

NI DAQPad™ -6015/6016 Family Specifications

This document lists the I/O terminal summary and specifications for the NI DAQPad-6015/6016 family of devices. This family includes the following devices:

- NI DAQPad-6015
- NI DAQPad-6015 mass termination
- NI DAQPad-6015 BNC
- NI DAQPad-6016

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 100 pF	25/15	—	—	—	±200 pA
AI SENSE	AI	100 GΩ 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	—	—	—	—	—	—	—

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 fuse	—	—	—
P0.<0..7>	DIO	—	$V_{CC} + 0.5$	13 at ($V_{CC} - 0.4$)	24 at 0.4	1.1	50 k Ω pu
P1.<0..7> [†]	DIO	—	$V_{CC} + 0.5$	2.5 at 3.0 min	2.5 at 0.4	5	100 k Ω pu
P2.<0..7> [†]	DIO	—	$V_{CC} + 0.5$	2.5 at 3.0 min	2.5 at 0.4	5	100 k Ω pu
P3.<0..7> [†]	DIO	—	$V_{CC} + 0.5$	2.5 at 3.0 min	2.5 at 0.4	5	100 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

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
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
<p>* Indicates active low. † NI 6016 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 (bipolar only) ... ±10 V, ±5 V, ±500 mV,
 ±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 4,096 samples

Data transfers Interrupts,
 programmed I/O

Configuration memory size 512 words

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

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

BNC version

Powered on

CH+ (AI <0..7>) 100 G Ω in parallel with 100 pF

CH- (AI <8..15>)

With built-in bias resistor disengaged 100 G Ω in parallel with 100 pF

With built-in bias resistor engaged (default) 5 K Ω in parallel with 0.1 μF

Powered off 820 Ω min

Overload 820 Ω min

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

System noise (LSB_{rms} , including quantization)

Input Range	LSB_{rms}
± 10 V, ± 5 V	0.9
± 500 mV	1.1
± 50 mV	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 μ V/ $^{\circ}$ C
Postgain ± 175 μ V/ $^{\circ}$ C
Gain temperature coefficient ± 32 ppm/ $^{\circ}$ C

Analog Output

Output Characteristics

Number of channels 2 voltage
Resolution 16 bits, 1 in 65,536
Max update rate
Software timed 300 S/s,
system dependent
Hardware timed 50 S/s, system dependent
Type of DAC Double-buffered,
multiplying
FIFO buffer size None
Data transfers Interrupts,
programmed I/O

Accuracy Information

Nominal Range at Full Scale (V)		Absolute Accuracy				
Positive Full Scale	Negative Full Scale	% 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.

Transfer Characteristics

Relative accuracy (INL)	± 3 LSB, typ
DNL	± 2 LSB, typ
Monotonicity	15 bits
Offset error	
After calibration	$\pm 372\ \mu\text{V}$ max
Before calibration	$\pm 250\ \text{mV}$ max
Gain error (relative to internal reference)	
After calibration	± 75 ppm
Before calibration	$\pm 22,700$ ppm

Voltage Output

Range	$\pm 10\text{ V}$
Output coupling	DC
Output impedance	$0.1\ \Omega$ max
Current drive	$\pm 5\ \text{mA}$ max
Protection	Short-circuit to ground
Power-on state (steady state)	$\pm 250\ \text{mV}$
Initial power-up glitch	
Magnitude	$\pm 6.0\ \text{V}$
Duration	4 ms
Power reset glitch	
Magnitude	$\pm 3.0\ \text{V}$
Duration	3 ms

Dynamic Characteristics

Settling time for full-scale step	8 μs to ± 1 LSB accuracy
Slew rate	4 $\text{V}/\mu\text{s}$

Noise	360 μV_{rms} , DC to 400 kHz
Midscale transition glitch	
Magnitude	$\pm 100\ \text{mV}$
Duration	4.0 μs

Stability

Offset temperature coefficient	$\pm 128\ \mu\text{V}/^{\circ}\text{C}$
Gain temperature coefficient	$\pm 26.8\ \text{ppm}/^{\circ}\text{C}$

Digital I/O

Number of channels	
NI DAQPad-6015	8 input/output
NI DAQPad-6016	32 input/output
Compatibility	5 V TTL/CMOS

PO.<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 ($V_{\text{in}} = 0\ \text{V}$)	—	-320 μA
Input high current ($V_{\text{in}} = 5\ \text{V}$)	—	3.33 mA
Output low voltage ($I_{\text{OL}} = 24\ \text{mA}$)	—	0.4 V
Output high voltage ($I_{\text{OH}} = -13\ \text{mA}$)	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 250 S/s,
system dependent

P1.<0..7>, P2.<0..7>, P3.<0..7>
(NI DAQPad-6016 Only)

Digital logic levels

Level	Min	Max
Input low voltage	0 V	0.8 V
Input high voltage	2.2 V	5.0 V
Input low current ($V_{in} = 0$ V, 100 k Ω pu)	—	-75 μ A
Input high current ($V_{in} = 5$ V, 100 k Ω pu)	—	10 μ A
Output low voltage ($I_{OL} = 2.5$ mA)	—	0.4 V
Output high voltage ($I_{OH} = -2.5$ mA)	3.0 V	—

Handshaking 2-wire

Power-on state

P1.<0..7> Input (high-impedance),
100 k Ω pull-up to
+5 VDC

P2.<0..7> Input (high-impedance),
100 k Ω pull-up to
+5 VDC

P3.<0..7> Input (high-impedance),
100 k Ω pull-up to
+5 VDC

Data transfers Interrupts,
programmed I/O

Max transfer rate 250 S/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 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 minutes
Calibration interval	1 year
External calibration reference	>6 V and <10 V
Onboard calibration reference	
Level	5.000 V (± 3.5 mV), over full operating temperature, actual value stored in EEPROM
Temperature coefficient	± 5.0 ppm/ $^{\circ}C$ max
Long-term stability	± 15.0 ppm/ $\sqrt{1,000 h}$

Bus Interface

Type	USB, full-speed
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Power Requirement

9-25 V	12 W
Power available at I/O connector	+4.65 to +5.25 VDC at 1 A



Note Power supply voltages are absolute minimum and maximum values.

Physical

Dimensions (not including connectors)	
NI DAQPad-6015/6016	17.6 cm \times 14.85 cm \times 3.08 cm (8 in. \times 6.75 in. \times 1.4 in.)
NI DAQPad-6015 mass termination, DAQPad-6015 BNC	30.7 cm \times 25.4 cm \times 4.3 cm (12.1 in. \times 10 in. \times 1.7 in.)

Weight

NI DAQPad-6015/6016	907 g (2 lb)
NI DAQPad-6015 mass termination	1417 g (3.125 lb)
NI DAQPad BNC	1735 g (3.825 lb)

I/O connector

NI DAQPad-6015/6016	Screw terminals
NI DAQPad-6015 mass termination	SCSI-II
NI DAQPad BNC	BNCs and removable screw terminals

Maximum Working Voltage

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

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

Operating temperature	0 to 50 $^{\circ}C$
Storage temperature	-55 to 150 $^{\circ}C$
Humidity	5 to 90% RH, noncondensing
Maximum altitude	2,000 meters
Pollution Degree (indoor use only)	2



Note Clean the device with a soft, non-metallic brush. Make sure that the device is completely dry and free from contaminants before returning it to service.

Safety

These products are 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, operate this device with shielded cabling.

CE Compliance

These products meet 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 these products, visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

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

Figure 1. NI DAQPad-6015 Pinout

PFI 9	2	1	P0.7
PFI 8	4	3	P0.6
PFI 7	6	5	P0.5
PFI 6	8	7	P0.4
PFI 5	10	9	P0.3
PFI 4	12	11	P0.2
PFI 3	14	13	P0.1
PFI 2	16	15	P0.0
PFI 1	18	17	CTR 1 OUT
D GND	20	19	D GND
USER 2	22	21	USER 1
FREQ OUT	24	23	AI HOLD COMP
+5 V	26	25	EXT STROBE
+5 V	28	27	AI SENSE
D GND	30	29	AI GND

Figure 2. NI DAQPad-6015 BNC 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 3. NI DAQPad-6015 Mass Termination Pinout

Extended Digital			Digital and Timing			Analog					
P3.7	96	80	P3.3	P0.0	33	49	CTR 0 OUT	AI 0	1	17	AI 4
D GND	95	79	D GND	P0.1	34	50	PFI 8/CTR 0 SOURCE	AI 8	2	18	AI 12
P3.6	94	78	P3.2	D GND	35	51	D GND	AI GND	3	19	AI GND
P3.5	93	77	P3.1	P0.2	36	52	PFI 9/CTR 0 GATE	AI 1	4	20	AI 5
P3.4	92	76	P3.0	P0.3	37	53	PFI 5/AO SAMP CLK	AI 9	5	21	AI 13
D GND	91	75	D GND	P0.4	38	54	PFI 6/AO START TRIG	AI GND	6	22	AI GND
P2.7	90	74	P2.3	D GND	39	55	D GND	AI 2	7	23	AI 6
P2.6	89	73	P2.2	P0.5	40	56	PFI 7/AI SAMP CLK	AI 10	8	24	AI 14
P2.5	88	72	P2.1	P0.6	41	57	CTR 1 OUT	AI GND	9	25	AI GND
D GND	87	71	D GND	P0.7	42	58	PFI 3/CTR 1 SOURCE	AI 3	10	26	AI 7
P2.4	86	70	P2.0	D GND	43	59	D GND	AI 11	11	27	AI 15
P1.7	85	69	P1.3	AI HOLD COMP	44	60	PFI 4/CTR 1 GATE	AI GND	12	28	AI GND
P1.6	84	68	P1.2	EXT STROBE	45	61	PFI 1/AI REF TRIG	AI SENSE	13	29	AI GND
D GND	83	67	D GND	PFI 2/AI CONV CLK	46	62	PFI 0/AI START TRIG	AI GND	14	30	AI GND
P1.5	82	66	P1.1	+5 V	47	63	D GND	AO 0	15	31	AO 1
P1.4	81	65	P1.0	D GND	48	64	FREQ OUT	AO GND	16	32	AO GND

Figure 4. NI DAQPad-6016 Pinout

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