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	—	—	—	—	—	—	—

NATIONAL INSTRUMENTS™

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 kΩ pu
P1.<0..7>†	DIO	—	V_{CC} + 0.5	2.5 at 3.0 min	2.5 at 0.4	5	100 kΩ pu
P2.<0..7>†	DIO	—	V_{CC} + 0.5	2.5 at 3.0 min	2.5 at 0.4	5	100 kΩ pu
P3.<0..7>†	DIO	—	V_{CC} + 0.5	2.5 at 3.0 min	2.5 at 0.4	5	100 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

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

* 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.

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 (%/°C)		
	24 Hours	1 Year		Single Pt.	Averaged			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 ±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

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 .....±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

BNC version

- Powered on
  - CH+ (AI <0..7>) ..... 100 GΩ in parallel with 100 pF
  - CH– (AI <8..15>)
    - With built-in bias resistor disengaged ..... 100 GΩ in parallel with 100 pF
    - With built-in bias resistor engaged (default)..... 5 KΩ 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 µs typ

Gain 1 ..... ±2 LSB, 5 µs max

Gain 0.5 ..... ±4 LSB, 5 µs 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 µV/°C

Postgain ..... ±175 µV/°C

Gain temperature coefficient..... ±32 ppm/°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				
		% of Reading				
Positive Full Scale	Negative Full Scale	24 Hours	1 Year	Offset (µV)	Temp Drift (%/°C)	Absolute Accuracy at Full Scale (µV)
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 ±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 (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

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 ..... ±100 mV
- Duration ..... 4.0 µs

Stability

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

Gain temperature coefficient ..... ±26.8 ppm/°C

Digital I/O

Number of channels

- NI DAQPad-6015 ..... 8 input/output
- NI DAQPad-6016 ..... 32 input/output

Compatibility ..... 5 V 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 µA
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 kΩ 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 kΩ pu)	—	–75 µA
Input high current (V_{in} = 5 V, 100 kΩ pu)	—	10 µA
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 kΩ pull-up to +5 VDC

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

P3.<0..7> ..... Input (high-impedance), 100 kΩ 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 ..... ±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/°C max
- Long-term stability ..... ±15.0 ppm/ $\sqrt{1{,}000\ \text{h}}$

Bus Interface

Type ..... USB, full-speed

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 × 14.85 cm × 3.08 cm (8 in. × 6.75 in. × 1.4 in.)
- NI DAQPad-6015 mass termination, DAQPad-6015 BNC ..... 30.7 cm × 25.4 cm × 4.3 cm (12.1 in. × 10 in. × 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

Environmental

Operating temperature ..... 0 to 50 °C

Storage temperature ..... –55 to 150 °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.

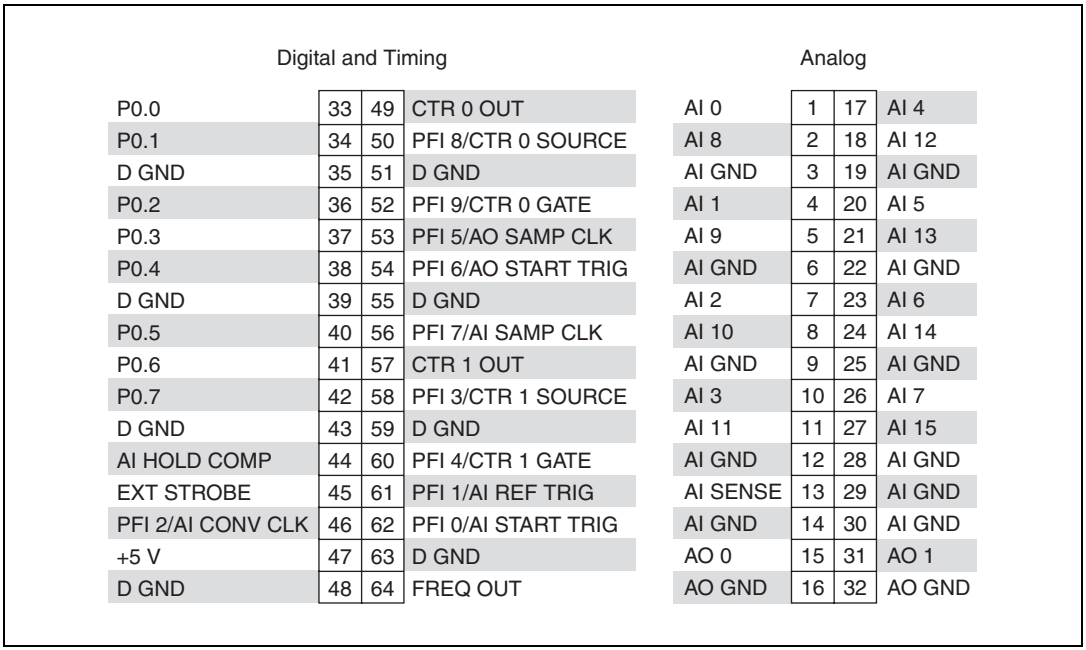
CE Compliance

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.



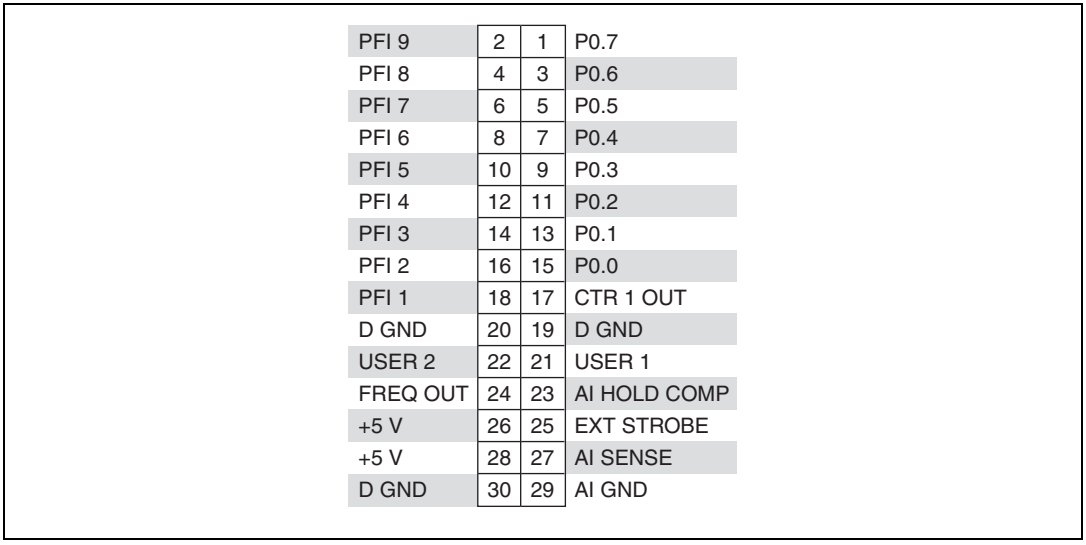
Digital and Timing

P0.0	33	49	CTR 0 OUT
P0.1	34	50	PFI 8/CTR 0 SOURCE
D GND	35	51	D GND
P0.2	36	52	PFI 9/CTR 0 GATE
P0.3	37	53	PFI 5/AO SAMP CLK
P0.4	38	54	PFI 6/AO START TRIG
D GND	39	55	D GND
P0.5	40	56	PFI 7/AI SAMP CLK
P0.6	41	57	CTR 1 OUT
P0.7	42	58	PFI 3/CTR 1 SOURCE
D GND	43	59	D GND
AI HOLD COMP	44	60	PFI 4/CTR 1 GATE
EXT STROBE	45	61	PFI 1/AI REF TRIG
PFI 2/AI CONV CLK	46	62	PFI 0/AI START TRIG
+5 V	47	63	D GND
D GND	48	64	FREQ OUT

Analog

AI 0	1	17	AI 4
AI 8	2	18	AI 12
AI GND	3	19	AI GND
AI 1	4	20	AI 5
AI 9	5	21	AI 13
AI GND	6	22	AI GND
AI 2	7	23	AI 6
AI 10	8	24	AI 14
AI GND	9	25	AI GND
AI 3	10	26	AI 7
AI 11	11	27	AI 15
AI GND	12	28	AI GND
AI SENSE	13	29	AI GND
AI GND	14	30	AI GND
AO 0	15	31	AO 1
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

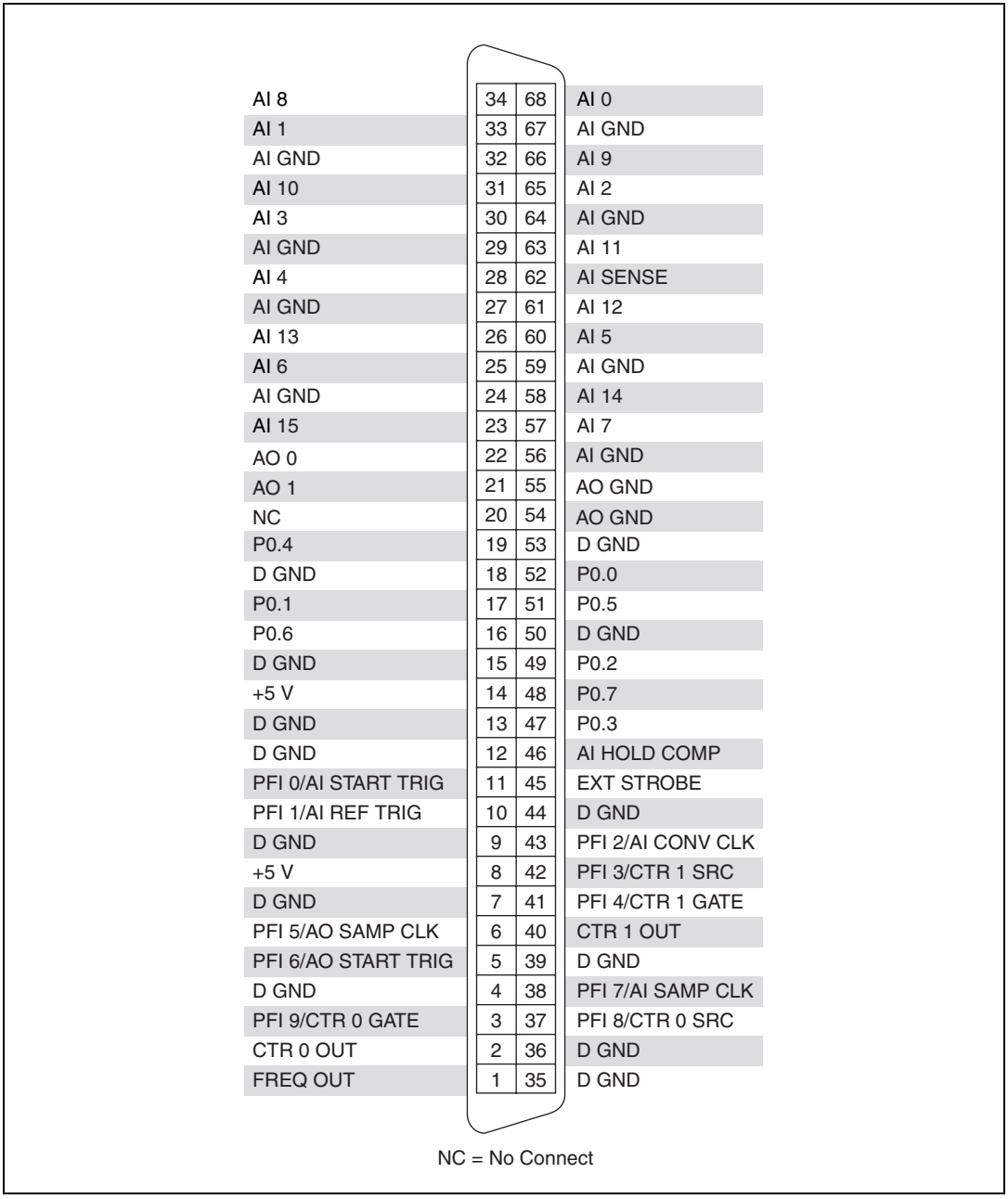
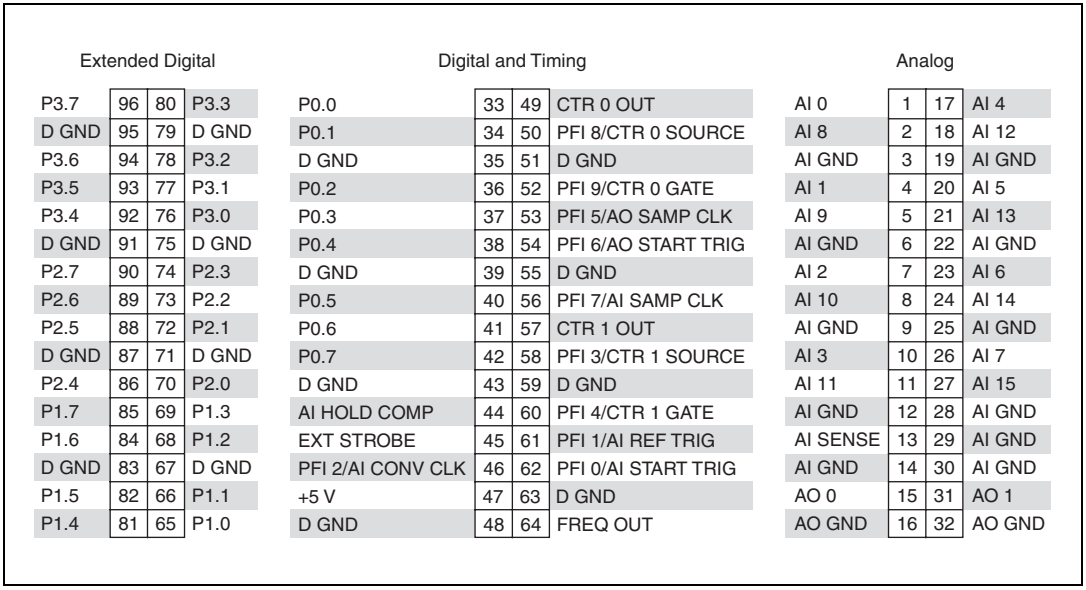


Figure 3. NI DAQPad-6015 Mass Termination Pinout



Extended Digital

P3.7	96	80	P3.3
D GND	95	79	D GND
P3.6	94	78	P3.2
P3.5	93	77	P3.1
P3.4	92	76	P3.0
D GND	91	75	D GND
P2.7	90	74	P2.3
P2.6	89	73	P2.2
P2.5	88	72	P2.1
D GND	87	71	D GND
P2.4	86	70	P2.0
P1.7	85	69	P1.3
P1.6	84	68	P1.2
D GND	83	67	D GND
P1.5	82	66	P1.1
P1.4	81	65	P1.0

Digital and Timing

P0.0	33	49	CTR 0 OUT
P0.1	34	50	PFI 8/CTR 0 SOURCE
D GND	35	51	D GND
P0.2	36	52	PFI 9/CTR 0 GATE
P0.3	37	53	PFI 5/AO SAMP CLK
P0.4	38	54	PFI 6/AO START TRIG
D GND	39	55	D GND
P0.5	40	56	PFI 7/AI SAMP CLK
P0.6	41	57	CTR 1 OUT
P0.7	42	58	PFI 3/CTR 1 SOURCE
D GND	43	59	D GND
AI HOLD COMP	44	60	PFI 4/CTR 1 GATE
EXT STROBE	45	61	PFI 1/AI REF TRIG
PFI 2/AI CONV CLK	46	62	PFI 0/AI START TRIG
+5 V	47	63	D GND
D GND	48	64	FREQ OUT

Analog

AI 0	1	17	AI 4
AI 8	2	18	AI 12
AI GND	3	19	AI GND
AI 1	4	20	AI 5
AI 9	5	21	AI 13
AI GND	6	22	AI GND
AI 2	7	23	AI 6
AI 10	8	24	AI 14
AI GND	9	25	AI GND
AI 3	10	26	AI 7
AI 11	11	27	AI 15
AI GND	12	28	AI GND
AI SENSE	13	29	AI GND
AI GND	14	30	AI GND
AO 0	15	31	AO 1
AO GND	16	32	AO GND

Figure 4. NI DAQPad-6016 Pinout