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

I/O Terminal Summary

Note With NI-DAQmx, National Instruments 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 (Legacy) terminal names and their NI-DAQmx equivalents, refer to *Terminal Name Equivalents* of the *E Series Help*.

Table 1. I/O Terminals

Terminal Name	Terminal Type and Direction	Impedance Input/ Output	Protection (V) On/Off	Source (mA at V)	Sink (mA at V)	Rise Time (ns)	Bias
AI <0..15>	AI	100 GΩ in parallel with 100 pF	42/35	—	—	—	±200 pA
AI SENSE	AI	100 GΩ in parallel with 100 pF	40/25	—	—	—	±200 pA
AI GND	—	—	—	—	—	—	—
AO 0†	AO	0.1 Ω	Short-circuit to ground	5 at 10	5 at –10	10 V/µs	—
AO 1†	AO	0.1 Ω	Short-circuit to ground	5 at 10	5 at –10	10 V/µs	—
AO GND	—	—	—	—	—	—	—
D GND	—	—	—	—	—	—	—

NATIONAL INSTRUMENTS

Table 1. I/O Terminals (Continued)

Terminal Name	Terminal Type and Direction	Impedance Input/ Output	Protection (V) On/Off	Source (mA at V)	Sink (mA at V)	Rise Time (ns)	Bias
+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 kΩ pu
P1.<0..7>‡	DIO	—	V_{CC} + 0.5	2.5 at 3.0 min	2.5 at 0.4	5	100 kΩ pu
P2.<0..7>‡	DIO	—	V_{CC} + 0.5	2.5 at 3.0 min	2.5 at 0.4	5	100 kΩ pu
P3.<0..7>‡	DIO	—	V_{CC} + 0.5	2.5 at 3.0 min	2.5 at 0.4	5	100 kΩ pu
AI HOLD COMP or AI HOLD	DO	—	—	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
EXT STROBE*	DO	—	—	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ 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 kΩ 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 kΩ 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 kΩ 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 kΩ 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 kΩ pu
CTR 1 OUT	DO	—	—	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ 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 kΩ pu
PFI 6/ (AO START TRIG)	DIO	—	V_{CC} + 0.5	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ 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 kΩ 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 kΩ 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 kΩ pu

Table 1. I/O Terminals (Continued)

Terminal Name	Terminal Type and Direction	Impedance Input/ Output	Protection (V) On/Off	Source (mA at V)	Sink (mA at V)	Rise Time (ns)	Bias
CTR 0 OUT	DO	—	—	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
FREQ OUT	DO	—	—	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu

* Indicates active low.

† NI 6024/6025E only.

‡ 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 kΩ pull-up resistors is large. Actual value might range between 17 kΩ and 100 kΩ.

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 coupling ..... DC

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 6025E.....512 S

DMA (PCI/PXI only)

Channels.....1

Data sources/destinations.....Analog input, analog output, counter/timer 0, or counter/timer 1

Data transfers.....Direct memory access (DMA), interrupts, programmed I/O

DMA modes[1].....Scatter-gather (single transfer, demand transfer)

Configuration memory size.....512 words (1 word = 8 bits)

[1] DMA is not available on the NI DAQCard-6024E.

Accuracy Information (NI DAQCard-6024E Only)

Nominal Range (V)		Absolute Accuracy							Relative Accuracy Resolution (mV)	
		% of Reading			Noise + Quantization (mV)					
Positive Full Scale	Negative Full Scale	24 Hours	1 Year	Offset (mV)	Single Pt.	Averaged	Temp Drift (%/°C)	Absolute Accuracy at Full Scale (mV)	Single Pt.	Averaged
10	–10	–10	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. Go to `ni.com/info` and enter info code `rdspec` for example calculations.

Accuracy Information (NI 6023E, NI PCI-6024E, NI 6025E Only)

Nominal Range (V)		Absolute Accuracy							Relative Accuracy Resolution (mV)	
		% of Reading			Noise + Quantization (mV)					
Positive Full Scale	Negative Full Scale	24 Hours	1 Year	Offset (mV)	Single Pt.	Averaged	Temp Drift (%/°C)	Absolute Accuracy 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. 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. Go to `ni.com/info` and enter info code `rdspec` for example calculations.

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 µV 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) .....±0.02% of reading max
- Before calibration .....±2.75% of reading max

Gain ≠ 1 with gain error adjusted to 0 at gain = 1 .....±0.05% of reading max

Amplifier Characteristics

Input impedance

- Normal powered on .....100 GΩ in parallel with 100 pF
- Powered off.....4.7 kΩ
- Overload.....4.7 kΩ

Input bias current.....±200 pA

Input offset current .....±100 pA

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 ±1.0 LSB accuracy[1]

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* of 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

DMA[1] ..... 10 kHz, system dependent

Interrupts ..... 1 kHz, system dependent

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

FIFO buffer size..... None

Data transfers ..... DMA[1], interrupts, programmed I/O

DMA modes[1] ..... Scatter-gather (single transfer, demand transfer)

Accuracy Information (NI DAQCard-6024E Only)

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

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. Go to `ni.com/info` and enter info code `rdspec` for example calculations.

Accuracy Information (NI PCI-6024E, NI 6025E Only)

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

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. Go to `ni.com/info` and enter info code `rdspec` for example calculations.

[1] DMA is not available 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.....±0.01% of output max
- Before calibration .....±0.75% of output max

Voltage Output

Range.....±10 V

Output coupling.....DC

Output impedance.....0.1 Ω 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 µs

Dynamic Characteristics

Settling time for full-scale step..... 10 µs to ±0.5 LSB accuracy

Slew rate ..... 10 V/µs

Noise ..... 200 μV_{rms}, DC to 1 MHz

Midscale transition glitch
- Magnitude
  - NI DAQCard-6024E..... ±13 mV
  - NI PCI-6024E, NI 6025E..... ±42 mV
- Duration..... 2.0 µs

Stability

Offset temperature coefficient ..... ±50 µV/°C

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

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

Level	Min	Max
Input low voltage	0 V	0.8 V
Input high voltage	2.0 V	5.0 V
Input low current (V_{in} = 0 V)	—	–320 µA
Input high current (V_{in} = 5 V)	—	10 µA
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 kΩ pull-up to +5 VDC

Data transfers ..... Programmed I/O

Digital logic levels on P1.<0..7>, P2.<0..7>, and P3.<0..7> (NI 6025E Only)

Level	Min	Max
Input low voltage	0 V	0.8 V
Input high voltage	2.2 V	5.0 V
Input low current (V_{in} = 0 V, 100 kΩ pu)	—	–75 µA
Input high current (V_{in} = 5 V, 100 kΩ pu)	—	10 µA
Output low voltage (I_{OL} = 2.5 mA)	—	0.4 V
Output high voltage (I_{OH} = –2.5 mA)	3.0 V	—

Handshaking 2-wire

Power-on state

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

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

P3.<0..7> ..... Input (high-impedance), 100 kΩ 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 scalers ..... 4 bits

Compatibility ..... 5 V/TTL

Base clocks available

Counter/timers ..... 20 MHz, 100 kHz

Frequency scalers ..... 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 modes[1] ..... 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>

Compatibility ..... 5 V TTL

Response ..... Rising or falling edge

Pulse width ..... 10 ns min

RTSI (PCI and PXI Only)

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/°C max

Long-term stability ..... ±15 ppm/$\sqrt{1{,}000\ \text{h}}$

Power Requirement

+5 VDC (±5%)

NI DAQCard-6024E ..... 270 mA typ, 750 mA max

NI 6023E, NI PCI-6024E, NI 6025E ..... 0.7 A

[1] DMA is not available on the NI DAQCard-6024E.

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

Note Excludes power consumed through +5 V available at the I/O connector.

Physical

Dimensions (not including connectors)

PCI devices ..... 17.5 cm × 10.7 cm (6.9 in. × 4.2 in.)

PXI devices ..... 16.0 cm × 10.0 cm (6.3 in. × 3.9 in.)

NI DAQCard-6024E

PC card type ..... Type II

Weight

NI PCI-6023E, PCI-6024E ..... 115 g (4.1 oz)

NI DAQCard-6024E ..... 32 g (1.1 oz)

NI PCI-6025E ..... 117 g (4.1 oz)

NI PXI-6025E ..... 202 g (7.1 oz)

I/O connector

NI 6023E, NI PCI-6024E ..... 68-pin male SCSI-II type

NI DAQCard-6024E ..... 68-position VHDCI female connector

NI 6025E ..... 100-pin female 0.05D type

Maximum Working Voltage

Channel-to-earth ..... 11 V, Installation Category I

Channel-to-channel ..... 11 V, Installation Category I

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 humidity ..... 10 to 90%, noncondensing

Maximum altitude ..... 2,000 m

Pollution Degree (indoor use only) 2

(NI PXI-6025E Only)

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 Only)

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 61010-1
- CAN/CSA-C22.2 No. 61010-1

(NI DAQCard-6024E Only)

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

- IEC 60950-1, EN 60950-1
- UL 60950-1
- CAN/CSA-C22.2 No. 60950-1

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

Electromagnetic Compatibility

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

Immunity ..... EN 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:
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/certification`, search by model number or product line, and click the appropriate link in the Certification column.

Figure 1. NI 6023E Pinout

Figure 2. NI 6024E Pinout

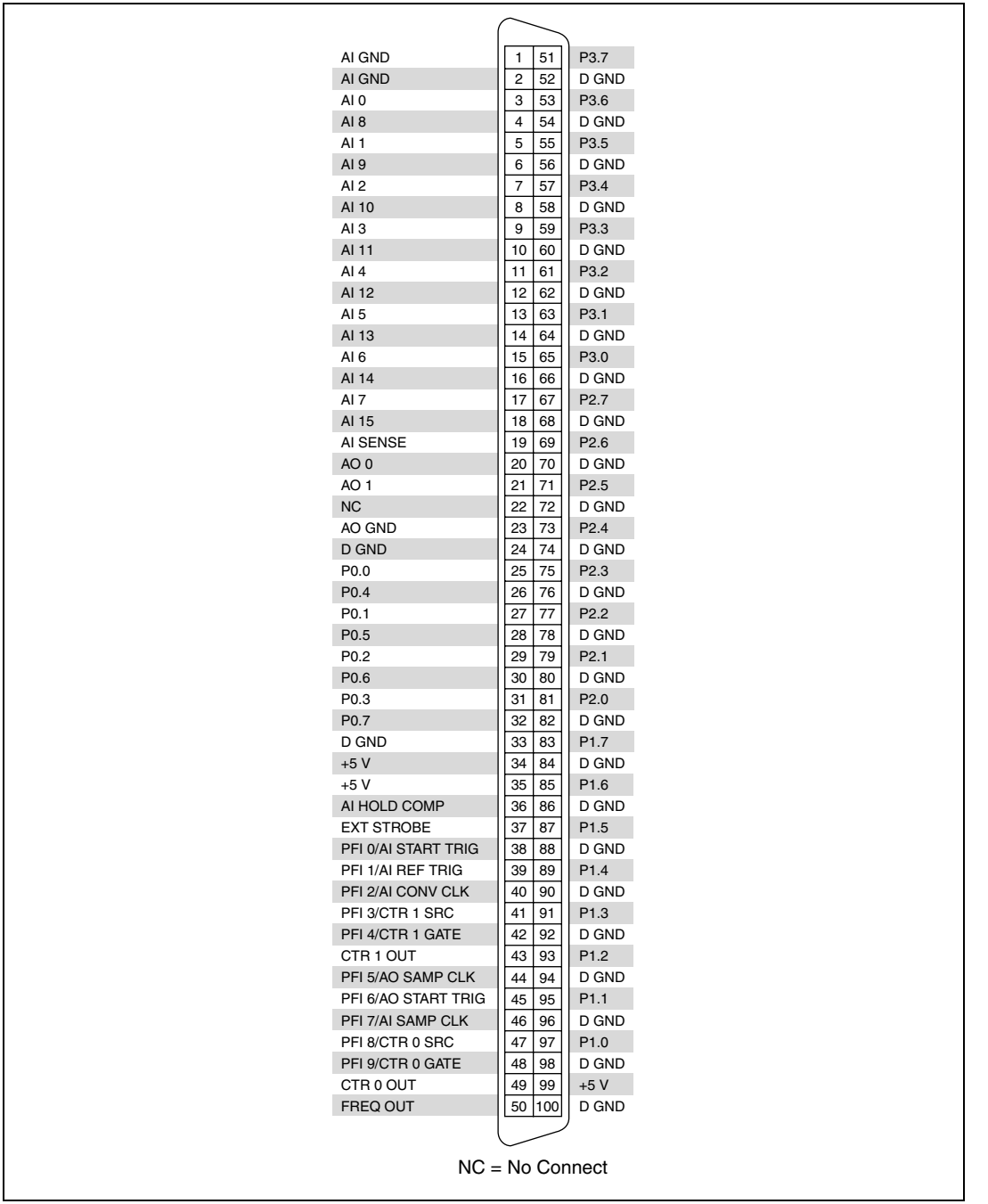

Figure 3. NI 6025E Pinout