page 234 for an example calculation of this type.

Table 1. NI 601xE Analog Input Accuracy Specifications