NI DAQPad™-6020E Family Specifications

This document lists the I/O terminal summary and specifications for the NI DAQPad-6020E family of devices. This family includes the following devices:

- NI DAQPad-6020E (Half-Size Box)
- NI DAQPad-6020E (Full-Size Box)
- NI DAQPad-6020E BNC

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 50 pF	35/25	—	—	—	±200 pA
AI SENSE	AI	100 GΩ in parallel with 50 pF	35/25	—	—	—	±200 pA
AI GND	—	—	—	—	—	—	—
AO 0	AO	0.1 Ω	Short-circuit to ground	5 at 10	5 at –10	15 V/µs	—
AO 1	AO	0.1 Ω	Short-circuit to ground	5 at 10	5 at –10	15 V/µs	—
AO EXT REF	AI	10 kΩ	35/25	—	—	—	—
AO GND	—	—	—	—	—	—	—
D GND	—	—	—	—	—	—	—

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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	—	—	—
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
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

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
FREQ OUT	DO	—	—	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu

* Indicates active low.

† P0.<6..7> are also pulled down with a 50 kΩ resistor.

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)

Type of A/D converter (ADC)..... Successive approximation

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

Max sampling rate ..... 100 kS/s guaranteed

Input signal ranges

Range (Software-Selectable)	Input Range	
	Bipolar	Unipolar
20 V	±10 V	—
10 V	±5 V	0 to 10 V
5 V	±2.5 V	0 to 5 V
2 V	±1 V	0 to 2 V
1 V	±500 mV	0 to 1 V
500 mV	±250 mV	0 to 500 mV
200 mV	±100 mV	0 to 200 mV
100 mV	±50 mV	0 to 100 mV

Input coupling ..... DC

Max working voltage
(signal + common mode)..... Each input should remain within ±11 V of ground

Overvoltage protection
Powered on ..... ±35 V
Powered off..... ±25 V

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

FIFO buffer size ..... 4,096 samples (S)

Data transfers..... Interrupts, programmed I/O

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

Accuracy Information

Nominal Range at Full Scale (V)	Absolute Accuracy							Relative Accuracy Resolution (mV)	
	% of Reading		Offset (mV)	Noise + Quantization (μV)		Temp Drift (%/°C)	Absolute Accuracy at Full Scale (mV)		
	24 Hours	1 Year		Single Pt.	Averaged			Single Pt.	Averaged
±10.0	0.072	0.076	6.380	3.467	0.846	0.0010	14.826	5.729	1.114
±5.0	0.019	0.021	3.198	1.733	0.423	0.0005	4.6710	2.865	0.557
±2.5	0.072	0.076	1.608	0.867	0.211	0.0010	3.7190	1.432	0.278
±1.0	0.072	0.076	0.653	0.347	0.085	0.0010	1.4980	0.573	0.111
±0.5	0.072	0.076	0.335	0.173	0.042	0.0010	0.7570	0.286	0.056
±0.25	0.072	0.076	0.176	0.105	0.021	0.0010	0.3870	0.151	0.028
±0.1	0.072	0.076	0.081	0.061	0.008	0.0010	0.1650	0.074	0.011
±0.05	0.072	0.076	0.049	0.049	0.004	0.0010	0.0910	0.056	0.006
0 to 10	0.019	0.021	3.198	1.733	0.423	0.0005	5.7210	2.865	0.557
0 to 5	0.072	0.076	1.608	0.867	0.211	0.0010	5.6190	1.432	0.278
0 to 2	0.072	0.076	0.653	0.347	0.085	0.0010	2.2580	0.573	0.111
0 to 1	0.072	0.076	0.335	0.173	0.042	0.0010	1.1370	0.286	0.056
0 to 0.5	0.072	0.076	0.176	0.105	0.021	0.0010	0.5770	0.151	0.028
0 to 0.2	0.072	0.076	0.081	0.061	0.008	0.0010	0.2410	0.074	0.011
0 to 0.1	0.072	0.076	0.049	0.049	0.004	0.0010	0.1290	0.056	0.006

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 .....±0.2 LSB typ
- Undithered .....±1.5 LSB max undithered

Differential nonlinearity (DNL) .....±0.2 LSB typ, ±1.0 LSB max

No missing codes.....12 bits, guaranteed

Offset error

- Pregain error after calibration .....±2 μV max
- Pregain error before calibration .....±24 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 ..... ±2.0% of reading max
- Gain ≠ 1 with gain error adjusted to 0 at gain = 1 ..... ±0.05% of reading max

Amplifier Characteristics

Input impedance 68-pin
I/O connector ..... 100 GΩ in parallel with 50 pF

BNC version
- Powered on
  - CH+ (AI <0..7>) ..... 100 GΩ in parallel with 50 pF
  - CH– (AI <8..15>)
    - With built-in bias resistor disengaged ..... 100 GΩ in parallel with 50 pF
    - With built-in bias resistor engaged (default) ..... 100 Ω in parallel with 50 pF
  - Powered off ..... 3 kΩ min
  - Overload ..... 3 kΩ min

Input bias current ..... ±200 pA

Input offset current ..... ±100 pA

Common-mode rejection ratio (CMRR), 100 mV to 20 V ..... 90 dB, DC to 60 Hz

Dynamic Characteristics

Bandwidth
- Small signal (–3 dB) ..... 150 kHz
- Large signal (1% THD) ..... 200 kHz

Settling time for full-scale step ..... 10 µs max to ±0.5 LSB accuracy[1]

System noise (LSB_{rms}, not including quantization)

Range	Dither Off	Dither On
1 to 20 V	0.07	0.5
500 mV	0.12	0.5
200 mV	0.25	0.6
100 mV	0.5	0.7

Crosstalk, DC to 100 kHz
- Adjacent channels ..... –60 dB
- All other channels ..... –80 dB

Stability

Recommended warm-up time ..... 30 minutes

Offset temperature coefficient
- Pregain ..... ±15 µV/°C
- Postgain ..... ±240 µV/°C

Gain temperature coefficient ..... ±20 ppm/°C

Onboard calibration reference
- Level ..... 5.000 V (±2.5 mV), actual value stored in EEPROM
- Temperature coefficient ..... ±5 ppm/°C max
- Long-term stability ..... ±15 ppm/$\sqrt{1{,}000\ \text{h}}$

Analog Output

Output Characteristics

Number of channels ..... 2 voltage

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

Max update rate ..... 20 S/s (system-dependent)

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

FIFO buffer size ..... None

Data transfers ..... Interrupts, programmed I/O

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

Accuracy Information

Nominal Range (V)		Absolute Accuracy					Absolute Accuracy at Full Scale (mV)
		% of Reading			Offset (µV)	Temp Drift (%/°C)	
Positive Full Scale	Negative Full Scale	24 Hours	90 Days	1 Year			
10	–10	0.018	0.020	0.022	5.93	0.0005	8.133
10	0	0.018	0.020	0.022	3.49	0.0005	5.691

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 non-linearity (INL)
- After calibration ..... ±0.3 LSB typ, ±0.5 LSB max
- Before calibration ..... ±4 LSB max

DNL
- After calibration ..... ±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 ..... ±0.5% of output max

Gain error (relative to external reference) ..... 0% to +0.5% of output max, not adjustable

Voltage Output

Ranges ..... ±10 V, 0 to 10 V, ±AO EXT REF, 0 to AO EXT REF (software-selectable)

Output coupling ..... DC

Output impedance ..... 0.1 Ω max

Current drive ..... ±5 mA max

Protection ..... Short-circuit to ground

Power-on state ..... 0 V (±200 mV)

External reference input
- Range ..... ±11 V
- Overvoltage protection
  - Powered on ..... ±35 V
  - Powered off ..... ±25 V
- Input impedance ..... 10 kΩ
- Bandwidth (–3 dB) ..... 300 kHz

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

Glitch energy (at midscale transition)
- Magnitude ..... ±100 mV
- Duration ..... 3 µs

Stability

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

Gain temperature coefficient
- Internal reference ..... ±25 ppm/°C
- External reference ..... ±25 ppm/°C

Onboard calibration reference
- Level ..... 5.000 V (±2.5 mV), actual value stored in EEPROM
- Temperature coefficient ..... ±5 ppm/°C max
- Long-term stability ..... ±15 ppm/$\sqrt{1{,}000\ \text{h}}$

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	—

Data transfers ..... Programmed I/O

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 scalers ..... 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 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 ..... Interrupts, 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

Calibration

Recommended warm-up time ..... 30 minutes

Calibration interval ..... 1 year

Onboard calibration reference level

- DC level ..... 5.000 V (±3.5 mV) over full operating temperature, actual value stored in EEPROM
- Temperature coefficient ..... ±5.0 ppm/°C max
- Long-term stability ..... ±15.0 ppm/$\sqrt{1{,}000\ \text{h}}$

Bus Interface

Type ..... USB full-speed

Power Requirement

9 to 30 VDC ..... 15 W

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

Note Power supply voltage should never go below 8.5 V, including AC ripple.

Physical

Dimensions

DAQPad-6020E (full-size box)

- DAQPad-6020E BNC ..... 25.4 cm × 30.7 cm × 4.3 cm (10 in. × 12.1 in. × 1.7 in.)
- DAQPad (half-size box) ..... 14.6 cm × 21.3 cm × 3.8 cm (5.8 in. × 8.4 in. × 1.5 in.)

Weight

- NI DAQPad-6020E (half-size box) ..... 806 g (1 lb 12.4 oz)
- NI DAQPad-6020E (full-size box) ..... 1703 g (3 lb 12 oz)
- NI DAQPad-6020E BNC ..... 1886 g (4 lb 2.5 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.....–55 to 150 °C

Relative humidity .....10 to 90%, 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 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:

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 DAQPad-6020E (Full- and Half-Size Box) Pinout

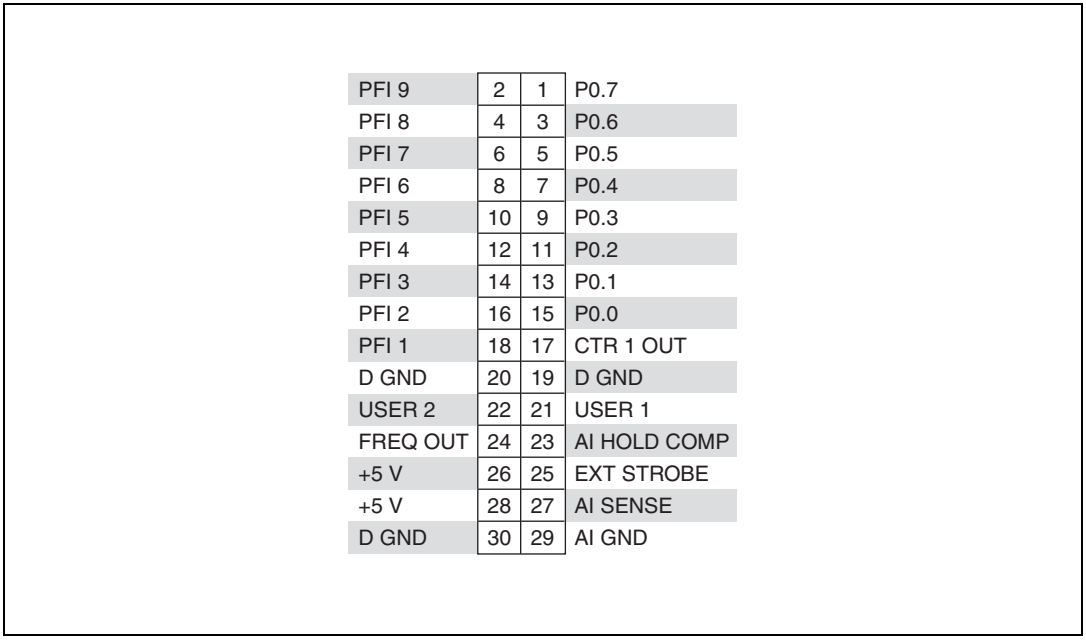

Figure 2. NI DAQPad-6020E BNC Pinout