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NI PCI-MIO-16XE-50 (NI 6011E) Specifications

This document lists the I/O terminal summary and specifications for the NI PCI-MIO-16XE-50 (NI 6011E).

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	20 GΩ in parallel with 100 pF	25/15	—	—	—	±3 nA ±10 nA
AI SENSE	AI	20 GΩ in parallel with 100 pF	25/15	—	—	—	±3 nA ±10 nA
AI GND	—	—	—	—	—	—	—
AO 0	AO	0.1 Ω	Short-circuit to ground	5 at –10	5 at –10	2 V/µs	—
AO 1	AO	0.1 Ω	Short-circuit to ground	5 at –10	5 at –10	2 V/µs	—
AO GND	—	—	—	—	—	—	—
D GND	—	—	—	—	—	—	—
+5 V	—	0.1 Ω 0.45 Ω	Short-circuit to ground	1 A	—	—	—
P0.<0..7>	DIO	—	V_{CC} + 0.5	13 at (V_{CC} – 0.4)	24 at 0.4	1.1	50 kΩ pu
AI HOLD COMP	DO	—	—	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu

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
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
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.

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

Max sampling rate ..... 20 kS/s guaranteed

Input signal rates

Range (Software-Selectable)	Input Range	
	Bipolar	Unipolar
20 V	±10 V	—
10 V	±5 V	0 to 10 V
5 V	—	0 to 5 V
2 V	±1 V	—
1 V	—	0 to 1 V
200 mV	±100 mV	—
100 mV	—	0 to 100 mV

Input coupling ..... DC

Max working voltage
(signal + common mode) ..... The common-mode signal (the average of two signals in a differential pair) should remain within ±8 V of ground, and each input should remain within ±11 V of ground

Overvoltage protection

- Powered on ..... ±25 V
- Powered off ..... ±15 V

Inputs protected..... AI <0..15>, AI SENSE

FIFO buffer size..... 2,048 samples (S)

DMA

- Channels..... 3
- 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 ..... Scatter-gather (single transfer, demand transfer)

Configuration memory size..... 512 words

Accuracy Information

Nominal Range (V)	Absolute Accuracy								Relative Accuracy Resolution (µV)	
	% of Reading			Offset (µV)	Noise + Quantization (µV)		Temp Drift (%/°C)	Absolute Accuracy at Full Scale (mV)		
	24 Hours	90 Days	1 Year		Single Pt.	Averaged			Single Pt.	Averaged
±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

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 ..... ±0.5 LSB typ, ±1 LSB max

Differential nonlinearity (DNL)..... ±0.5 LSB typ, ±1 LSB max

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

Offset error

- Pregain error after calibration..... ±3 µV max
- Pregain error before calibration..... ±1 mV max
- Postgain error after calibration ... ±76 µV max
- Postgain error before calibration..... ±4 mV max

Gain error (relative to calibration reference)

- After calibration (gain = 1)..... ±30.5 ppm of reading max
- Before calibration ..... ±2,250 ppm of reading max

With gain error adjusted to 0 at gain = 1

- Gain = 2, 10 ..... ±100 ppm of reading
- Gain = 100 ..... ±2,250 ppm of reading

Amplifier Characteristics

Input impedance

- Normal, powered on ..... 7 GΩ in parallel with 100 pF
- Powered off ..... 820 Ω min
- Overload ..... 820 Ω min

Input bias current ..... ±10 nA

Input offset current..... ±20 nA

Common-mode rejection ratio (CMRR), DC to 60 Hz

Range	Bipolar	Unipolar
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

Range	Small Signal (–3 dB)
5 to 20 V	63 kHz
1 to 2 V	57 kHz
100 to 200 mV	33 kHz

Settling time for full-scale step

Range	Accuracy*	
	±0.0015% (±1 LSB)	±0.0061% (±4 LSB)
1 to 20 V	50 µs max	50 µs max
200 mV (bipolar)	75 µs max	50 µs max
100 mV (unipolar)	75 µs max	50 µs max

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

System noise (including quantization noise)

Range	Bipolar	Unipolar
1 to 20 V	1.0	1.0
100 to 200 mV	1.2	1.6

Crosstalk, DC to 100 kHz

- Adjacent channels .....–85 dB
- All other channels .....–100 dB

Stability

Offset temperature coefficient

- Pregain .....±1 µV/°C
- Postgain.....±12 µV/°C

Gain temperature coefficient.....±5 ppm/°C

Analog Output

Output Characteristics

Number of channels.....2 voltage

Resolution.....12 bits, 1 in 4,096

Max update rate.....20 kS/s, system dependent

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

FIFO buffer size.....None

Data transfers.....DMA, interrupts, programmed I/O

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

Accuracy Information

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	0.014	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: 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, or integral nonlinearity (INL).....±0.5 LSB max

DNL.....±1.0 LSB max

Monotonicity.....12 bits, guaranteed

Offset error

- After calibration.....±0.5 mV max
- Before calibration.....±85 mV max

Gain error (relative to calibration reference)

- After calibration.....±0.01% of output max
- Before calibration.....±1% of output max

Voltage Output

Range.....±10 V

Output coupling.....DC

Output impedance.....0.1 Ω max

Current drive.....±5 mA

Protection.....Short-circuit to ground

Power-on state.....0 V (±85 mV)

Dynamic Characteristics

Settling time for full-scale step.....50 µs to ±0.5 LSB

Slew rate.....2 V/µs

Noise.....40 μV_{rms}, DC to 1 MHz

Glitch energy (at midscale transition)

- Magnitude.....±30 mV
- Duration.....10 µs

Stability

Offset temperature coefficient ..... ±25 µV/°C

Gain temperature coefficient..... ±15 ppm/°C

Digital I/O

Number of channels ..... 8 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)

Data transfers ..... Programmed I/O

Max transfer rate
(1 word = 8 bits)..... 50 kwords/s, system dependent

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

Timing I/O

Number of channels ..... 2 up/down counter/timers, 1 frequency scaler

Resolution
- Counter/timers ..... 24 bits (1 in 16,777,216)
- Frequency scaler..... 4 bits

Compatibility ..... 5 V TTL/CMOS

Base clocks available
- Counter/timers ..... 20 MHz, 100 kHz
- Frequency scaler..... 10 MHz, 100 kHz

Base clock accuracy..... ±0.01%

Max source frequency..... 20 MHz

Min source pulse duration..... 10 ns, edge-detect mode

Min gate pulse duration ..... 10 ns, edge-detect mode

Data transfers..... DMA, interrupts, programmed I/O

DMA modes ..... Scatter-gather

Triggers

Digital Trigger

Compatibility..... 5 V TTL

Response..... Rising or falling edge

Pulse width ..... 10 ns min

RTSI

Trigger lines 7

Calibration

Recommended warm-up time ..... 15 minutes

Calibration interval..... 1 year

External calibration reference ..... >6 and <10 V

Onboard calibration reference
- DC level ..... 5.000 V (±3.5 mV), over full operating temperature, actual value stored in EEPROM
- Temperature coefficient..... ±2.0 ppm/°C max
- Long-term stability ..... ±15.0 ppm/$\sqrt{1{,}000\ \text{h}}$

Bus Interface

Type..... Maser, slave

Power

Bus Requirement

+5 VDC (±5%)..... 1.1 A

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

I/O Connector Power

Power available at I/O connector .... +4.65 to +5.25 VDC at 1 A

Physical

Dimensions
(not including connectors)..... 17.5 cm × 10.6 cm (6.9 in. × 4.2 in.)

Weight ..... 279 g (9.8 oz)

I/O connector..... 68-pin male SCSI-II type

Maximum Working Voltage

Maximum working voltage refers to the signal voltage plus the common-mode voltage.

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

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

Environmental

Operating temperature.....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

Safety

NI 6011E devices meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

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

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

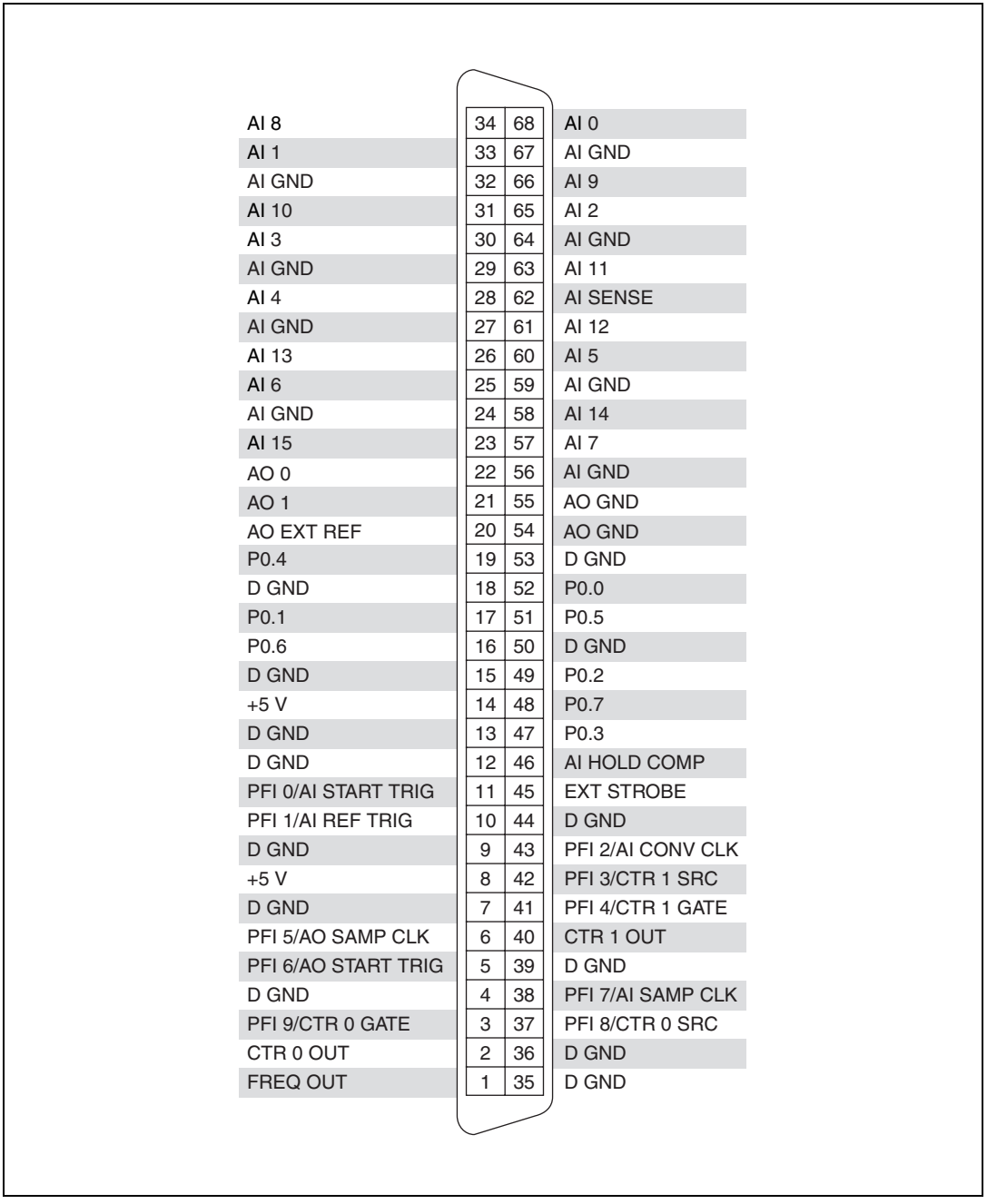


Figure 1. NI PCI-MIO-16XE-50 (NI 6011E) Pinout

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