DEVICE SPECIFICATIONS

NI USB-6212

M Series Data Acquisition: 16 AI, 2 AO, 32 DIO Bus-Powered USB

The following specifications are typical at 25 °C, unless otherwise noted. For more information about the NI USB-6212, refer to the *NI USB-621x User Manual* available at *ni.com/manuals*.

Caution The input/output ports of this device are not protected for electromagnetic interference due to functional reasons. As a result, this device may experience reduced measurement accuracy or other temporary performance degradation when connected cables are routed in an environment with radiated or conducted radio frequency electromagnetic interference.

To ensure that this device functions within specifications in its operational electromagnetic environment and to limit radiated emissions, care should be taken in the selection, design, and installation of measurement probes and cables.

Analog Input

Number of channels	8 differential or 16 single ended
ADC resolution	16 bits
DNL	No missing codes guaranteed
INL	Refer to the *AI Absolute Accuracy* section
Sample rate	
Single channel maximum	400 kS/s
Multichannel maximum (aggregate)	400 kS/s
Minimum	0 S/s
Timing resolution	50 ns
Timing accuracy	50 ppm of sample rate
Input coupling	DC
Input range	±0.2 V, ±1 V, ±5 V, ±10 V
Maximum working voltage for analog inputs (signal + common mode)	±10.4 V of AI GND

NATIONAL INSTRUMENTS

CMRR (DC to 60 Hz)	100 dB
Input impedance	
Device on	
AI+ to AI GND	>10 GΩ in parallel with 100 pF
AI- to AI GND	>10 GΩ in parallel with 100 pF
Device off	
AI+ to AI GND	1,200 Ω
AI- to AI GND	1,200 Ω
Input bias current	±100 pA
Crosstalk (at 100 kHz)	
Adjacent channels	-75 dB
Non-adjacent channels	-90 dB
Small signal bandwidth (-3 dB)	1.5 MHz
Input FIFO size	4,095 samples
Scan list memory	4,095 entries
Data transfers	USB Signal Stream, programmed I/O
Overvoltage protection for all analog input and sense channels	
Device on	±30 V for up to two AI pins
Device off	±20 V for up to two AI pins
Input current during overvoltage condition	±20 mA maximum/AI pin

Settling Time for Multichannel Measurements

Accuracy, full-scale step, all ranges	
±90 ppm of step (±6 LSB)	2.5 µs convert interval
±30 ppm of step (±2 LSB)	3.5 µs convert interval
±15 ppm of step (±1 LSB)	5.5 µs convert interval

Typical Performance Graphs

Figure 1. Settling Error versus Time for Different Source Impedances

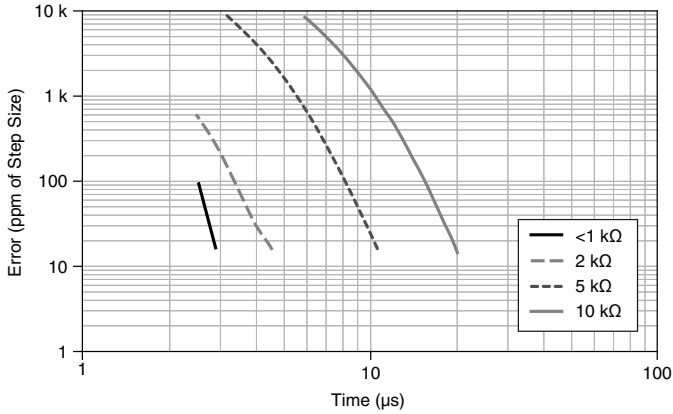
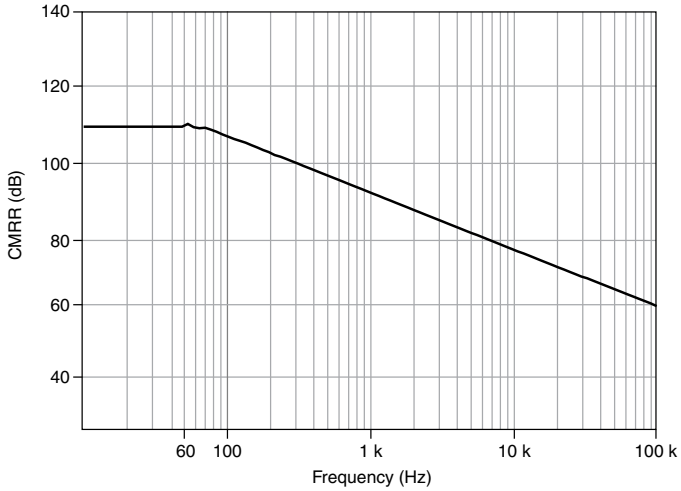


Figure 2. AI CMRR



AI Absolute Accuracy

Note Accuracies listed are valid for up to one year from the device external calibration.

Table 1. AI Absolute Accuracy

Nominal Range Positive Full Scale	Nominal Range Negative Full Scale	Residual Gain Error (ppm of Reading)	Residual Offset Error (ppm of Range)	Offset Tempco (ppm of Range/°C)	Random Noise, σ (μVrms)	Absolute Accuracy at Full Scale (μV)	Sensitivity (μV)
10	-10	75	20	34	295	2,710	118.0
5	-5	85	20	36	149	1,420	59.6
1	-1	95	25	49	32	310	12.8
0.2	-0.2	135	40	116	13	89	5.2

Note Sensitivity is the smallest voltage change that can be detected. It is a function of noise.

Gain tempco	7.3 ppm/°C
Reference tempco	5 ppm/°C
INL error	76 ppm of range

AI Absolute Accuracy Equation

$AbsoluteAccuracy = Reading \cdot (GainError) + Range \cdot (OffsetError) + NoiseUncertainity$

$GainError = ResidualAIGainError + GainTempco \cdot (TempChangeFromLastInternalCal) + ReferenceTempco \cdot (TempChangeFromLastExternalCal)$

$OffsetError = ResidualAIOffsetError + OffsetTempco \cdot (TempChangeFromLastInternalCal) + INLError$

$NoiseUncertainty = \frac{\text{Random Noise} \cdot 3}{\sqrt{100}}$ for a coverage factor of 3 σ and averaging 100 points.

AI Absolute Accuracy Example

Absolute accuracy at full scale on the analog input channels is determined using the following assumptions:

- TempChangeFromLastExternalCal = 10 °C
- TempChangeFromLastInternalCal = 1 °C
- number_of_readings = 100
- CoverageFactor = 3 σ

For example, on the 10 V range, the absolute accuracy at full scale is as follows:

GainError = 75 ppm + 7.3 ppm · 1 + 5 ppm · 10 = 132 ppm

OffsetError = 20 ppm + 34 ppm · 1 + 76 ppm = 130 ppm

NoiseUncertainity = $\frac{295\ \mu V \cdot 3}{\sqrt{100}}$ = 88.5 µV

AbsoluteAccuracy = 10 V · (GainError) + 10 V · (OffsetError) + NoiseUncertainity = 2,710 µV

Analog Output

Number of channels	2
DAC resolution	16 bits
DNL	±1 LSB
Monotonicity	16 bit guaranteed
Maximum update rate	
1 channel	250 kS/s
2 channels	250 kS/s per channel
Timing accuracy	50 ppm of sample rate
Timing resolution	50 ns
Output range	±10 V
Output coupling	DC
Output impedance	0.2 Ω
Output current drive	±2 mA
Overdrive protection	±30 V
Overdrive current	2.4 mA
Power-on state	±20 mV
Power-on glitch	±1 V for 200 ms
Output FIFO size	8,191 samples shared among channels used
Data transfers	USB Signal Stream, programmed I/O
AO waveform modes	Non-periodic waveform, periodic waveform regeneration mode from onboard FIFO, periodic waveform regeneration from host buffer including dynamic update
Settling time, full-scale step, 15 ppm (1 LSB)	32 µs
Slew rate	5 V/µs
Glitch energy	
Magnitude	100 mV
Duration	2.6 µs

AO Absolute Accuracy

Absolute accuracy at full-scale numbers is valid immediately following internal calibration and assumes the device is operating within 10 °C of the last external calibration.

Note Accuracies listed are valid for up to one year from the device external calibration.

Table 2. AO Absolute Accuracy

Nominal Range Positive Full Scale (V)	Nominal Range Negative Full Scale (V)	Residual Gain Error (ppm of Reading)	Gain Tempco (ppm/°C)	Residual Offset Error (ppm of Range)	Offset Tempco (ppm of Range/°C)	Absolute Accuracy at Full Scale (µV)
10	-10	90	11	60	12	3,512

Reference tempco	5 ppm/°C
INL error	128 ppm of range

AO Absolute Accuracy Equation

AbsoluteAccuracy = OutputValue · (GainError) + Range · (OffsetError)

GainError = ResidualGainError + GainTempco · (*TempChangeFromLastInternalCal*) + *ReferenceTempco* · (*TempChangeFromLastExternalCal*)

OffsetError = ResidualOffsetError + AOOffsetTempco · (TempChangeFromLastInternalCal) + INLError

Digital I/O/PFI

Static Characteristics

Digital input or output (Screw Terminal)	32 total, 16 (P0.<0..15>), 16 (PFI <0..7>/P1.<0..7>, PFI <8..15>/P2.<0..7>)
Digital input or output (Mass Termination/BNC)	24 total, 8 (P0.<0..7>), 16 (PFI <0..7>/P1.<0..7>, PFI <8..15>/P2.<0..7>)
Ground reference	D GND
Pull-down resistor	50 kΩ typical, 20 kΩ minimum
Input voltage protection	±20 V on up to 8 pins[1]

PFI Functionality

Functionality	Static digital input, static digital output, timing input, timing output
Timing output sources	Many AI, AO, counter timing signals
Debounce filter settings	125 ns, 6.425 µs, 2.56 ms, disable; high and low transitions; selectable per input

Maximum Operating Conditions

I_{OL} output low current	16 mA maximum
I_{OH} output high current	-16 mA maximum

Digital Input Characteristics

Level	Minimum	Maximum
V_{IL} input low voltage	0 V	0.8 V
V_{IH} input high voltage	2.2 V	5.25 V
I_{IL} input low current (V_{in} = 0 V)	-	-10 µA
I_{IH} input high current (V_{in} = 5 V)	-	250 µA
Positive-going threshold (VT+)	-	2.2 V
Negative-going threshold (VT-)	0.8 V	-
Delta VT hysteresis (VT+ - VT-)	0.2 V	-

[1] Stresses beyond those listed under *Input voltage protection* may cause permanent damage to the device.

Digital Output Characteristics

Figure 3. PFI <0..15>/P0.<0..15>: I_{oh} versus V_{oh}

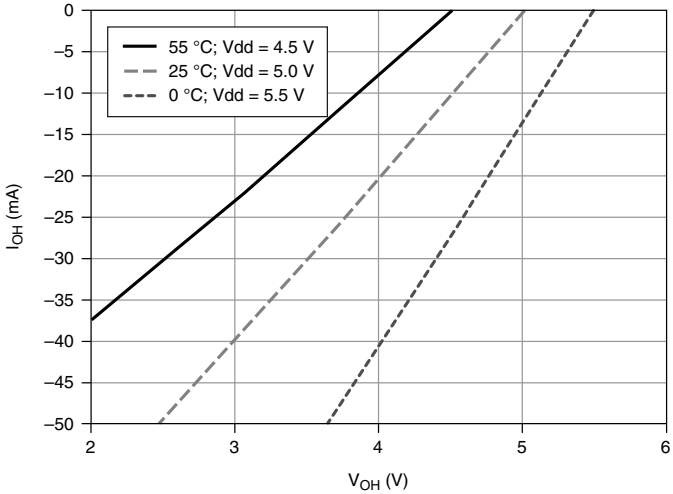
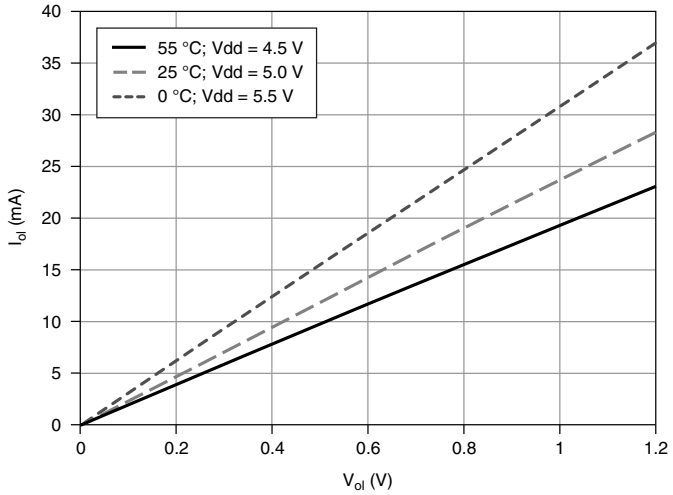


Figure 4. PFI <0..15>/P0.<0..15>: I_{ol} versus V_{ol}



General-Purpose Counters/Timers

Number of counter/timers	2
Resolution	32 bits
Counter measurements	Edge counting, pulse, semi-period, period, two-edge separation
Position measurements	X1, X2, X4 quadrature encoding with Channel Z reloading; two-pulse encoding
Output applications	Pulse, pulse train with dynamic updates, frequency division, equivalent time sampling
Internal base clocks	80 MHz, 20 MHz, 0.1 MHz
External base clock frequency	0 MHz to 20 MHz
Base clock accuracy	50 ppm
Inputs	Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down
Routing options for inputs	PFI <0..15>, many internal signals
FIFO	1,023 samples
Data transfers	USB Signal Stream, programmed I/O

Frequency Generator

Number of channels	1
Base clocks	10 MHz, 100 kHz
Divisors	1 to 16
Base clock accuracy	50 ppm

Output can be available on any output PFI terminal.

External Digital Triggers

Source	PFI <0..15>
Polarity	Software-selectable for most signals
Analog input function	Start Trigger, Reference Trigger, Pause Trigger, Sample Clock, Convert Clock, Sample Clock Timebase

Analog output function	Start Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase
Counter/timer function	Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down

Bus Interface

USB	USB 2.0 Hi-Speed or full-speed[2]
USB Signal Stream	4, can be used for analog input, analog output, counter/timer 0, counter/timer 1

Current Limits

+5 V terminal as output[3]	
Voltage	4.6 V to 5.2 V
Current (internally limited)	50 mA maximum, shared with digital outputs
+5 V terminal as input[3]	
Voltage	4.75 V to 5.35 V
Current	350 mA maximum, self-resetting fuse

Caution Do *not* exceed 16 mA per DIO pin.

Protection	±10 V

Power Requirements

Input voltage on USB port	4.5 V to 5.25 V in configured state
Maximum inrush current	500 mA
No load typical current	320 mA at 4.5 V

[2] If you are using an USB M Series device in full-speed mode, device performance will be lower and you will not be able to achieve maximum sample/update rates.

[3] USB Screw Terminal/BNC devices have a self-resetting fuse that opens when current exceeds this specification. USB Mass Termination devices have a user-replaceable socketed fuse that opens when current exceeds this specification. Refer to the *NI USB-621x User Manual* for information about fuse replacement.

Maximum load	
Typical current	400 mA at 4.5 V
Suspend current	260 µA typical

Physical Characteristics

Dimensions (includes connectors)	
Screw terminal enclosure	16.9 cm × 9.4 cm × 3.1 cm (6.65 in. × 3.70 in. × 1.20 in.)
Mass Termination	19.3 cm × 9.4 cm × 3.1 cm (7.61 in. × 3.68 in. × 1.20 in.)
BNC enclosure	23.5 cm × 11.2 cm × 6.4 cm (9.25 in. × 4.40 in. × 2.50 in.)
Weight	
Screw Terminal	206 g (7.2 oz)
Mass Termination	227 g (8.0 oz)
BNC	950 g (33.5 oz)
OEM	76 g (2.6 oz)
I/O connectors	
Screw terminal	4 16-position combicon
Mass Termination	1 68-pin SCSI
BNC	19 BNCs and 26 screw terminals
USB connector	Series B receptacle
Screw terminal wiring	16 to 28 AWG
Torque for screw terminals	0.22 to 0.25 N · m (2.0 to 2.2 lb · in.)

Calibration

Recommended warm-up time	15 minutes
Calibration interval	1 year

Environmental

Operating temperature	0 ºC to 45 ºC
Storage temperature	-20 ºC to 70 ºC

Humidity	10% RH to 90% RH, noncondensing
Maximum altitude	2,000 m
Pollution Degree	2

Indoor use only.

Maximum Working Voltage

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

Channel-to-earth ground	11 V, Measurement Category I

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS voltage. MAINS is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

Caution Do not use for measurements within Categories II, III, or IV.

Note Measurement Categories CAT I and CAT O (Other) are equivalent. These test and measurement circuits are not intended for direct connection to the MAINS building installations of Measurement Categories CAT II, CAT III, or CAT IV.

Safety

This product is designed to meet the requirements of the following electrical equipment safety standards for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1

Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for sensitive electrical equipment for measurement, control, and laboratory use:

- EN 61326-2-1 (IEC 61326-2-1): Class A emissions; Basic immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions

- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions

Note In the United States (per FCC 47 CFR), Class A equipment is intended for use in commercial, light-industrial, and heavy-industrial locations. In Europe, Canada, Australia and New Zealand (per CISPR 11) Class A equipment is intended for use only in heavy-industrial locations.

Note Group 1 equipment (per CISPR 11) is any industrial, scientific, or medical equipment that does not intentionally generate radio frequency energy for the treatment of material or inspection/analysis purposes.

Note For EMC declarations and certifications, and additional information, refer to the *Online Product Certification* section.

CE Compliance CE

This product meets the essential requirements of applicable European Directives, as follows:

- 2014/35/EU; Low-Voltage Directive (safety)
- 2014/30/EU; Electromagnetic Compatibility Directive (EMC)
- 2011/65/EU; Restriction of Hazardous Substances (RoHS)

Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and 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.

Environmental Management

NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the *Minimize Our Environmental Impact* web page at *ni.com/environment*. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

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Device Pinouts

Figure 5. NI USB-6212 Screw Terminal Pinout

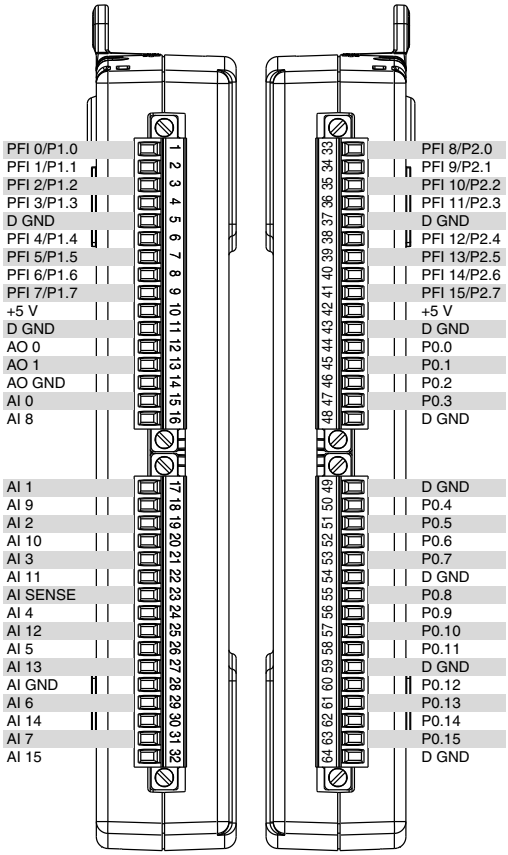
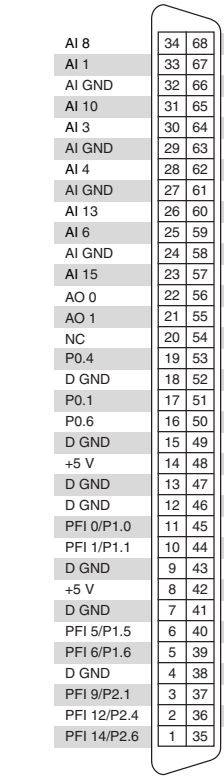


Figure 6. NI USB-6212 Mass Termination Pinout



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	PFI 11/P2.3
PFI 0/P1.0	11	45	PFI 10/P2.2
PFI 1/P1.1	10	44	D GND
D GND	9	43	PFI 2/P1.2
+5 V	8	42	PFI 3/P1.3
D GND	7	41	PFI 4/P1.4
PFI 5/P1.5	6	40	PFI 13/P2.5
PFI 6/P1.6	5	39	PFI 15/P2.7
D GND	4	38	PFI 7/P1.7
PFI 9/P2.1	3	37	PFI 8/P2.0
PFI 12/P2.4	2	36	D GND
PFI 14/P2.6	1	35	D GND

NC = No Connect

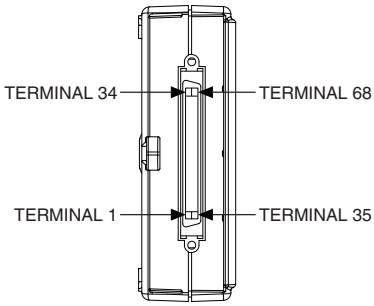
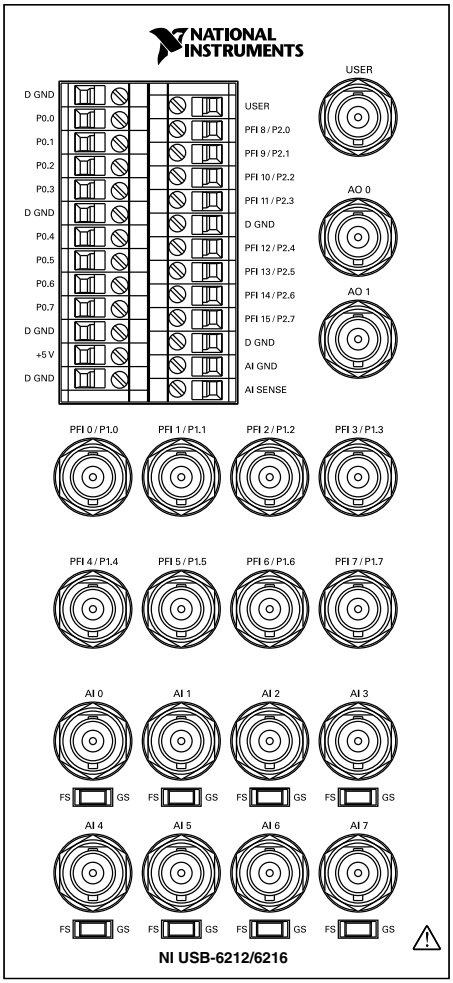
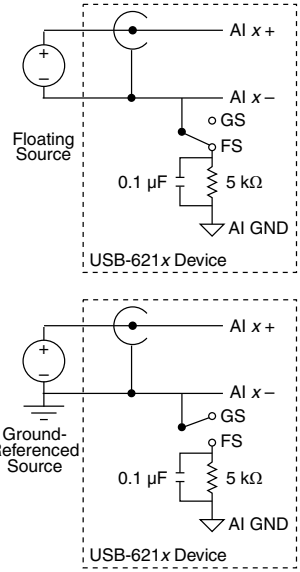


Figure 7. NI USB-6212 BNC Pinout





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