NI USB-621*x* Specifications

Specifications listed below are typical at 25 °C unless otherwise noted. Refer to the *NI USB-621x User Manual* for more information about USB-621*x* devices.

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.

Français Deutsch 日本語 한국어 简体中文

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Analog Input

Number of channels
- USB-6210/6211/6212/6215/6216 ..... 8 differential or 16 single ended
- USB-6218 ..... 16 differential or 32 single ended

ADC resolution ..... 16 bits

DNL ..... No missing codes guaranteed

INL ..... Refer to the *AI Absolute Accuracy Tables*

Sampling rate
- Maximum
  - USB-6210/6211/6215/6218 ... 250 kS/s single channel, 250 kS/s multichannel (aggregate)
  - USB-6212/6216 ..... 400 kS/s single channel, 400 kS/s multichannel (aggregate)
- Minimum ..... 0 S/s
- Timing accuracy ..... 50 ppm of sample rate
- Timing resolution ..... 50 ns

Input coupling ..... DC

Input range ..... ±10 V, ±5 V, ±1 V, ±0.2 V

Maximum working voltage for analog inputs (signal + common mode) ..... ±10.4 V of AI GND

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 ..... 1200 Ω
  - AI– to AI GND ..... 1200 Ω

Input bias current ..... ±100 pA

Crosstalk (at 100 kHz)
- Adjacent channels ..... –75 dB
- Non-adjacent channels ..... –90 dB

Small signal bandwidth (–3 dB)
- USB-6210/6211/6215/6218 ..... 450 kHz
- USB-6212/6216 ..... 1.5 MHz

NATIONAL INSTRUMENTS

Input FIFO size.....4,095 samples

Scan list memory.....4,095 entries

Data transfers.....USB Signal Stream, programmed I/O

Overvoltage protection (AI <0..31>, AI SENSE)

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 max/AI pin

Settling Time for Multichannel Measurements

Accuracy, full scale step, all ranges

USB-6210/6211/6215/6218

±90 ppm of step (±6 LSB).....4 µs convert interval

±30 ppm of step (±2 LSB).....5 µs convert interval

±15 ppm of step (±1 LSB).....7 µs convert interval

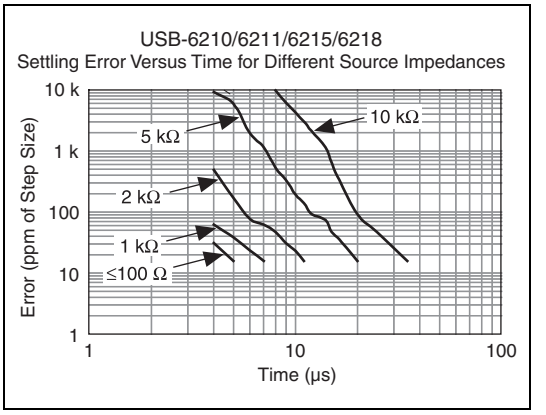
USB-6212/6216

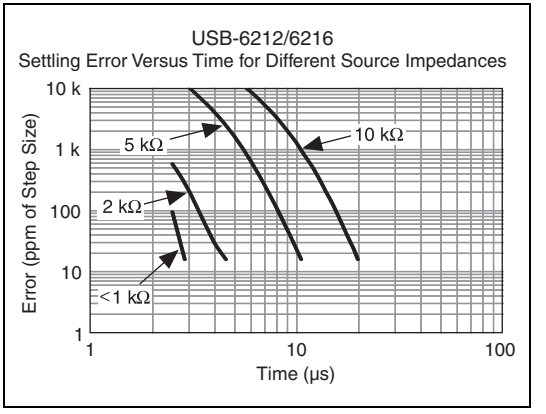
±90 ppm of step (±6 LSB).....2.5 µs convert interval

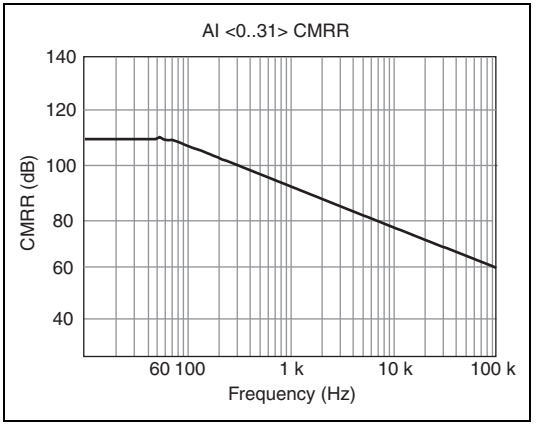
±30 ppm of step (±2 LSB).....3.5 µs convert interval

±15 ppm of step (±1 LSB).....5.5 µs convert interval

Typical Performance Graphs







Analog Output

Number of channels

- USB-6210 0
- USB-6211/6212/6215/6216/6218 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

Calibration (AI and AO)

Recommended warm-up time ..... 15 minutes

Calibration interval ..... 1 year

AI Absolute Accuracy Table (USB-6210/6211/6215/6218)

Nominal Range		Residual Gain Error (ppm of Reading)	Gain Tempco (ppm/°C)	Reference Tempco	Residual Offset Error (ppm of Range)	Offset Tempco (ppm of Range/°C)	INL Error (ppm of Range)	Random Noise, σ (μVrms)	Absolute Accuracy at Full Scale[1] (μV)	Sensitivity[2] (μV)
Positive Full Scale	Negative Full Scale									
10	–10	75	7.3	5	20	34	76	229	2,690	91.6
5	–5	85	7.3	5	20	36	76	118	1,410	47.2
1	–1	95	7.3	5	25	49	76	26	310	10.4
0.2	–0.2	135	7.3	5	40	116	76	12	88	4.8

AbsoluteAccuracy = Reading · (GainError) + Range · (OffsetError) + NoiseUncertainty

GainError = ResidualAIGainError + GainTempco · (TempChangeFromLastInternalCal) + ReferenceTempco · (TempChangeFromLastExternalCal)

OffsetError = ResidualAIOffsetError + OffsetTempco · (TempChangeFromLastInternalCal) + INL_Error

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

[1] 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 GainError = 132 ppm

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

$$\text{NoiseUncertainty} = \frac{229\ \mu\text{V} \cdot 3}{\sqrt{100}}$$ NoiseUncertainty = 68.7 μV

AbsoluteAccuracy = 10 V · (GainError) + 10 V · (OffsetError) + NoiseUncertainty AbsoluteAccuracy = 2,690 μV

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

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

AI Absolute Accuracy Table (USB-6212/6216)

Nominal Range		Residual Gain Error (ppm of Reading)	Gain Tempco (ppm/°C)	Reference Tempco	Residual Offset Error (ppm of Range)	Offset Tempco (ppm of Range/°C)	INL Error (ppm of Range)	Random Noise, σ (μVrms)	Absolute Accuracy at Full Scale[1] (μV)	Sensitivity[2] (μV)
Positive Full Scale	Negative Full Scale									
10	–10	75	7.3	5	20	34	76	295	2,710	118.0
5	–5	85	7.3	5	20	36	76	149	1,420	59.6
1	–1	95	7.3	5	25	49	76	32	310	12.8
0.2	–0.2	135	7.3	5	40	116	76	13	89	5.2

AbsoluteAccuracy = Reading · (GainError) + Range · (OffsetError) + NoiseUncertainty

GainError = ResidualAIGainError + GainTempco · (TempChangeFromLastInternalCal) + ReferenceTempco · (TempChangeFromLastExternalCal)

OffsetError = ResidualAIOffsetError + OffsetTempco · (TempChangeFromLastInternalCal) + INL_Error

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

[1] 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 GainError = 132 ppm

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

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

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

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

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

AO Absolute Accuracy Table

Nominal Range		Residual Gain Error (ppm of Reading)	Gain Tempco (ppm/°C)	Reference Tempco	Residual Offset Error (ppm of Range)	Offset Tempco (ppm of Range/°C)	INL Error (ppm of Range)	Absolute Accuracy at Full Scale[1] (μV)
Positive Full Scale	Negative Full Scale							
10	–10	90	11	5	60	12	128	3,512

[1] 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. Accuracies listed are valid for up to one year from the device external calibration.

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

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

OffsetError = ResidualOffsetError + AOOffsetTempco · (TempChangeFromLastInternalCal) + INL_Error

Digital I/O/PFI

Static Characteristics

Number of channels

Digital input

USB-6210/6211/6215 ..... 4 (PFI <0..3>/P0.<0..3>)

USB-6218 ..... 8 (PFI <0..3>/P0.<0..3>, PFI <8..11>/P0.<4..7>)

Digital output

USB-6210/6211/6215 ..... 4 (PFI <4..7>/P1.<0..3>)

USB-6218 ..... 8 (PFI <4..7>/P1.<0..3>, PFI <12..15>/P1.<4..7>)

Digital input or output

USB-6212/6216 Screw Terminal ..... 32 total, 16 (P0.<0..15>), 16 (PFI <0..7>/P1.<0..7>, PFI <8..15>/P2.<0..7>)

USB-6212/6216 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

USB-6210/6211/6215/6218..... 47 kΩ ±1%

USB-6212/6216..... 50 kΩ typical, 20 kΩ minimum

Input voltage protection[1] ..... ±20 V on up to 8 pins

PFI Functionality

USB-6210/6211/6215/6218

PFI <0..3>, PFI <8..11>/Port 0

Functionality ..... Static digital input, timing input

Debounce filter settings ..... 125 ns, 6.425 µs, 2.56 ms, disable; high and low transitions; selectable per input

PFI <4..7>, PFI <12..15>/Port 1

Functionality ..... Static digital output, timing output

Timing output sources ..... Many AI, AO, counter timing signals

USB-6212/6216 PFI <0..15>

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 Operation Conditions

Level	Min	Max
I_{OL} output low current	—	16 mA
I_{OH} output high current	—	–16 mA

Digital Input Characteristics (USB-6210/6211/6215/6218)

Level	Min	Max
V_{IL} input low voltage	0 V	0.8 V
V_{IH} input high voltage	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)	—	120 µA

Digital Input Characteristics (USB-6212/6216)

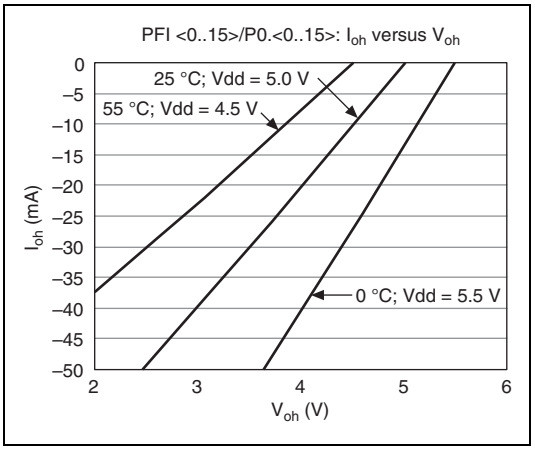
Level	Min	Max
V_{IL} input low voltage	0 V	0.8 V
V_{IH} input high voltage	2.2 V	5.25 V
I_{IL} input low current (V_{in} = 0 V)	—	–10 µA
I_{IH} input high current (V_{in} = 5 V)	—	250 µA
Positive-going threshold (VT+)	—	2.2 V
Negative-going threshold (VT–)	0.8 V	—
Delta VT hysteresis (VT+ – VT–)	0.2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

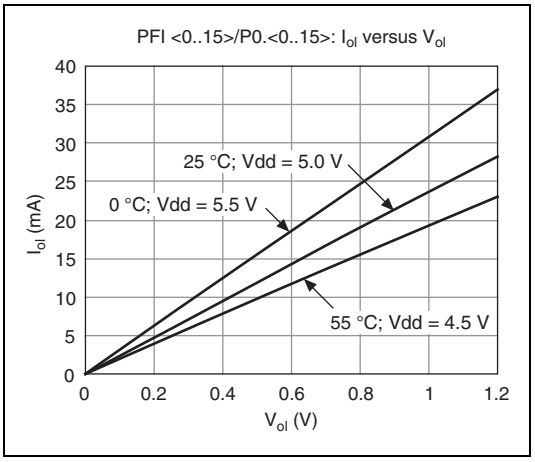
Digital Output Characteristics (USB-6210/6211/6215/6218)

Parameter	Voltage Level	Current Level
V_{OL}	0.6 V	6 mA
V_{OH}	2.7 V	–16 mA
	3.8 V	–6 mA

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

Digital Output Characteristics (USB-6212/6216)





General-Purpose Counter/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

- USB-6210/6211/6215/6218 ..... PFI <0..3>, PFI <8..11>, many internal signals
- USB-6212/6216 ..... 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

- USB-6210/6211/6215/6218 ..... PFI <0..3>, PFI <8..11>
- USB-6212/6216 ..... 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 functions ..... Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down,

Bus Interface

USB ..... USB 2.0 Hi-Speed or Full-Speed[1]

USB Signal Stream (USB) ..... 4, can be used for analog input, analog output, counter/timer 0, counter/timer 1

Power Limits

+5 V terminal as output[2]

- Voltage ..... 4.6 to 5.2 V
- Current (internally limited) ..... 50 mA max, shared with digital outputs

+5 V terminal as input[2]

- Voltage ..... 4.75 to 5.35 V
- Current ..... 350 mA max, self-resetting fuse

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

- Protection ..... ±10 V

Power Requirements

Input voltage on USB-621*x*

- USB port ..... 4.5 to 5.25 V in configured state

Maximum inrush current ..... 500 mA

No load typical current ..... 320 mA at 4.5 V

Maximum load

- Typical current ..... 400 mA at 4.5 V
- Suspend current ..... 260 µA, typical

Physical Characteristics

Enclosure dimensions (includes connectors)

- USB-621*x* Screw Terminal ..... 16.9 × 9.4 × 3.1 cm (6.65 × 3.70 × 1.20 in.)
- USB-621*x* Mass Termination ..... 19.3 × 9.4 × 3.1 cm (7.61 × 3.68 × 1.20 in.)
- USB-621*x* BNC ..... 23.5 × 11.2 × 6.4 cm (9.25 × 4.40 × 2.50 in.)

Weight

- USB-621*x* Screw Terminal ..... 206 g (7.2 oz)
- USB-6212 Mass Termination ..... 227 g (8.0 oz)
- USB-6216 Mass Termination ..... 231 g (8.1 oz)
- USB-6212/6216/6218 BNC ..... 950 g (33.5 oz)
- USB-6210 OEM ..... 73 g (2.5 oz)
- USB-6212/6216/6218 OEM ..... 76 g (2.6 oz)

I/O connectors

- USB-6210/6211/6215 ..... Two 16-position combicon
- USB-6212/6216/6218 Screw Terminal ..... Four 16-position combicon
- USB-6212/6216 Mass Termination ..... One 68-pin SCSI
- USB-6212/6216/6218 BNC ..... 19 BNCs and 26 screw terminals

USB connector ..... Series B receptacle

Screw terminal wiring ..... 16 to 28 AWG

Torque for screw terminals ..... 0.22–0.25 N · m (2.0–2.2 lb · in.)

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[1] If you are using a USB M Series device in Full-Speed mode, device performance will be lower and you will not be able to achieve maximum sampling/update rates.

[2] USB-621*x* Screw Terminal/BNC devices have a self-resetting fuse that opens when current exceeds this specification. USB-621*x* 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.

Environmental

Operating temperature.....0 to 45 °C

Storage temperature.....–20 to 70 °C

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

Maximum altitude .....2,000 m

Pollution Degree (indoor use only) 2

Maximum Working Voltage[1]

USB-6210/6211/6212 Rated Voltage

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

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

USB-6215/6216/6218 Rated Voltage

Channel-to-earth ground[2]

Continuous .....≤60 VDC, Measurement Category I[3]

Withstand .....≤1000 Vrms, verified by a 5 s dielectric withstand test

Analog channel to AI GND/AO GND (in Figure 1, $|V_a - V_c|$).....≤11 V, Measurement Category I[3]

Digital channel to D GND (in Figure 1, $V_b - V_c$) .....≤5.25 V, Measurement Category I[3]

Caution This device is rated for Measurement Category I and the voltage across the isolation barrier is limited to no greater than 30 Vrms/ 60 VDC/42.4 V_{pk} continuous. Do *not* use for measurements within Categories II, III, or IV.

Figure 1 illustrates the maximum working voltage specifications.

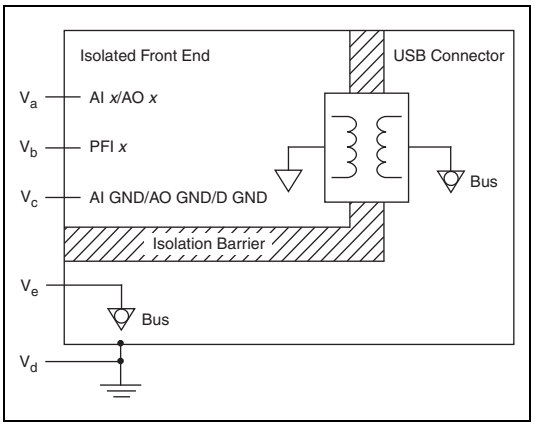


Figure 1. USB-6215/6216/6218 Maximum Working Voltage

Safety

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

- EN 61326 (IEC 61326): 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

[1] *Maximum working voltage* refers to the signal voltage plus the common-mode voltage.

[2] In Figure 1, $|V_a - V_d|$, $|V_b - V_d|$, and $|V_c - V_d|$.

[3] 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.

Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

Note For EMC compliance, operate this product according to the documentation.

Note For EMC compliance, operate this device with shielded cables.

CE Compliance CE

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

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

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 *NI and the Environment* 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.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers At the end of their life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit `ni.com/environment/weee.htm`.

电子信息产品污染控制管理办法 （中国 RoHS）

中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请登录 `ni.com/environment/rohs_china`。(For information about China RoHS compliance, go to `ni.com/environment/rohs_china`.)

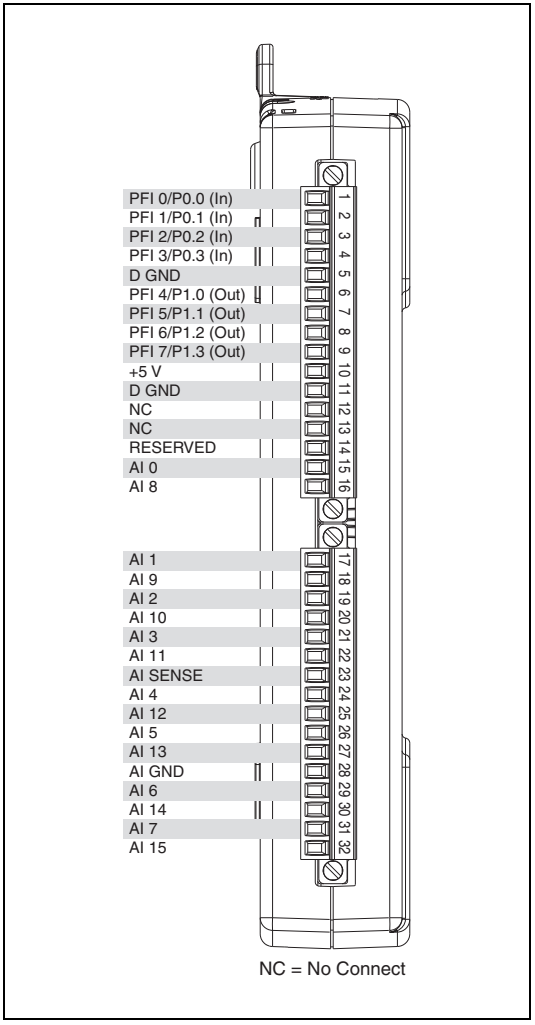


Figure 2. USB-6210 Pinout

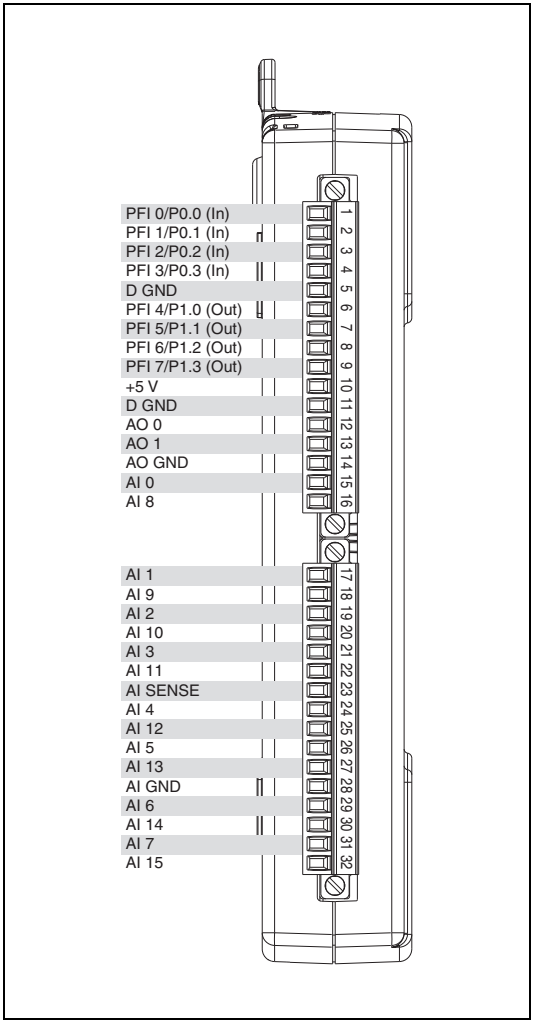


Figure 3. USB-6211/6215 Pinout

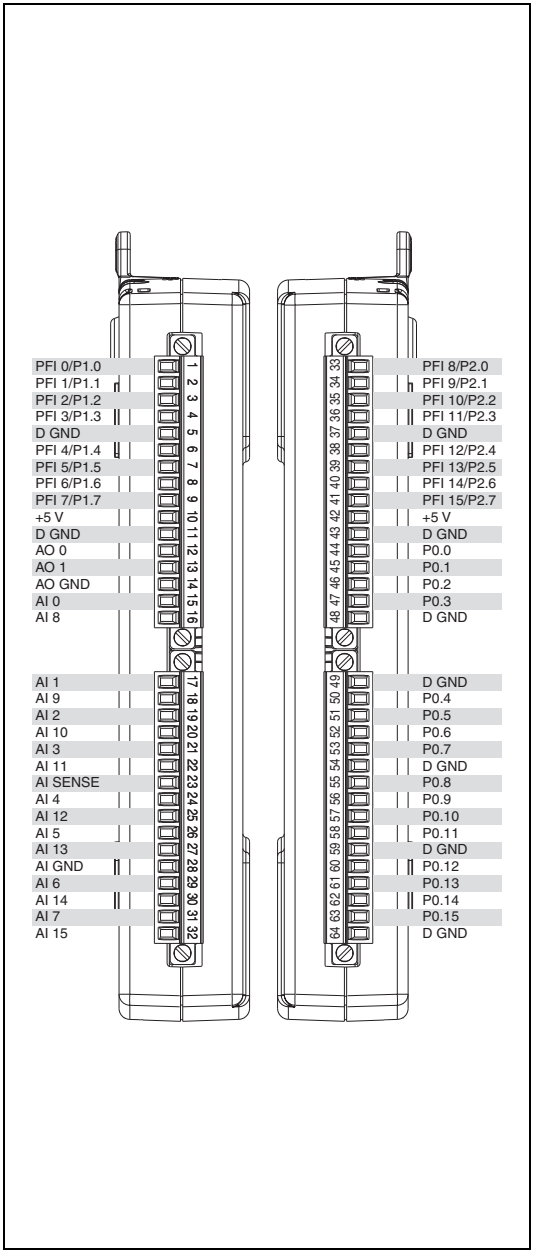


Figure 4. USB-6212/6216 Screw Terminal Pinout

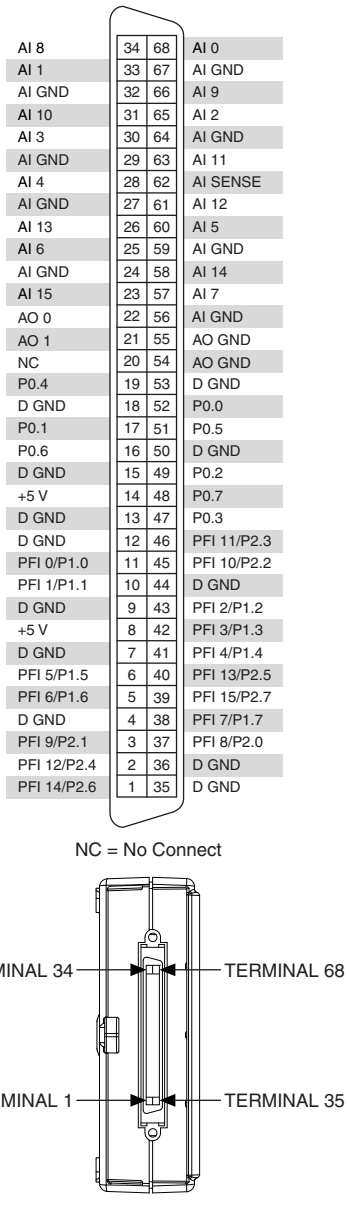


Figure 5. USB-6212/6216 Mass Termination Pinout

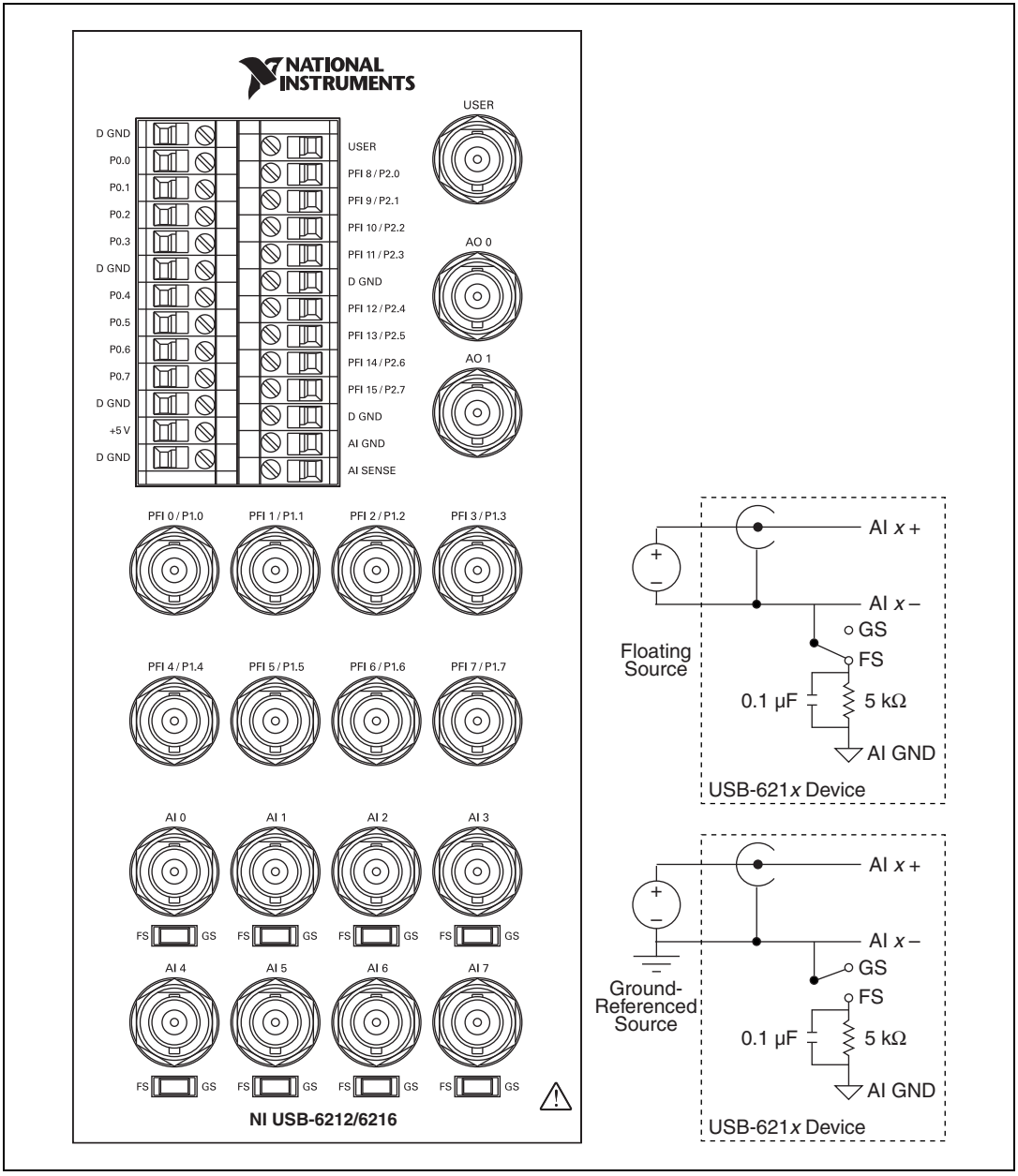


Figure 6. USB-6212/6216 BNC Pinout

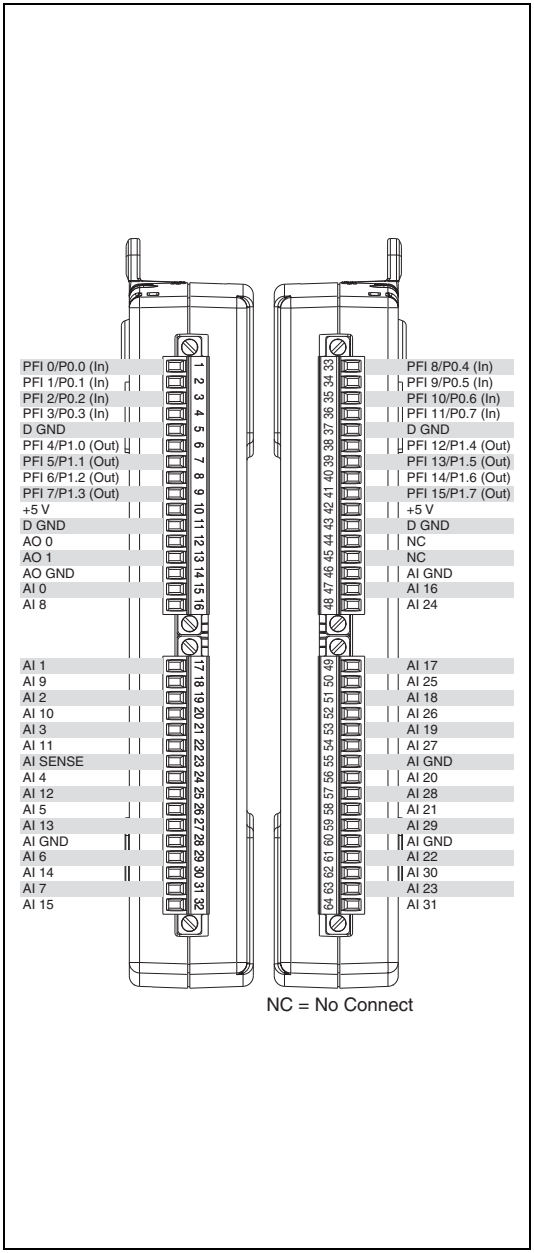
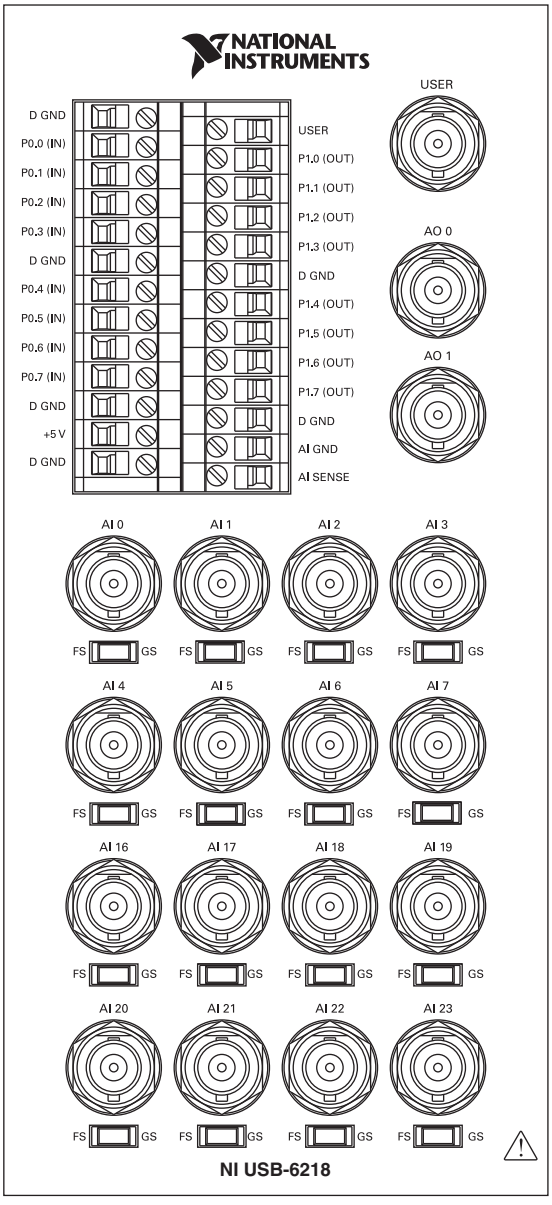


Figure 7. USB-6218 Screw Terminal Pinout



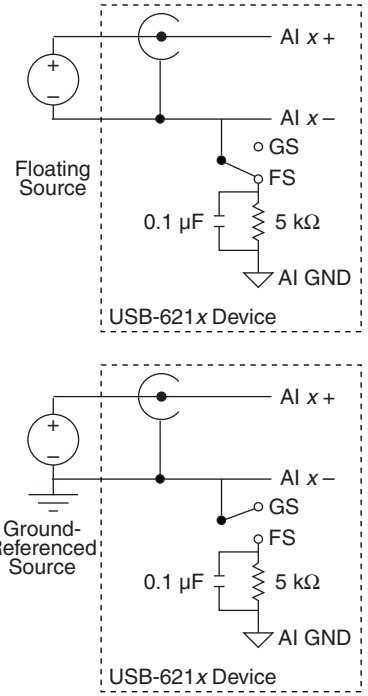


Figure 8. USB-6218 BNC Pinout