

NI 6013/6014 Family Specifications

This document lists the I/O terminal summary and specifications for the NI 6013/6014 family of devices. This family includes the following devices:

- NI PCI-6013
- NI PCI-6014

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 G Ω in parallel with 100 pF	25/15	—	—	—	± 200 pA
AI SENSE	AI	100 G Ω in parallel with 100 pF	25/15	—	—	—	± 200 pA
AI GND	—	—	—	—	—	—	—
AO 0 [†]	AO	0.1 Ω	Short-circuit to ground	5 at 10	5 at -10	—	—
AO 1 [†]	AO	0.1 Ω	Short-circuit to ground	5 at 10	5 at -10	—	—
AO GND	—	—	—	—	—	—	—
D GND	—	—	—	—	—	—	—
+5 V	—	0.1 Ω	Short-circuit to ground	1 A fuse	—	—	—

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
P0.<0..7>	DIO	—	$V_{CC} + 0.5$	10 at $(V_{CC} - 0.4)$	24 at 0.4	1.1	50 k Ω pu
AI HOLD COMP	DO	—	—	3.5 at $(V_{CC} - 0.4)$	5 at 0.4	1.5	50 k Ω pu
EXT STROBE*	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
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
<p>* Indicates active low. † NI 6014 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.</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 ADC Successive
approximation

Resolution 16 bits, 1 in 65,536

Max sampling rate 200 kS/s guaranteed

Input signal ranges

Device Gain (Software-Selectable)	Range
0.5	±10 V
1	±5 V
10	±500 mV
100	±50 mV

Input coupling DC

Maximum working voltage Each input should remain
within ±11 V of ground

Overvoltage protection

Signal Name	Powered Off	Powered On
AI <0..15>	±15 V	±25 V
AI SENSE	±15 V	±25 V

FIFO buffer size 512 samples

Data transfers DMA, interrupts,
programmed I/O

DMA modes Scatter-gather (Single
transfer, demand transfer)

Number of DMA channels 1¹

Configuration memory size 512 words

¹ The NI 6013/6014 has one DMA channel to be shared by all resources on the device.

Accuracy Information

Nominal Range at Full Scale (V)	Absolute Accuracy							Relative Accuracy Resolution (μV)	
	% of Reading		Offset (μV)	Noise + Quantization (μV)		Absolute Accuracy at Full Scale (mV)	Temp Drift ($\%/^{\circ}\text{C}$)	Single Pt.	Averaged
	24 Hours	1 Year		Single Pt.	Averaged				
± 10	0.0658	0.0700	1897.5	933.0	82.40	8.984	0.0010	1084.9	108.5
± 5	0.0158	0.0200	959.8	466.5	41.20	2.003	0.0005	542.4	54.2
± 0.5	0.0658	0.0700	115.8	56.2	5.035	0.471	0.0010	66.3	6.6
± 0.05	0.0658	0.0700	31.4	31.40	3.067	0.069	0.0010	40.4	4.0

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 ± 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

INL ± 1.5 LSB typ,
 ± 3.0 LSB max

No missing codes 16 bits, guaranteed

CMRR (DC to 60 Hz)
 Gain 0.5, 1.0 85 dB
 Gain 10, 100 96 dB

Offset error

Pregain error after calibration ± 2.0 μV max
 Pregain error before calibration ± 28.8 mV max
 Postgain error after calibration ... ± 305 μV max
 Postgain error before calibration ± 40.2 mV max

Gain error (relative to calibration reference)

After calibration (gain = 1) ± 74 ppm of reading max
 Before calibration $\pm 18,900$ ppm of reading max

Gain $\neq 1$ with gain error

adjusted to 0 at gain = 1 ± 300 ppm of reading max

Amplifier Characteristics

Input impedance

Normal powered on 100 G Ω in parallel with 100 pF
 Powered off 820 Ω
 Overload 820 Ω

Input bias current ± 200 pA

Input offset current ± 100 pA

Dynamic Characteristics

Bandwidth

Signal	Bandwidth
Small (-3 dB)	425 kHz
Large (1% THD)	450 kHz

Settling time for full-scale step

Gain 100 ± 2 LSB, 5 μs typ
 Gain 1, 10 ± 2 LSB, 5 μs max
 Gain 0.5 ± 4 LSB, 5 μs typ

System noise (LSB_{rms} , including quantization)

Gain	LSB_{rms}
0.5, 1.0	0.9
10	1.1
100	6.7

Crosstalk (DC to 100 kHz)

Adjacent channels -75 dB
 Other channels ≤ -90 dB

Stability

Recommended warm-up time 15 min

Offset temperature coefficient

Pregain $\pm 20 \mu\text{V}/^\circ\text{C}$

Postgain $\pm 175 \mu\text{V}/^\circ\text{C}$

Gain temperature coefficient $\pm 32 \text{ ppm}/^\circ\text{C}$

Analog Output (NI 6014 Only)

Output Characteristics

Number of channels 2 voltage

Resolution 16 bits, 1 in 65,536

Max update rate

DMA 10 kHz,
system dependent

Interrupts 1 kHz, system dependent

Type of DAC Double-buffered,
multiplying

FIFO buffer size None

Data transfers DMA, interrupts,
programmed I/O

DMA modes Scatter-gather (Single
transfer, demand transfer)

Number of DMA channels 1¹

Accuracy Information

Nominal Range (V)		Absolute Accuracy				
Positive FS	Negative FS	% of Reading		Offset (μV)	Temp Drift ($\%/^\circ\text{C}$)	Absolute Accuracy at Full Scale (μV)
		24 Hours	1 Year			
10	-10	0.0252	0.0337	2,461	0.0005	5,827

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 and enter info code `rdspec` for example calculations.

¹ The NI 6013/6014 has one DMA channel to be shared by all resources on the device.

Transfer Characteristics

Relative accuracy (INL)±3 LSB, typ

DNL.....±2 LSB, typ

Monotonicity15 bits

Offset error

 After calibration±372 μ V max

 Before calibration±250 mV max

Gain error (relative to internal reference)

 After calibration±75 ppm

 Before calibration±22,700 ppm

Voltage Output

Range.....±10 V

Output couplingDC

Output impedance.....0.1 Ω max

Current drive.....±5 mA max

Protection.....Short-circuit to ground

Power-on state (steady state).....±250 mV

Initial power-up glitch

 Magnitude±6.0 V

 Duration4 ms

Power reset glitch

 Magnitude±3.0 V

 Duration3 ms

Dynamic Characteristics

Settling time for full-scale step8 μ s to ±1 LSB accuracy

Slew rate4 V/ μ s

Noise.....360 μ V_{rms},
DC to 400 kHz

Midscale transition glitch

 Magnitude±200 mV

 Duration2.0 μ s

Stability

Offset temperature coefficient±128 μ V/ $^{\circ}$ C

Gain temperature coefficient±26.8 ppm/ $^{\circ}$ C

Digital I/O

Number of channels 8 input/output

Compatibility TTL/CMOS

P0.<0..7>

Digital logic levels

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 μ A
Input high current ($V_{in} = 5$ V)	—	3.33 mA
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),
1.5 k Ω pull down to
D GND

Data transfers Programmed I/O

Max transfer rate 50 kwords/s,
system dependent

Timing I/O

Number of channels

 Up/down counter/timers 2

 Frequency scaler..... 1

Resolution

 Up/down counter/timers 24 bits

 Frequency scaler..... 4 bits

Compatibility 5 V TTL/CMOS

Digital logic levels

Level	Min	Max
Input low voltage	0.0 V	0.8 V
Input high voltage	2.0 V	5.0 V
Output low voltage ($I_{out} = 5$ mA)	—	0.4 V
Output high voltage ($I_{out} = -3.5$ mA)	4.35 V	—

Base clocks available

Up/down counter/timers 20 MHz, 100 kHz

Frequency scaler..... 10 MHz, 100 kHz

Base clock accuracy	$\pm 0.01\%$
Max external source frequency	
Up/down counter/timers	20 MHz
External source selections	PFI <0..9>
External gate selections	PFI <0..9>
Min source pulse duration	10 ns in edge-detect mode
Min gate pulse duration	10 ns in edge-detect mode
Data transfers	
Up/down counter/timers	DMA (scatter-gather), interrupts, programmed I/O
Frequency scaler	Programmed I/O

Digital Trigger

Purpose	
Analog input	Start, reference, and pause trigger, sample clock
Analog output	Start and pause trigger, sample clock
Counter/timers	Source, gate
Source	PFI <0..9>
Compatibility	5 V TTL
Response	Rising or falling edge
Pulse width	10 ns min
External input for digital trigger	
Protection	-0.5 V to VCC + 0.5 V

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	± 5 ppm/ $^{\circ}\text{C}$ max
Long-term stability	± 15 ppm/ $\sqrt{1,000}$ h

Power Requirement

+5 VDC ($\pm 5\%$) 0.7 A



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

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

Physical

Dimensions
(not including connectors) 16.2 cm \times 9.2 cm
(6.4 in. \times 3.6 in.)

Weight

PCI-6013 101 g (3.5 oz)
PCI-6014 104 g (3.6 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 $^{\circ}\text{C}$

Storage temperature -20 to 70 $^{\circ}\text{C}$

Relative humidity 10 to 90%,
noncondensing

Maximum altitude 2,000 m

Pollution Degree
(indoor use only) 2

Safety

NI 6013/6014 devices meet 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



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

ImmunityEN 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.

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
NC	22	56	AI GND
NC	21	55	AO GND
NC	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

NC = No Connect

Figure 1. NI 6013 Pinout

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
NC	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

NC = No Connect

Figure 2. NI 6014 Pinout

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