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

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 GΩ in parallel with 100 pF	25/15	—	—	—	±200 pA
AI SENSE	AI	100 GΩ in parallel with 100 pF	25/15	—	—	—	±200 pA
AI GND	—	—	—	—	—	—	—
AO 0[1]	AO	0.1 Ω	Short-circuit to ground	5 at 10	5 at –10	—	—

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 1[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	—	—	—
P0.<0..7>	DIO	—	V_{CC} + 0.5	10 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
EXTSTROBE*	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 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
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

[1] 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.

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 ..... Bipolar only

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

Input coupling ..... DC

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.....1[1]

Configuration memory size.....512 words

Accuracy Information

Nominal Range at Full Scale (V)	Absolute Accuracy						Temp Drift	Relative Accuracy	
	% of Reading		Offset	Noise + Quantization (µV)		Absolute Accuracy at Full Scale (mV)		Resolution (µV)	
	24 Hours	1 Year	(µV)	Single Pt.	Averaged		(%/°C)	Single Point	Averaged
±10	0.0658	0.0700	1897.5	933.0	82.40	8.984	0.0010	1084.90	108.49
±5	0.0158	0.0200	959.8	466.5	41.20	2.003	0.0005	542.45	54.245
±0.5	0.0658	0.0700	115.8	56.2	5.035	0.471	0.0010	66.299	6.630
±0.05	0.0658	0.0700	31.4	31.40	3.067	0.069	0.0010	40.382	4.038

Note: Accuracies are valid for measurements after 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.

Transfer Characteristics

Relative accuracy.....±1.5 LSB typ, ±3.0 LSB max

DNL.....±0.5 LSB typ, ±1.0 LSB max

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

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

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 ..... ±18,900 ppm of reading max

Gain ≠ 1 with gain error
adjusted to 0 at gain = 1 ..... ±300 ppm of reading max

Amplifier Characteristics

Input impedance

Normal powered on ..... 100 GΩ in parallel with 100 pF

Powered off..... 820 Ω

Overload..... 820 Ω

Input bias current ..... ±200 pA

Input offset current..... ±100 pA

CMRR (DC to 60 Hz)

Gain 0.5, 1.0..... 85 dB

Gain 10, 100..... 96 dB

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.....±20 µV/°C
Postgain .....±175 µV/°C

Gain temperature coefficient .....±32 ppm/°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 ..... 1[1]

Accuracy Information

Nominal Range (V)		Absolute Accuracy					
		% of Reading					
Positive FS	Negative FS	24 Hours	90 Days	1 Year	Offset (µV)	Temp Drift (%/°C)	Absolute Accuracy at Full Scale (µV)
10	–10	0.0154	0.0174	0.0196	1,568	0.0005	3,530

Transfer Characteristics

Relative accuracy (INL) ..... ±3 LSB, typ

DNL ..... ±2 LSB, typ

Monotonicity ..... 15 bits

Offset error

- After calibration ..... ±372 µV 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 coupling ..... DC

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
- Duration ..... 4 ms

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

Power reset glitch

Magnitude.....±3.0 V

Duration.....3 ms

Dynamic Characteristics

Settling time for full-scale step.....8 µs to ±1 LSB accuracy

Slew rate .....4 V/µs

Noise.....360 μV_{rms}, DC to 400 kHz

Midscale transition glitch

Magnitude.....±200 mV

Duration.....2.0 µs

Stability

Offset temperature coefficient .....±128 µV/°C

Gain temperature coefficient .....±26.8 ppm/°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	0.0 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),
1.5 kΩ pull down to DGND

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 ..... ±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 V_{CC} + 0.5 V

Calibration

Recommended warm-up time ..... 15 min

Interval ..... 1 year

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

Onboard calibration reference

- Level ..... 5.000 V (±3.5 mV) (over full operating temperature, 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%) ..... 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 by 9.2 cm (6.4 by 3.6 in.)

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 II

Environmental

Operating temperature..... 0 to 50 °C

Storage temperature ..... –20 to 70 °C

Humidity ..... 10 to 90% RH, noncondensing

Maximum altitude ..... 2,000 m

Pollution Degree (indoor use only)..... 2

Safety

This product is designed to 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 3111-1, UL 61010B-1
- 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

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:

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.

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