Low-Cost E Series Multifunction DAQ – 200 kS/s, 12-Bit, 16 Analog Inputs

NI 6023E, NI 6024E, NI 6025E

NI 6023E
PCI-6023E
NI 6024E
PCI-6024E
DAQCard-6024E
NI 6025E
PCI-6025E
PXI-6025E

Analog Inputs
16 single-ended, 8 differential channels
200 kS/s sampling rate
200 kS/s stream-to-disk rate
12-bit resolution

Analog Output
(NI 6024E and NI 6025E only)
2 channels, 12-bit resolution

Digital I/O
8 (5 V/TTL) lines (6023E and 6024E)
32 (5 V/TTL) lines (6025E)

Counter/Timers
2 up/down, 24-bit resolution

Triggering
Digital

Real-Time
See page 184.

Driver Software
NI-DAQ
Windows 2000/NT/Me/9x
Mac OS – not for all hardware

Application Software
LabVIEW
Lookout
Measurement Studio
Measure
VirtualBench

Calibration Certificate Included
See page 256.

Ordering Information

NI 6023E
PCI-6023E 777742-01
NI 6024E
PCI-6024E 777743-01
DAQCard-6024E* 778269-01
NI 6025E
PCI-6025E* 777744-01
PXI-6025E* 777798-01

Includes NI-DAQ for Windows 2000/NT/Me/9x and Mac OS unless otherwise noted.
*Windows only

Extended warranty and value added services .....page 880

Recommended Configurations

Family	DAQ Device	Accessory	Cable
NI 6023E	PCI-6023E	CB-68LP (777145-01)	R6868 (182482-01)
NI 6024E	PCI-6024E	CB-68LP (777145-01)	R6868 (182482-01)
	DAQCard-6024E	CB-68LP (777145-01)	RC68-68 (187252-01)
NI 6025E	PCI-6025E	Two CB-50LPs (777101-01)	R1005050 (182762-01)
	PXI-6025E	Two CB-50LPs (777101-01)	R1005050 (182762-01)

See page 334 for accessory and cable information.

Overview

The NI 6023E, NI 6024E, and NI 6025E are our low-cost 12-bit DAQ devices that use E Series technology to deliver high performance and reliable data acquisition capabilities in a wide range of applications. You get up to 200 kS/s, 12-bit performance on 16 single-ended analog inputs. Depending on your type of hard drive, these devices can stream to disk at rates up to 200 kS/s. The new DAQCard-6024E gives you the same performance in a PCMCIA card for portable application needs.

These E Series devices feature digital triggering capability, as well as two 24-bit, 20 MHz counter/timers; and 8 digital I/O lines. The NI 6024E and NI 6025E also feature two 12-bit analog outputs. An additional 24 lines of 5 V/TTL I/O makes the NI 6025E family the best value of any PCI data acquisition device available.

See the E Series Multifunction DAQ Overview on page 306 for a more detailed hardware overview.

Family	Bus	Analog Inputs	Resolution	Sampling Rate	Input Range	Analog Outputs	Resolution	Output Rate	Output Range	Digital I/O	Counter/ Timers	Triggers
NI 6023E	PCI	16 SE/8 DI	12 bits	200 kS/s	±0.05 to ±10 V	–	–	–	–	8	2, 24-bit	Digital
NI 6024E	PCI, PCMCIA	16 SE/8 DI	12 bits	200 kS/s	±0.05 to ±10 V	2	12 bits	10 kS/s[1]	±10 V	8	2, 24-bit	Digital
NI 6025E	PCI, PXI, CompactPCI	16 SE/8 DI	12 bits	200 kS/s	±0.05 to ±10 V	2	12 bits	10 kS/s[1]	±10 V	32	2, 24-bit	Digital

[1] 10 kS/s system-dependent when using the single DMA channel for analog output. 1 kS/s system-dependent when using the single DMA channel for either analog input or counter/timer operations.

Table 1. NI 6023E, NI 6024E, and NI 6025E Channel, Speed, and Resolution Specifications (see page 344 for detailed specifications)

Low-Cost E Series Multifunction DAQ – 200 kS/s, 12-Bit, 16 Analog Inputs

Nominal Range (V)		Absolute Accuracy							Relative Accuracy	
		% of Reading			Noise + Quantization (mV)		Temp	Absolute Accuracy	Resolution (mV)	
Positive FS	Negative FS	24 Hrs	1 Year	Offset (mV)	Single Pt.	Averaged	Drift (%/°C)	at Full Scale (mV)	Single Pt.	Averaged
10	-10	0.0872	0.0914	6.38	3.91	0.975	0.0010	16.504	5.89	1.28
5	-5	0.0272	0.0314	3.20	1.95	0.488	0.0005	5.263	2.95	0.642
0.5	-0.5	0.0872	0.0914	0.340	0.195	0.049	0.0010	0.846	0.295	0.064
0.05	-0.05	0.0872	0.0914	0.054	0.063	0.006	0.0010	0.106	0.073	0.008

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 312 for an example calculation of this type.

Table 2. NI 6023E, PCI-6024E, and NI 6025E Analog Input Accuracy Specifications

Nominal Range (V)		Absolute Accuracy							Relative Accuracy	
		% of Reading			Noise + Quantization (mV)		Temp	Absolute Accuracy	Resolution (mV)	
Positive FS	Negative FS	24 Hrs	1 Year	Offset (mV)	Single Pt.	Averaged	Drift (%/°C)	at Full Scale (mV)	Single Pt.	Averaged
10	-10	0.0872	0.0914	8.83	3.91	1.042	0.0010	19.012	5.89	1.37
5	-5	0.0272	0.0314	4.42	1.95	0.521	0.0005	6.517	2.95	0.686
0.5	-0.5	0.0872	0.0914	0.462	0.452	0.052	0.0010	0.972	0.516	0.069
0.05	-0.05	0.0872	0.0914	0.066	0.063	0.007	0.0010	0.119	0.073	0.009

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 312 for an example calculation of this type.

Table 3. DAQCard-6024E Analog Input Accuracy Specifications

Nominal Range (V)		Absolute Accuracy					Absolute
		% of Reading				Temp	Accuracy at
Positive FS	Negative FS	24 Hrs	90 Days	1 Year	Offset (mV)	Drift (%/°C)	Full Scale (mV)
10	-10	0.0177	0.0197	0.0219	5.93	0.0005	8.127

Note: Temp Drift applies only if ambient is greater than ±10 °C of previous external calibration. See page 312 for example calculations.

Table 4. NI 6023E, PCI-6024E, and NI 6025E Analog Output Accuracy Specifications

Nominal Range (V)		Absolute Accuracy					Absolute
		% of Reading				Temp	Accuracy at
Positive FS	Negative FS	24 Hrs	90 Days	1 Year	Offset (mV)	Drift (%/°C)	Full Scale (mV)
10	-10	0.0177	0.0197	0.0219	8.37	0.0005	10.568

Note: Temp Drift applies only if ambient is greater than ±10 °C of previous external calibration. See page 312 for example calculations.

Table 5. DAQCard-6024E Analog Output Accuracy Specifications

Product	Analog Input			Analog Output			Available DMA Channels	PCI Bus Master
	Sample Rate	Polarity	Range Selections	Update Rate	Polarity	FIFO Size		
PCI-6023E/6024E/6025E	200 kS/s	Bipolar	20 V, 10 V, 1 V, 100 mV	Up to 10 kS/s[1]	Bipolar	–	1	✓
PCI-6040E	250 kS/s	Unipolar or Bipolar	20 V, 10 V, 5 V, 2 V, 1 V 500 mV, 200 mV, 100 mV	Up to 1 MS/s	Unipolar or Bipolar	512 Samples	3	✓
PCI-6070E	1.25 MS/s	Unipolar or Bipolar	20 V, 10 V, 5 V, 2 V, 1 V 500 mV, 200 mV, 100 mV	Up to 1 MS/s	Unipolar or Bipolar	2,048 Samples	3	✓

[1] 10 kS/s system-dependent when using the single DMA channel for analog output. 1 kS/s system-dependent when using the single DMA channel for either analog input or counter/timer operations.

Table 6. How To Choose Between the PCI-6024E, PCI-6040E, and PCI-6070E DAQ Devices. This table highlights the differences between these product families. Use the table to determine which device has the features your application requires.

Visit ni.com/info and enter ex6q2w to find block diagrams in the user manuals for the NI 6023E, NI 6024E, and NI 6025E devices.

See page 310 in the E Series Multifunction DAQ Overview for I/O connector diagrams.

See page 344 for more detailed specifications.

E Series Multifunction DAQ Specifications

12-Bit E Series (NI 607xE, NI 606xE, NI 604xE, NI 602xE)

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

6070E 6060E 6062E 604xE 602xE	16 single-ended or 8 differential (software selectable per channel)
6071E 6061E	64 single-ended or 32 differential (software selectable per channel)

Type of ADC ..... Successive approximation
Resolution ..... 12 bits, 1 in 4,096
Maximum sampling rate

607xE	1.25 MS/s
606xE	500 kS/s
604xE	500 kS/s single-channel scanning 250 kS/s multichannel scanning
6061E	500 kS/s single-channel scanning 333 kS/s multichannel
6023E 6024E 6025E	200 kS/s
6020E 6021E	100 kS/s

Streaming-to-disk rate (system dependent)[1]

607xE	1.25 MS/s
606xE	500 kS/s
604xE	250 kS/s
6023E 6024E 6025E	200 kS/s
6020E 6021E	100 kS/s[2]

[1]Streaming-to-disk rates do not apply to RT Series devices.
[2]DAQPad™-6020E rates with SCSI or DMA-enabled EIDE.

Input signal ranges

Device	Range (Software Selectable)	Input Range	
		Bipolar	Unipolar
607xE	20 V	±10 V	–
606xE	10 V	±5 V	0 to 10 V
604xE	5 V	±2.5 V	0 to 5 V
6020E	2 V	±1 V	0 to 2 V
6021E	1 V	±500 mV	0 to 1 V
	500 mV	±250 mV	0 to 500 mV
	200 mV	±100 mV	0 to 200 mV
	100 mV	±50 mV	0 to 100 mV
6023E	20 V	±10 V	–
6024E	10 V	±5 V	–
6025E	1 V	±500 mV	–
	100 mV	±50 mV	–

Input coupling ..... DC
Maximum working voltage
(signal + common mode) ..... Input should remain within ±11 V of ground

Overvoltage protection

Device	Powered On	Powered Off
607xE 606xE 604xE	±25 V	±15 V
6023E 6024E 6025E	±40 V	±25 V
6020E 6021E	±35 V	±25 V

Inputs protected

6070E, 6060E 6062E, 604xE 602xE	ACH<0..15>, AISENSE
6071E, 6061E	ACH<0..63>, AISENSE, AISENSE2

FIFO buffer size

AT-MIO-16E-1 DAQCard-6062E	8,192 samples
DAQPad-6020E	4,096 samples
6060E/6061E DAQPad-6070E DAQCard-6024E	2,048 samples
6041E	1,024 samples
PCI-MIO-16E-1 PXI-6070E 6071E, 6040E PCI-602xE (except DAQPad) PXI-6025E	512 samples

Data transfers
PCI, PXI, AT, DAQPad for IEEE 1394 ..... DMA, interrupts, programmed I/O
DAQCard, DAQPad for USB ..... Interrupts, programmed I/O
DMA modes
PCI, PXI, DAQPad for IEEE 1394 ..... Scatter-gather (single-transfer, demand transfer)
AT ..... Single transfer, demand transfer
Configuration memory size ..... 512 words

Transfer Characteristics

Relative accuracy

Device	Typical Dithered	Maximum Undithered
607xE 606xE 604xE 6023E 6024E 6025E	±0.5 LSB	±1.5 LSB
6020E 6021E	±0.2 LSB	±1.5 LSB

DNL

Device	Typical	Maximum
607xE 6060E 6061E 604xE 6023E PCI-6024E 6025E	±0.5 LSB	±1.0 LSB
6020E 6021E	±0.2 LSB	±1.0 LSB
6062E DAQCard-6024E	±0.75 LSB	-0.9, +1.5 LSB

No missing codes ..... 12 bits, guaranteed

12-Bit E Series (NI 607xE, NI 606xE, NI 604xE, NI 602xE) (continued)

Amplifier Characteristics

Input impedance

Device	Normal Powered On	Powered Off	Overload
6070E 606xE 6040E PCI-6071E PXI-6071E	100 GΩ in parallel with 100 pF	820 Ω	820 Ω
6041E	100 GΩ in parallel with 100 pF	1 kΩ	1 kΩ
602xE	100 GΩ in parallel with 100 pF	4.7 kΩ	4.7 kΩ

Input bias current..... ±200 pA
Input offset current..... ±100 pA

CMRR, DC to 60 Hz

Device	Range	CMRR
607xE 6060E 6061E	20 V 10 V 100 mV to 5 V	95 dB 100 dB 106 dB
604xE 6062E	10 to 20 V 5 V 100 mV to 2 V	85 dB 95 dB 100 dB
6023E 6024E 6025E	10 to 20 V 100 mV to 1 V	85 dB 90 dB
6020E 6021E	100 mV to 20 V	90 dB

Dynamic Characteristics

Bandwidth

Device	Small Signal (-3 dB)	Large Signal (1% THD)
607xE	1.6 MHz	1 MHz
6060E/6061E	1 MHz	300 kHz
6062E	1.3 MHz	250 kHz
6041E	800 kHz	400 kHz
6040E	600 kHz	350 kHz
6023E PCI-6024E 6025E	500 kHz	225 kHz
DAQCard-6024E	500 kHz	265 kHz
6021E	150 kHz	120 kHz

Settling time to full-scale step

Device	Range	Accuracy ±0.012% (±0.5 LSB)	Accuracy ±0.024% (±1 LSB)	Accuracy ±0.098% (±4 LSB)
6070E	20 V	2 µs typical 3 µs max	1.5 µs typical 2 µs max	1.5 µs typical 2 µs max
	10 V	2 µs typical 3 µs max	1.5 µs typical 2 µs max	1.3 µs typical 1.5 µs max
	200 mV to 5 V	2 µs typical 3 µs max	1.5 µs typical 2 µs max	0.9 µs typical 1 µs max
	100 mV	2 µs typical 3 µs max	1.5 µs typical 2 µs max	1 µs typical 1.5 µs max
PCI-6071E PXI-6071E	20 V	3 µs typical 5 µs max	1.9 µs typical 2.5 µs max	1.9 µs typical 2 µs max
	10 V	3 µs typical 5 µs max	1.9 µs typical 2.5 µs max	1.2 µs typical 1.5 µs max
	200 mV to 5 V	3 µs typical 5 µs max	1.9 µs typical 2.5 µs max	1.2 µs typical 1.3 µs max
	100 mV	3 µs typical 5 µs max	1.9 µs typical 2.5 µs max	1.2 µs typical 1.5 µs max
6060E	All	2 µs typical 4 µs max	1.9 µs typical 2 µs max	1.8 µs typical 2 µs max
6061E		5 µs max	3 µs max	2 µs max
6062E	All	2.5 µs typical 4 µs max	2.5 µs typical 3 µs max	2 µs typical 2.5 µs max
604xE	All	4 µs typical 8 µs max	4 µs max	4 µs max
6023E 6024E 6025E	All	5 µs typical	5 µs max	5 µs max
6020E 6021E	All	10 µs max	10 µs max	10 µs max

System noise (LSBrms, not including quantization)

Device	Range	Dither Off	Dither On
6070E PCI-6071E PXI-6071E	1 to 20 V 500 mV 200 mV 100 mV	0.25 0.4 0.5 0.8	0.5 0.6 0.7 0.9
6060E 6061E	200 mV 100 mV	0.3 0.5	0.6 0.7
6062E	1 to 20 V 500 mV 200 mV 100 mV	0.25 0.4 0.5 0.8	0.6 0.75 0.8 1.0
604xE	1 to 20 V 500 mV 200 mV 100 mV	0.2 0.25 0.5 0.9	0.5 0.5 0.7 1.0
6023E PCI-6024E, 6025E	1 to 20 V 100 mV	0.1 0.7	0.6 0.8
DAQCard-6024E	10 to 20 V 1 V 100 mV	0.1 0.45 0.70	0.65 0.65 0.90
6020E 6021E	1 to 20 V 500 mV 200 mV 100 mV	0.07 0.12 0.25 0.5	0.5 0.5 0.6 0.7

Crosstalk, DC to 100 KHz

Device	Adjacent Channels	All Other Channels
607xE, 606xE, 604xE	-75 dB	-90 dB
602xE	-60 dB	-80 dB

E Series Multifunction DAQ Specifications

12-Bit E Series (NI 607xE, NI 606xE, NI 604xE, NI 602xE) (continued)

Analog Output

Output Characteristics

Number of channels

607xE 606xE 6040E 6020E 6021E 6024E 6025E	2 voltage outputs
6041E 6023E	None

Resolution ..... 12 bits, 1 in 4096
Type of DAC ..... Double buffered, multiplying
Maximum update rate

Device	Waveform Generation			
	FIFO Mode		Non-FIFO Mode	
	Internally Timed	Externally Timed	1 Channel	2 Channels
607xE 6060E, 6061E 6040E	1 MS/s	950 kS/s	800 kS/s, system dependent	400 kS/s, system dependent
6062E	850 kS/s	850 kS/s	800 kS/s, system dependent	400 kS/s, system dependent
6023E PCI-6024E 6025E	N/A	N/A	10 kS/s with DMA 1 kS/s with interrupts system dependent	10 kS/s with DMA 1 kS/s with interrupts system dependent
DAQCard-6024E	N/A	N/A	1 kS/s with interrupts system dependent	1 kS/s with interrupts system dependent
6020E; except DAQPad-6020E	N/A	N/A	100 kS/s, system dependent	100 kS/s, system dependent
DAQPad-6020E	N/A	N/A	20 S/s, system dependent	20 S/s, system dependent

FIFO buffer size

607xE, 606xE	2,048 samples
6040E	512 samples
602xE	None

Data transfers
- PCI, PXI, AT, DAQPad for IEEE 1394 ..... DMA, interrupts, programmed I/O
- DAQCard, DAQPad for USB ..... Interrupts, programmed I/O

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

Transfer Characteristics

Relative accuracy
- After calibration (6062E, DAQCard-6024E) ..... ±0.5 LSB typical, ±1.0 LSB max
- After calibration (all others) ..... ±0.3 LSB typical, ±0.5 LSB max
- Before calibration ..... ±4 LSB max

DNL
- After calibration (6062E, DAQCard-6024E) ..... ±0.5 LSB typical, ±1.0 LSB max
- After calibration (all others) ..... ±0.3 LSB typical, ±1.0 LSB max
- Before calibration ..... ±3 LSB max

Monotonicity ..... 12 bits, guaranteed after calibration
Gain error (relative to external reference)
- 6062E ..... ±0.5% of output max, not adjustable
- All others ..... 0 to 0.67% of output max, not adjustable

Voltage Output

Ranges

607xE, 6060E 6061E, 6040E 6020E, 6021E	±10 V, 0 to 10 V, ±EXTREF, 0 to EXTREF; software selectable
6062E	±10 V, ±EXTREF, software selectable
6020E, 6021E 6024E, 6025E	±10 V

Output coupling ..... DC
Output impedance ..... 0.1 Ω max
Current drive ..... ±5 mA max
Protection ..... Short-circuit to ground
Power-on state ..... 0 V (±200 mV)

External reference input (not available on 6024E or 6025E)
- Range ..... ±11 V
- Overvoltage protection

607xE 606xE 604xE	±25 V powered on, ±15 V powered off
602xE	±35 V powered on, ±25 V powered off

- Input impedance ..... 10 kΩ
- Bandwidth (-3 dB)

607xE 6060E, 6061E 604xE	1 MHz
6062E	50 kHz
602xE	300 kHz

Dynamic Characteristics

Settling time and slew rate

Device	Settling Time for Full-Scale Step	Slew Rate
607xE 606xE 6040E	3 µs to ±0.5 LSB accuracy	20 V/µs
602xE	10 µs to ±0.5 LSB accuracy	10 V/µs

Noise ..... 200 µVrms, DC to 1 MHz
Glitch energy (at mid-scale transition)
- Magnitude

Device	Reglitching Disabled	Reglitching Enabled
DAQPad-6070E PCI-MIO-16E-1 PCI-6071E PXI-6070E PXI-6071E	±20 mV	±4 mV
AT-MIO-16E-1 6060E, 6061E 604xE	±200 mV	±30 mV
PCI-6024E 6025E	±42 mV	N/A
DAQCard-6024E	± 13 mV	N/A
6020E 6021E	±100 mV	N/A
6062E	±80 mV	±30 mV

Duration

607xE 6060E, 6061E 604xE	1.5 µs
6024E 6025E	2 µs
6020E 6021E 6062E	3 µs

Stability

Gain temperature coefficient
- External reference ..... ±25 ppm/°C

Digital I/O

Number of channels

6021E 6025E	32 input/output
All others	8 input/output

12-Bit E Series (NI 607xE, NI 606xE, NI 604xE, NI 602xE) (continued)

Compatibility ..... 5 V/TTL
Power-on state ..... Input; high impedance
Digital logic levels
DIO<0..7> on all devices
PA<0..7>, PB<0..7>, PC<0..7> on remaining 24 lines of 6021E and 6025E

Level	Minimum	Maximum
Input low voltage	0 V	0.8 V
Input high voltage	2 V	5 V
Output low voltage (I_{out} = 24 mA)	–	0.4 V
Output high voltage (I_{out} = 13 mA)	4.35 V	–

Level	Minimum	Maximum
Input low voltage	0 V	0.8 V
Input high voltage	2 V	5 V
Output low voltage (I_{out} = 2.5 mA)	–	0.4 V
Output high voltage (I_{out} = 2.5 mA)	3.9 V	–

Data transfers

6021E 6025E	Interrupts, programmed I/O
All others	Programmed I/O

Handshaking (6021E and 6025E only)
Direction ..... Input or output
Modes 2-wire
Transfer rate (1 word = 8 bits)
Maximum with NI-DAQ™, system dependent

DAQPad-6070E	5 kwords/s
All others	50 kwords/s

Constant sustainable rate ..... 1 to 10 kwords/s, typical

Timing I/O

General-Purpose Up/Down Counter/Timers

Number of channels 2
Resolution ..... 24 bits
Compatibility ..... 5 V/TTL
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_{out} = 5 mA)	–	0.4 V
Output high voltage (I_{out} = 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[1] ..... PFI0..PFI9, RTSI0..RTSI6, analog trigger; software selectable
External gate selections[1] ..... PFI0..PFI9, RTSI0..RTSI6, analog trigger; software selectable
Minimum source pulse duration ..... 10 ns
Minimum gate pulse duration ..... 10 ns, edge-detect mode
Data transfers
PCI, PXI, AT, DAQPad for IEEE 1394 ..... DMA, interrupts, programmed I/O
DAQCard, DAQPad for USB ..... Interrupts, programmed I/O
DMA modes
PCI, PXI, DAQPad for IEEE 1394 ..... 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	Maximum
Input low voltage	0 V	0.8 V
Input high voltage	2 V	5 V
Output low voltage (I_{out} = 5 mA)	–	0.4 V
Output high voltage (I_{out} = 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

607xE 606xE 604xE	1
602xE	None

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

6070E 6062E, 6060E 604xE, 602xE	ACH<0..15>, PFI0/TRIG1
6071E 6061E	ACH<0..63>, PFI0/TRIG1

Level
Internal source, ACH<0..15/63> ..... ±Full-scale
External source, PFI0/TRIG1 ..... ±10 V
Slope ..... Positive or negative; software selectable
Resolution ..... 8 bits, 1 in 256
Bandwidth (-3 dB)

Device	Internal Source	External Source
607xE	2 MHz	7 MHz
6060E, 6061E	1 MHz	7 MHz
6062E	500 kHz	2.5 MHz
604xE	2 MHz	3 MHz

Hysteresis ..... Programmable
Accuracy ..... ±5% of full-scale range max

Digital Triggers (all devices)

Number of triggers 2
Purpose
Analog input ..... Start and stop trigger, gate, clock
Analog output ..... Start trigger, gate, clock
General-purpose counter/timers ..... Source, gate
Source[1] ..... PFI0..PFI9, RTSI0..RTSI6
Slope ..... Positive or negative; software selectable
Compatibility ..... 5 V/TTL
Response ..... Rising or falling edge
Pulse width ..... 10 ns minimum
External input for digital or analog trigger ..... (PFI0/TRIG1)
Impedance
6062E ..... 12 kΩ
All others ..... 10 kΩ
Coupling ..... DC
Protection
Digital trigger ..... -0.5 to Vcc + 0.5 V
Analog trigger
On/off/disabled ..... ±35 V

Calibration

Recommended warm-up time ..... 15 minutes; 30 minutes for DAQCard and DAQPad
Calibration interval ..... 1 year
Onboard calibration reference
DC level ..... 5.000 V (±3.5 mV) over full operating temperatures, actual value stored in EEPROM
Temperature coefficient ..... ±5 ppm/°C max
Long-term stability ..... ±15 ppm/$\sqrt{1000\ h}$

E Series Multifunction DAQ Specifications

12-Bit E Series (NI 607xE, NI 606xE, NI 604xE, NI 602xE) (continued)

RTSI (PCI, DAQPad-6070E for IEEE 1394, and ISA only)

Trigger lines
- PCI, ISA 7
- DAQPad for IEEE 1394 4

PXI Trigger Bus (PXI only)

Trigger lines 6
Star trigger 1

Bus Interface

PCI, PXI, DAQPad for IEEE 1394 ..... Master, slave
AT, DAQCard, DAQPad for USB ..... Slave

Power Requirements[2]

Device	+5 VDC (±5%)*	Power Available at I/O Connector
607xE	1.1 A	+4.65 to +5.25 VDC, 1 A
6060E, 6061E 6040E	1.0 A	+4.65 to +5.25 VDC, 1 A
602xE, (except DAQPad and DAQCard)	0.7 A	+4.65 to +5.25 VDC, 1 A
DAQCard-6062E	340 mA typical 750 mA maximum	+4.65 to +5.25 VDC, 250 mA
DAQCard-6024E	270 mA typical 750 mA maximum	±4.65 to +5.25 VDC, 250 mA
DAQCard-AI-16E-4	280 mA typical 400 mA maximum	+4.65 to +5.25 VDC, 250 mA

Device	Power	Power Available at I/O Connector
DAQPad-6020E	15 W[3], +9 to +30 VDC	+4.65 to +5.25 VDC, 1 A
DAQPad-6070E	17 W[3], +9 to +25 VDC	+4.65 to +5.25 VDC, 1 A

Discharge time with BP-1 battery pack
*Excludes power consumed through I/O connector.
IEEE 1394 DAQPads ..... 2.5 hours, typical
USB DAQPads ..... 3 hours, typical

Physical[2]

Dimensions (not including connectors)
- PCI[2] ..... 17.5 by 9.9 c m (6.9 by 3.9 in.)
- PXI ..... 16.0 by 10.0 c m (6.3 by 3.9 in.)
- AT (long) ..... 33.8 by 9.9 c m (13.3 by 3.9 in.)
- AT (short) ..... 17.5 by 9.9 c m (6.9 by 4.2 in.)
- DAQPad (30 cm enclosure) ..... 25.4 by 30.5 by 4.6 c m (10 by 12 by 1.8 in.)
- DAQPad (15 cm enclosure) ..... 14.6 by 21.3 by 3.8 c m (5.8 by 8.4 by 1.5 in.)
- DAQCard ..... Type II PC Card

I/O connector[2]

6070E 6060E 6040E 6020E 6023E PCI-6024E	68-pin male 0.050 D-type
DAQCard-6062E, DAQCard-6024E	68-pin female VHDCI
6071E 6061E 6021E 6025E	100-pin female 0.050 D-type
DAQCard-AI-16E-4	68-pin female PCMCIA

Environment

Operating temperature ..... 0 to 55 °C; 0 to 40 °C for DAQCard-6062E and DAQCard-6024E with a maximum internal temperature of 70 °C as measured by onboard temperature sensor; case temperature should not exceed 55 °C for any DAQCard
Storage temperature ..... -20 to 70 °C
Relative humidity ..... 10 to 90%, noncondensing

Certifications and Compliances

CE Mark Compliance CE

1 Refer to RTSI™ specifications for available RTSI trigger lines.
2 See page 184 for RT Series devices power requirements and dimensions.

Accuracy Specifications for Data Acquisition

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 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:

% 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:

*Absolute Accuracy = ±[(Input Voltage * % of Reading) + (Offset + Noise + Quantization + 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:

*Drift = Temperature Difference * % Drift per °C * 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, the one year after calibration 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 ±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 ±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:

*Absolute Accuracy = ±[(10 * 0.0001) + 397.2 µV + 45.8 µV = ± 1.443 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).

*Absolute Accuracy = 1.443mV + ((45 °C – 35 °C) * 0.000002 / °C * 10 V) = ±1.643 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:

*Noise + Quantization for x averaged points = Averaged Noise + Quantization from table * $\sqrt{100/x}$*

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

*Noise + Quantization = 45.7 µV * $\sqrt{100/1000}$ = 14.5 µV*

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

See page 256 or visit *ni.com/calibration* for more information on the importance of calibration on DAQ device accuracy.

Accuracy Specifications for Data Acquisition

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 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 ±10 V range on the PCI-MIO-16XE-50 and averaging 100 points for each measurement. Using the accuracy table on page 333 (reprinted below for your convenience), we find:

Averaged Relative Accuracy = 60.3 µV

This means that a measurement taken at time t2 would have to be 60.3 µV greater or less than the measurement taken at time t1 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 344 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 349. For the 10 V range the CMRR specification for the NI 6052E devices is 97 dB.

	Nominal	Absolute Accuracy								Relative Accuracy	
		% of Reading			Offset	Noise + Quantization (µV)		Temp	Absolute Accuracy	Resolution (µV)	
	Range (V)	24 Hrs	90 Days	1 Year	(µV)	Single Pt.	Averaged	Drift (%/°C)	at Full Scale (mV)	Single Pt.	Averaged
PCI, AT, and DAQPad	±10	0.0058%	0.0078%	0.0100%	397.2	526.4	45.8	0.0002	1.443	602.7	60.3
	±5	0.0208%	0.0228%	0.0250%	200.6	263.2	22.9	0.0007	1.474	301.4	30.1
	±1	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	0.0075%	0.0095%	0.0117%	815.4	1029.1	91.6	0.0005	2.077	1205.4	120.5
	±5	0.0225%	0.0245%	0.0267%	409.7	514.6	45.8	0.0010	1.791	602.7	60.3
	±1	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 value (for example, 10 V for the ±10 V range) after one year assuming 100 pt averaging of data. See the overview on page 312 for an example calculation of this type.

Table 1. NI 601xE Analog Input Accuracy Specifications