

NI 6023E/6024E/6025E Family Specifications

This document lists the I/O terminal summary and specifications for the devices that make up the NI 6023E/6024E/6025E family of devices. This family includes the following devices:

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

For the most current edition of this document, refer to ni.com/manuals. For more information about using your E Series device, refer to the *E Series Help* at ni.com/manuals or on your NI-DAQ CD. Refer to the *DAQ Quick Start Guide* for more information about accessing documents on the NI-DAQ CD.



Note With NI-DAQmx, National Instruments has revised its terminal names so they are easier to understand and more consistent among NI hardware and software products. The revised terminal names used in this document are usually similar to the names they replace. For a complete list of traditional NI-DAQ terminal names and their NI-DAQmx equivalents, refer to the *Terminal Name Equivalences* table in the *E Series Help*.

Table 1. I/O Terminal Summary

Terminal Name	Terminal Type and Direction	Impedance Input/Output	Protection (Volts) On/Off	Source (mA at V)	Sink (mA at V)	Rise Time (ns)	Bias
AI <0..15>	AI	100 G Ω in parallel with 100 pF	42/35	—	—	—	± 200 pA
AI SENSE	AI	100 G Ω in parallel with 100 pF	40/25	—	—	—	± 200 pA

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Table 1. I/O Terminal Summary (Continued)

Terminal Name	Terminal Type and Direction	Impedance Input/Output	Protection (Volts) On/Off	Source (mA at V)	Sink (mA at V)	Rise Time (ns)	Bias
AI GND	—	—	—	—	—	—	—
AO 0 ¹	AO	0.1 Ω	Short-circuit to ground	5 at 10	5 at -10	10 V/ μ s	—
AO 1 ¹	AO	0.1 Ω	Short-circuit to ground	5 at 10	5 at -10	10 V/ μ s	—
AO GND	—	—	—	—	—	—	—
D GND	—	—	—	—	—	—	—
V _{CC}	—	0.1 Ω	Short-circuit to ground	1A fused	—	—	—
P0.<0..7>	DIO	—	V _{CC} + 0.5	13 at (V _{CC} - 0.4)	24 at 0.4	1.1	50 k Ω pu
P0.<0..7> ²	DIO	—	V _{CC} + 0.5	2.5 at 3.7 min	2.5 at 0.4	5	100 k Ω pu
P1.<0..7> ²	DIO	—	V _{CC} + 0.5	2.5 at 3.7 min	2.5 at 0.4	5	100 k Ω pu
P2.<0..7> ²	DIO	—	V _{CC} + 0.5	2.5 at 3.7 min	2.5 at 0.4	5	100 k Ω pu
AI HOLD COMP or AI HOLD	DO	—	—	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 k Ω pu
EXTSTROBE*	DO	—	—	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 k Ω pu
PFI 0 or PFI 0/ (AI START TRIG or AI START)	DIO	—	V _{CC} + 0.5	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 k Ω pu
PFI 1 or PFI 1/ (AI REF TRIG or REF TRIG)	DIO	—	V _{CC} + 0.5	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 k Ω pu
PFI 2 or PFI 2/ (AI CONV CLK or AI CONV)*	DIO	—	V _{CC} + 0.5	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 k Ω pu
PFI 3 or PFI 3/ (CTR 1 SOURCE or CTR 1 SRC)	DIO	—	V _{CC} + 0.5	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 k Ω pu
PFI 4 or PFI 4/ CTR 1 GATE	DIO	—	V _{CC} + 0.5	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 k Ω pu

Table 1. I/O Terminal Summary (Continued)

Terminal Name	Terminal Type and Direction	Impedance Input/Output	Protection (Volts) On/Off	Source (mA at V)	Sink (mA at V)	Rise Time (ns)	Bias
CTR 1 OUT	DO	—	—	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 5 or PFI 5/ (AO SAMP CLK or AO SAMP)*	DIO	—	V _{CC} + 0.5	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 6 or PFI 6/ (AO START TRIG or AO START)	DIO	—	V _{CC} + 0.5	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 7 or PFI 7/ (AI SAMP CLK or AI SAMP)	DIO	—	V _{CC} + 0.5	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 8 or PFI 8/ (CTR 0 SOURCE or CTR 0 SRC)	DIO	—	V _{CC} + 0.5	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 9 or PFI 9/ CTR 0 GATE	DIO	—	V _{CC} + 0.5	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 kΩ pu
CTR 0 OUT	DO	—	—	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 kΩ pu
FREQ OUT or F OUT	DO	—	—	3.5 at (V _{CC} - 0.4)	5 at 0.4	1.5	50 kΩ pu
<p>* Indicates active low</p> <p>¹ NI PCI-6024E and NI 6025E only</p> <p>² NI 6025E only</p> <p>AI = Analog Input DIO = Digital Input/Output pu = pull-up AO = Analog Output DO = Digital Output</p> <p>Note: The tolerance on the 50 kΩ pull-up resistors is large. Actual value might range between 17 kΩ and 100 kΩ.</p>							

Specifications

The following specifications are typical at 25 °C unless otherwise noted.

Analog Input

Input Characteristics

Number of channels 16 single-ended or 8 differential (software-selectable per channel)

Type of A/D converter (ADC) Successive approximation

Resolution12 bits, 1 in 4,096
 Sampling rate200 kS/s guaranteed

Input signal ranges (bipolar only)

Range	Bipolar
20 V	±10 V
10 V	±5 V
1 V	±500 mV
100 mV	±50 mV

Input couplingDC

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

Overvoltage protection

Signal	Powered On	Powered Off
AI <0..15>	±42	±35
AI SENSE	±40	±25

FIFO buffer size

NI DAQCard-6024E2,048 samples (S)
 NI 6023E, NI PCI-6024E,
 NI 6025E512 S

Data transfersDirect memory access (DMA)¹,
 interrupts, programmed I/O

DMA¹ modesScatter-gather
 (single transfer, demand transfer)

Configuration memory size512 words (1 word = 8 bits)

¹ No DMA on the NI DAQCard-6024E.

Accuracy Information

NI DAQCard-6024E

Nominal Range (V)		Absolute Accuracy						Relative Accuracy		
		% of Reading		Offset (mV)	Noise + Quantization (mV)		Temp Drift (%/°C)	Absolute Accuracy at Full Scale (mV)	Resolution (mV)	
Positive Full Scale	Negative Full Scale	24 Hours	1 Year		Single Pt.	Averaged			Single Pt.	Averaged
10	-10	0.0872	0.0914	8.830	3.910	1.042	0.0010	19.012	5.890	1.370
5	-5	0.0272	0.0314	4.420	1.950	0.521	0.0005	6.517	2.950	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. NI recommends a one-year calibration interval. 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 points of averaged data.

NI 6023E, NI PCI-6024E, NI 6025E

Nominal Range (V)		Absolute Accuracy						Relative Accuracy		
		% of Reading		Offset (mV)	Noise + Quantization (mV)		Temp Drift (%/°C)	Absolute Accuracy at Full Scale (mV)	Resolution (mV)	
Positive Full Scale	Negative Full Scale	24 Hours	1 Year		Single Pt.	Averaged			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. NI recommends a one-year calibration interval. 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 points of averaged data.

Transfer Characteristics

Relative accuracy

Dithered	± 0.5 LSB typ
Undithered	± 1.5 LSB max

Differential nonlinearity (DNL)

NI DAQCard-6024E.....	± 0.75 LSB typ, -0.9 to +1.5 LSB max
NI 6023E, NI PCI-6024E, NI 6025E	± 0.5 LSB typ, ± 1.0 LSB max

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

Offset error

Pregain error after calibration.....	± 12 μ V max
Pregain error before calibration.....	± 28 mV max
Postgain error after calibration	± 0.5 mV max
Postgain error before calibration	± 100 mV max

Gain error (relative to calibration reference)

After calibration (gain = 1).....	$\pm 0.02\%$ of reading max
Before calibration	$\pm 2.75\%$ of reading max
Gain $\neq 1$ with gain error adjusted to 0 at gain = 1.....	$\pm 0.05\%$ of reading max

Amplifier Characteristics

Input impedance

Normal powered on	100 G Ω in parallel with 100 pF
Powered off	4 k Ω min
Overload	4 k Ω min

Input bias current

.....	± 200 pA
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Input offset current

.....	± 100 pA
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Common-mode rejection ratio (CMRR), DC to 60 Hz

Range 10 to 20 mV	85 dB
Range 100 mV to 1 V	90 dB

Dynamic Characteristics

Bandwidth

Small signal (–3 dB) 500 kHz

Large signal (1% THD)

NI DAQCard-6024E..... 265 kHz

NI PCI-6023E, NI PCI-6024E,

NI 6025E..... 225 kHz

Settling time for full-scale step 5 μ s max to ± 1.0 LSB accuracy¹

System noise (LSB_{rms}, not including quantization)

Device	Range	Dither Off	Dither On
NI DAQCard-6024E	10 to 20 V	0.1	0.65
	1 V	0.45	0.65
	100 mV	0.70	0.90
NI 6023E, NI PCI-6024E, NI 6025E	1 to 20 V	0.1	0.6
	100 mV	0.7	0.8

Crosstalk..... –60 dB, DC to 100 kHz

Stability

Recommended warm-up time

NI DAQCard-6024E 30 minutes

NI 6023E, NI PCI-6024E,

NI 6025E..... 15 minutes

Offset temperature coefficient

Pregain $\pm 15 \mu\text{V}/^\circ\text{C}$

Postgain..... $\pm 240 \mu\text{V}/^\circ\text{C}$

Gain temperature coefficient..... $\pm 25 \text{ ppm}/^\circ\text{C}$

¹ Accuracy values are valid for source impedances <1 k Ω . Refer to *Multichannel Scanning Considerations* in the *E Series Help* for more information.

Analog Output (NI 6024E/6025E Only)

Output Characteristics

Number of channels2 voltage

Resolution12 bits, 1 in 4,096

Max update rate
 DMA¹10 kHz, system dependent
 Interrupts.....1 kHz, system dependent

Type of D/A converter (DAC).....Double buffered, multiplying

FIFO buffer size.....None

Data transfersDMA¹, interrupts,
 programmed I/O

DMA¹ modesScatter-gather
 (single transfer, demand transfer)

Accuracy Information

NI DAQCard-6024E

Nominal Range (V)		Absolute Accuracy					Absolute Accuracy at Full Scale (mV)
		% of Reading			Offset (mV)	Temp Drift (%/ °C)	
Positive Full Scale	Negative Full Scale	24 Hours	90 Days	1 Year			
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.							

NI PCI-6024E, NI 6025E

Nominal Range (V)		Absolute Accuracy					Absolute Accuracy at Full Scale (mV)
		% of Reading			Offset (mV)	Temp Drift (%/ °C)	
Positive Full Scale	Negative Full Scale	24 Hours	90 Days	1 Year			
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.							

¹ No DMA on the NI DAQCard-6024E.

Transfer Characteristics

Relative accuracy, or integral nonlinearity (INL)

After calibration

NI DAQCard-6024E..... ± 0.5 LSB typ, ± 1.0 LSB max

NI PCI-6024E, NI 6025E ± 0.3 LSB typ, ± 0.5 LSB max

Before calibration ± 4 LSB max

DNL

After calibration

NI DAQCard-6024E..... ± 0.5 LSB typ, ± 1.0 LSB max

NI PCI-6024E, NI 6025E ± 0.3 LSB typ, ± 1.0 LSB max

Before calibration ± 3 LSB max

Monotonicity 12 bits, guaranteed after calibration

Offset error

After calibration ± 1.0 mV max

Before calibration ± 200 mV max

Gain error (relative to internal reference)

After calibration $\pm 0.01\%$ of output max

Before calibration $\pm 0.75\%$ of output max

Voltage Output

Range ± 10 V

Output coupling..... DC

Output impedance 0.1Ω max

Current drive ± 5 mA max

Protection Short-circuit to ground

Power-on state (steady state)..... ± 200 mV

Initial power-up glitch

Magnitude

NI DAQCard-6024E..... ± 1.5 V

NI PCI-6024E, NI 6025E ± 1.1 V

Duration

NI DAQCard-6024E	1.0 s
NI PCI-6024E, NI 6025E	2.0 ms

Power reset glitch

Magnitude

NI DAQCard-6024E	± 1.5 V
NI PCI-6024E, NI 6025E	± 2.2 V

Duration

NI DAQCard-6024E	1.0 s
NI PCI-6024E, NI 6025E	4.2 μ s

Dynamic Characteristics

Settling time for full-scale step..... 10 μ s to ± 0.5 LSB accuracy¹

Slew rate 10 V/ μ s

Noise 200 μ V_{rms}, DC to 1 MHz

Midscale transition glitch

Magnitude

NI DAQCard-6024E	± 13 mV
NI PCI-6024E, NI 6025E	± 42 mV

Duration..... 2.0 μ s

Stability

Offset temperature coefficient ± 50 μ V/ $^{\circ}$ C

Gain temperature coefficient ± 25 ppm/ $^{\circ}$ C

Digital I/O

Number of channels

NI DAQCard-6024E, NI 6023E, NI PCI-6024E	8 input/output
NI 6025E	32 input/output

Compatibility 5 V/TTL

¹ Accuracy values are valid for source impedances <1 k Ω . Refer to *Multichannel Scanning Considerations* in the *E Series Help* for more information.

◆ NI 6023E/6024E

Digital logic levels on P0.<0..7>

Level	Min	Max
Input low voltage	0 V	0.8 V
Input high voltage	2 V	5 V
Input low current ($V_{in} = 0$ V)	—	-320 μ A
Input high current ($V_{in} = 5$ V)	—	10 μ A
Output low voltage ($I_{OL} = 24$ mA)	—	0.4 V
Output high voltage ($I_{OH} = 13$ mA)	4.35 V	—

Power-on state..... Input (high-impedance),
50 k Ω pull-up to +5 VDC

Data transfers Programmed I/O

◆ NI 6025E

Digital logic levels on P0.<0..7>, P1.<0..7>, and P2.<0..7>

Level	Min	Max
Input low voltage	0 V	0.8 V
Input high voltage	2.2 V	5 V
Input low current ($V_{in} = 0$ V, 100 k Ω pull-up)	—	-75 μ A
Input high current ($V_{in} = 5$ V, 100 k Ω pull-up)	—	10 μ A
Output low voltage ($I_{OL} = 2.5$ mA)	—	0.4 V
Output high voltage ($I_{OH} = 2.5$ mA)	3.7 V	—

Handshaking..... 2-wire

Power-on state

P0.<0..7>..... Input (high-impedance),
100 k Ω pull-up to +5 VDC

P1.<0..7>..... Input (high-impedance),
100 k Ω pull-up to +5 VDC

P2.<0..7>..... Input (high-impedance),
100 k Ω pull-up to +5 VDC

Data transfers Interrupts, programmed I/O

Timing I/O

Number of channels	2 up/down counter/timers, 1 frequency scaler
Resolution	
Counter/timers	24 bits
Frequency scalars	4 bits
Compatibility	5 V/TTL
Base clocks available	
Counter/timers	20 MHz, 100 kHz
Frequency scalars	10 MHz, 100 kHz
Base clock accuracy.....	±0.01%
Max source frequency.....	20 MHz
Min source pulse duration	10 ns in edge-detect mode
Min gate pulse duration	10 ns in edge-detect mode
Data transfers	DMA ¹ , interrupts, programmed I/O
DMA ¹ modes	Scatter-gather (single transfer, demand transfer)

Triggers

Digital Trigger

Compatibility	5 V/TTL
Response	Rising or falling edge
Pulse width	10 ns min

RTSI²

Trigger lines.....	7
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¹ No DMA on the NI DAQCard-6024E.

² RTSI bus interface on PCI devices only.

Calibration

Recommended warm-up time	
NI DAQCard-6024E	30 minutes
NI 6023E, NI PCI-6024E, NI 6025E	15 minutes
Interval	1 year
External calibration reference	Between 6 and 10 V
Onboard calibration reference	
Level	5.000 V (± 3.5 mV), actual value stored in EEPROM
Temperature coefficient	± 5 ppm/ $^{\circ}$ C max
Long-term stability	± 15 ppm/ $\sqrt{1,000}$ h

Power Requirement

+5 VDC ($\pm 5\%$)	
NI DAQCard-6024E	270 mA typ, 750 mA max
NI 6023E, NI PCI-6024E, NI 6025E	0.7 A



Note Excludes power consumed through V_{CC} available at the I/O connector.

Power available at I/O connector	
NI DAQCard-6024E	+4.65 to +5.25 VDC at 250 mA
NI 6023E, NI PCI-6024E, NI 6025E	+4.65 to +5.25 VDC at 1 A

Physical

Dimensions (not including connectors)	
PCI devices	17.5 by 10.6 cm (6.9 by 4.2 in.)
PXI devices	16.0 by 10.0 cm (6.3 by 3.9 in.)
I/O connector	
NI DAQCard-6024E	68-position VHDCI female connector
NI 6023E, NI PCI-6024E	68-pin male SCSI-II type
NI 6025E	100-pin female 0.05D type

- ◆ NI DAQCard-6024E
PC card type.....Type II

Maximum Working Voltage

- Channel-to-earth42 V, Installation Category II
- Channel-to-channel.....42 V, Installation Category II

Environmental

Operating temperature

- NI DAQCard-6024E.....0 to 40 °C with a maximum internal device temperature of 70 °C as measured by onboard temperature sensor; case temperature should not exceed 55 °C

- NI 6023E, NI PCI-6024E,
NI 6025E0 to 55 °C

Storage temperature-20 to 70 °C

Relative humidity10 to 90%, noncondensing

Maximum altitude.....2,000 meters

Pollution Degree (indoor use only)2

- ◆ NI PXI-6025E

Functional shock.....MIL-T-28800 E Class 3 (per Section 4.5.5.4.1) half-sine shock pulse, 11 ms duration, 30 g peak, 30 shocks per face

Operational random vibration.....5 to 500 Hz, 0.31 g_{rms}, 3 axes

Non-operational random vibration5 to 500 Hz, 2.5 g_{rms}, 3 axes



Note Random vibration profiles for the NI PXI-6025E were developed in accordance with MIL-T-28800E and MIL-STD-810E Method 514. Test levels exceed those recommended in MIL-STD-810E for Category 1, Basic Transportation.

Safety

- ◆ NI PCI-6023E/6024E/6025E, NI PXI-6025E

The device meets the requirements of the following standards for safety and electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 3111-1, UL 61010B-1
- CAN/CSA C22.2 No. 1010.1



Note For UL and other safety certifications, refer to the product label or visit ni.com.

- ◆ NI DAQCard-6024E

The device meets the requirements of the following standards for safety and electrical equipment for measurement, control, and laboratory use:

- IEC 60950, EN 60950
- UL 1950, UL 60950
- CAN/CSA C22.2 No. 60950



Note For UL and other safety certifications, refer to the product label or visit ni.com.

Electromagnetic Compatibility

Emissions EN 55011 Class A at 10 m
FCC Part 15A above 1 GHz

Immunity EN 61326:1997 + A2:2001,
Table 1

EMC/EMI CE, C-Tick, and FCC Part 15
(Class A) Compliant



Note For EMC compliance, you *must* operate this device with shielded cabling.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE Marking, as follows:

Low-Voltage Directive (safety) 73/23/EEC

Electromagnetic Compatibility
Directive (EMC) 89/336/EEC



Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, click **Declarations of Conformity Information** at ni.com/hardref.nsf/. This Web site lists the DoCs by product family. Select the appropriate product family, followed by your product, and a link to the DoC appears in Adobe Acrobat format. Click the Acrobat icon to download or read the DoC.