

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 Equivalents* 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
AI GND	—	—	—	—	—	—	—

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
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	—	—	—	—	—	—	—
+5 V	—	0.1 Ω	Short-circuit to ground	1 A 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
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
P3.<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/(AI START TRIG)	DIO	—	$V_{CC} + 0.5$	3.5 at ($V_{CC} - 0.4$)	5 at 0.4	1.5	50 k Ω pu
PFI 1/(AI 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/(AI CONV CLK)*	DIO	—	$V_{CC} + 0.5$	3.5 at ($V_{CC} - 0.4$)	5 at 0.4	1.5	50 k Ω pu
PFI 3/CTR 1 SOURCE	DIO	—	$V_{CC} + 0.5$	3.5 at ($V_{CC} - 0.4$)	5 at 0.4	1.5	50 k Ω pu
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
CTR 1 OUT	DO	—	—	3.5 at ($V_{CC} - 0.4$)	5 at 0.4	1.5	50 k Ω pu
PFI 5/(AO SAMP CLK)*	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
PFI 6/(AO START TRIG)	DIO	—	$V_{CC} + 0.5$	3.5 at $(V_{CC} - 0.4)$	5 at 0.4	1.5	50 k Ω pu
PFI 7/(AI SAMP CLK)	DIO	—	$V_{CC} + 0.5$	3.5 at $(V_{CC} - 0.4)$	5 at 0.4	1.5	50 k Ω pu
PFI 8/CTR 0 SOURCE	DIO	—	$V_{CC} + 0.5$	3.5 at $(V_{CC} - 0.4)$	5 at 0.4	1.5	50 k Ω pu
PFI 9/CTR 0 GATE	DIO	—	$V_{CC} + 0.5$	3.5 at $(V_{CC} - 0.4)$	5 at 0.4	1.5	50 k Ω pu
CTR 0 OUT	DO	—	—	3.5 at $(V_{CC} - 0.4)$	5 at 0.4	1.5	50 k Ω pu
FREQ OUT	DO	—	—	3.5 at $(V_{CC} - 0.4)$	5 at 0.4	1.5	50 k Ω pu

* Indicates active low

¹ NI PCI-6024E and NI 6025E only

² NI 6025E only

AI = Analog Input DIO = Digital Input/Output pu = pull-up
 AO = Analog Output DO = Digital Output

Note: The tolerance on the 50 k Ω pull-up resistors is large. Actual value might range between 17 k Ω and 100 k Ω .

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

Resolution 12 bits, 1 in 4,096

Max sampling rate 200 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-6024E.....2,048 samples (S)
 NI 6023E, NI PCI-6024E,
 NI 6025E512 S

DMA (PCI/PXI only)

Channels1
 Data sources/destinationsAnalog input, analog output,
 counter/timer 0, or
 counter/timer 1

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	4.7 k Ω
Overload	4.7 k Ω

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 μs typ to ±0.5 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 ±15 μV/°C

Postgain..... ±240 μV/°C

Gain temperature coefficient..... ±25 ppm/°C

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

Analog Output (NI 6024E/6025E Only)

Output Characteristics

Number of channels.....2 voltage

Resolution.....12 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	5 μ s typ to ± 0.5 LSB accuracy ¹ 5 μ s max to ± 1.0 LSB accuracy
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Slew rate	10 V/ μ s
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Noise	200 μ V _{rms} , DC to 1 MHz
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Midscale transition glitch

Magnitude

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

Duration	2.0 μ s
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Stability

Offset temperature coefficient	± 50 μ V/ $^{\circ}$ C
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Gain temperature coefficient	± 25 ppm/ $^{\circ}$ C
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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
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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 P1.<0..7>, P2.<0..7>, and P3.<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

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

P3.<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	
Up/down counter/timers	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

Purpose	
Analog input	Start, reference, and pause trigger, sample clock
Analog output	Start and pause trigger, sample clock
Counter/timers	Source, gate
External sources.....	PFI <0..9>, RTSI <0..6> ²
Compatibility	5 V TTL

¹ No DMA on the NI DAQCard-6024E.

² No RTSI on the NI DAQCard-6024E.

Response Rising or falling edge

Pulse width 10 ns min

RTSI¹

Trigger lines 7

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 +5 V 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

¹ No RTSI on the NI DAQCard-6024E.

Physical

Dimensions (not including connectors)

PCI devices.....	17.5 by 10.7 cm (6.9 by 4.2 in.)
PXI devices.....	16.0 by 10.0 cm (6.3 by 3.9 in.)

NI DAQCard-6024E

PC card type	Type II
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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

Maximum Working Voltage

Channel-to-earth	42 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 6025E	0 to 55 °C

Storage temperature-20 to 70 °C

Relative humidity10 to 90%, noncondensing

Maximum altitude.....2,000 m

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 vibration 5 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

◆ 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. 1010.1



Note For UL and other safety certifications, refer to the product label, or visit ni.com/hardref.nsf, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

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

ImmunityEN 61326:1997
A2:2001, Table 1

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, visit ni.com/hardref.nsf, search by model number or product line, and click the appropriate link in the Certification column.

