

# 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 G $\Omega$ in parallel with 100 pF	25/15	—	—	—	$\pm 3$ nA $\pm 10$ nA
AI SENSE	AI	20 G $\Omega$ in parallel with 100 pF	25/15	—	—	—	$\pm 3$ nA $\pm 10$ nA
AI GND	—	—	—	—	—	—	—
AO 0	AO	0.1 $\Omega$	Short-circuit to ground	5 at -10	5 at -10	2 V/ $\mu$ s	—
AO 1	AO	0.1 $\Omega$	Short-circuit to ground	5 at -10	5 at -10	2 V/ $\mu$ s	—
AO GND	—	—	—	—	—	—	—
D GND	—	—	—	—	—	—	—
+5 V	—	0.1 $\Omega$ 0.45 $\Omega$	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 k $\Omega$ pu
AI HOLD COMP	DO	—	—	3.5 at ( $V_{CC} - 0.4$ )	5 at 0.4	1.5	50 k $\Omega$ 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
EXT STROBE*	DO	—	—	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 0/ (AI START TRIG)	DIO	—	V <sub>CC</sub> + 0.5	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 1/ (AI REF TRIG)	DIO	—	V <sub>CC</sub> + 0.5	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 2/ (AI CONV CLK)*	DIO	—	V <sub>CC</sub> + 0.5	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 3/ CTR 1 SOURCE	DIO	—	V <sub>CC</sub> + 0.5	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 4/CTR 1 GATE	DIO	—	V <sub>CC</sub> + 0.5	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
CTR 1 OUT	DO	—	—	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 5/ (AO SAMP CLK)*	DIO	—	V <sub>CC</sub> + 0.5	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 6/ (AO START TRIG)	DIO	—	V <sub>CC</sub> + 0.5	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 7/ (AI SAMP CLK)	DIO	—	V <sub>CC</sub> + 0.5	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 8/ CTR 0 SOURCE	DIO	—	V <sub>CC</sub> + 0.5	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 9/CTR 0 GATE	DIO	—	V <sub>CC</sub> + 0.5	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
CTR 0 OUT	DO	—	—	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
FREQ OUT	DO	—	—	3.5 at (V <sub>CC</sub> - 0.4)	5 at 0.4	1.5	50 kΩ pu
<p>* Indicates active low.            AI = Analog Input      DIO = Digital Input/Output      pu = pull-up            AO = Analog Output      DO = Digital Output</p> <p><b>Note:</b> 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

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 ( $\mu\text{V}$ )	
	% of Reading			Offset ( $\mu\text{V}$ )	Noise + Quantization ( $\mu\text{V}$ )		Temp Drift ( $\%/^{\circ}\text{C}$ )	Absolute Accuracy at Full Scale (mV)	Relative Accuracy Resolution ( $\mu\text{V}$ )			
	24 Hours	90 Days	1 Year		Single Pt.	Averaged			Single Pt.	Averaged		
$\pm 10.0$	0.0058	0.0078	0.0100	397.2	526.4	45.8	0.0002	1.443	602.7	60.3		
$\pm 5.0$	0.0208	0.0228	0.0250	200.6	263.2	22.9	0.0007	1.474	301.4	30.1		
$\pm 1.0$	0.0208	0.0228	0.0250	43.3	52.6	4.6	0.0007	0.298	60.3	6.0		
$\pm 0.1$	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  $\pm 1^{\circ}\text{C}$  of internal calibration temperature and  $\pm 10^{\circ}\text{C}$  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  $\pm 10\text{ V}$  range) after one year, assuming 100 points of averaged data. Go to [ni.com/info](http://ni.com/info) and enter info code `rdspec` for example calculations.

## Transfer Characteristics

Relative accuracy .....  $\pm 0.5$  LSB typ,  
 $\pm 1$  LSB max

Differential nonlinearity (DNL) .....  $\pm 0.5$  LSB typ,  
 $\pm 1$  LSB max

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

Offset error

  Pregain error after calibration .....  $\pm 3$   $\mu$ V max

  Pregain error before calibration .....  $\pm 1$  mV max

  Postgain error after calibration .....  $\pm 76$   $\mu$ V max

  Postgain error before calibration .....  $\pm 4$  mV max

Gain error (relative to calibration reference)

  After calibration (gain = 1) .....  $\pm 30.5$  ppm of reading max

  Before calibration .....  $\pm 2,250$  ppm of reading max

With gain error adjusted to 0 at gain = 1

  Gain = 2, 10 .....  $\pm 100$  ppm of reading

  Gain = 100 .....  $\pm 2,250$  ppm of reading

## Amplifier Characteristics

Input impedance

  Normal, powered on ..... 7 G $\Omega$  in parallel with 100 pF

  Powered off ..... 820  $\Omega$  min

  Overload ..... 820  $\Omega$  min

Input bias current .....  $\pm 10$  nA

Input offset current .....  $\pm 20$  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*	
	$\pm 0.0015\%$ ( $\pm 1$ LSB)	$\pm 0.0061\%$ ( $\pm 4$ LSB)
1 to 20 V	50 $\mu$ s max	50 $\mu$ s max
200 mV (bipolar)	75 $\mu$ s max	50 $\mu$ s max
100 mV (unipolar)	75 $\mu$ s max	50 $\mu$ s max

\* Accuracy values are valid for source impedances  $< 1$  k $\Omega$ . 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 .....  $\pm 1$   $\mu$ V/ $^{\circ}$ C

Postgain .....  $\pm 12$   $\mu$ V/ $^{\circ}$ C

Gain temperature coefficient .....  $\pm 5$  ppm/ $^{\circ}$ 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  $\pm 1$  °C of internal calibration temperature and  $\pm 10$  °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  $\pm 10$  V range) after one year, assuming 100 points of averaged data. Go to [ni.com/info](http://ni.com/info) and enter info code `rdspec` for example calculations.

### Transfer Characteristics

Relative accuracy, or integral nonlinearity (INL).....	$\pm 0.5$ LSB max
DNL.....	$\pm 1.0$ LSB max
Monotonicity .....	12 bits, guaranteed
Offset error	
After calibration.....	$\pm 0.5$ mV max
Before calibration .....	$\pm 85$ mV max
Gain error (relative to calibration reference)	
After calibration.....	$\pm 0.01\%$ of output max
Before calibration .....	$\pm 1\%$ of output max

### Voltage Output

Range.....	$\pm 10$ V
Output coupling.....	DC

Output impedance.....	0.1 $\Omega$ max
Current drive .....	$\pm 5$ mA
Protection .....	Short-circuit to ground
Power-on state.....	0 V ( $\pm 85$ mV)

### Dynamic Characteristics

Settling time for full-scale step.....	50 $\mu$ s to $\pm 0.5$ LSB
Slew rate .....	2 V/ $\mu$ s
Noise .....	40 $\mu$ V <sub>rms</sub> , DC to 1 MHz
Glitch energy (at midscale transition)	
Magnitude.....	$\pm 30$ mV
Duration.....	10 $\mu$ s

## Stability

Offset temperature coefficient .....  $\pm 25 \mu\text{V}/^\circ\text{C}$   
Gain temperature coefficient.....  $\pm 15 \text{ ppm}/^\circ\text{C}$

## 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 ( $V_{in} = 0 \text{ V}$ )	—	$-320 \mu\text{A}$
Input high current ( $V_{in} = 5 \text{ V}$ )	—	$10 \mu\text{A}$
Output low voltage ( $I_{OL} = 24 \text{ mA}$ )	—	0.4 V
Output high voltage ( $I_{OH} = -13 \text{ mA}$ )	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.....  $\pm 0.01\%$   
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 ( $\pm 3.5 \text{ mV}$ ),  
over full operating  
temperature, actual value  
stored in EEPROM  
Temperature coefficient.....  $\pm 2.0 \text{ ppm}/^\circ\text{C}$  max  
Long-term stability .....  $\pm 15.0 \text{ ppm}/\sqrt{1,000 \text{ h}}$

## Bus Interface

Type.....Maser, slave

## Power

### Bus Requirement

+5 VDC ( $\pm 5\%$ )..... 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  $\times$  10.6 cm  
(6.9 in.  $\times$  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](http://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](http://ni.com/certification), search by model number or product line, and click the appropriate link in the Certification column.



AI 8	34	68	AI 0
AI 1	33	67	AI GND
AI GND	32	66	AI 9
AI 10	31	65	AI 2
AI 3	30	64	AI GND
AI GND	29	63	AI 11
AI 4	28	62	AI SENSE
AI GND	27	61	AI 12
AI 13	26	60	AI 5
AI 6	25	59	AI GND
AI GND	24	58	AI 14
AI 15	23	57	AI 7
AO 0	22	56	AI GND
AO 1	21	55	AO GND
AO EXT REF	20	54	AO GND
P0.4	19	53	D GND
D GND	18	52	P0.0
P0.1	17	51	P0.5
P0.6	16	50	D GND
D GND	15	49	P0.2
+5 V	14	48	P0.7
D GND	13	47	P0.3
D GND	12	46	AI HOLD COMP
PFI 0/AI START TRIG	11	45	EXT STROBE
PFI 1/AI REF TRIG	10	44	D GND
D GND	9	43	PFI 2/AI CONV CLK
+5 V	8	42	PFI 3/CTR 1 SRC
D GND	7	41	PFI 4/CTR 1 GATE
PFI 5/AO SAMP CLK	6	40	CTR 1 OUT
PFI 6/AO START TRIG	5	39	D GND
D GND	4	38	PFI 7/AI SAMP CLK
PFI 9/CTR 0 GATE	3	37	PFI 8/CTR 0 SRC
CTR 0 OUT	2	36	D GND
FREQ OUT	1	35	D GND

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

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