NI 622*x* Specifications

Specifications listed below are typical at 25 °C unless otherwise noted. Refer to the *M Series User Manual* for more information about NI 622*x* devices.

Analog Input

Number of channels
- NI 6220/6221 ..... 8 differential or 16 single ended
- NI 6224/6229 ..... 16 differential or 32 single ended
- NI 6225 ..... 40 differential or 80 single ended

ADC resolution ..... 16 bits

DNL ..... No missing codes guaranteed

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

Sampling rate
- Maximum ..... 250 kS/s single channel, 250 kS/s multi-channel (aggregate)
- Minimum ..... No minimum
- 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) ..... ±11 V of AI GND

CMRR (DC to 60 Hz) ..... 92 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 ..... 820 Ω
  - AI– to AI GND ..... 820 Ω

Input bias current ..... ±100 pA

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

Small signal bandwidth (–3 dB) ..... 700 kHz

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

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

Data transfers
- PCI/PXI devices ..... DMA (scatter-gather), interrupts, programmed I/O
- USB devices ..... USB Signal Stream, programmed I/O

Overvoltage protection (AI <0..79>, AI SENSE, AI SENSE 2)
- Device on ..... ±25 V for up to two AI pins
- Device off ..... ±15 V for up to two AI pins

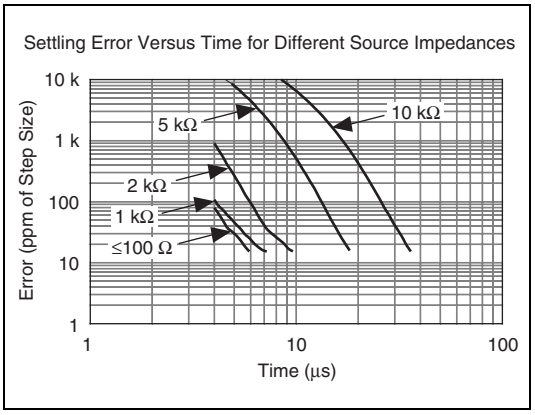
Input current during overvoltage condition ..... ±20 mA max/AI pin

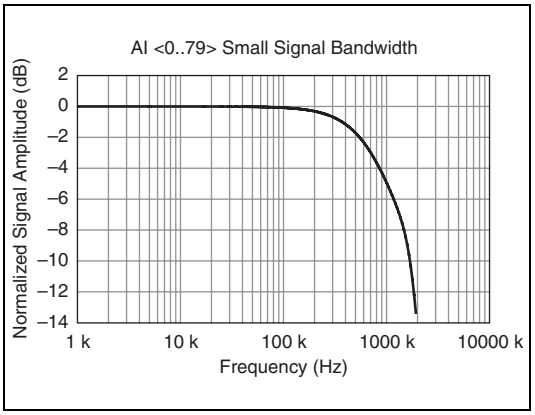
Settling Time for Multichannel Measurements

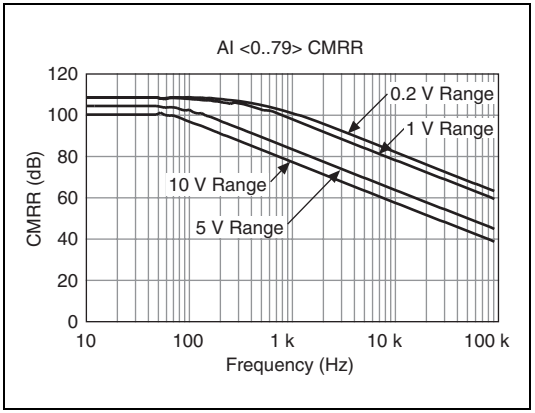
Accuracy, full scale step, all ranges
- ±90 ppm of step (±6 LSB) ..... 4 µs convert interval
- ±30 ppm of step (±2 LSB) ..... 5 µs convert interval
- ±15 ppm of step (±1 LSB) ..... 7 µs convert interval

NATIONAL INSTRUMENTS

Typical Performance Graphs







Analog Output

Number of channels
- NI 6220/6224 0
- NI 6221/6225 2
- NI 6229 4

DAC resolution ..... 16 bits

DNL ..... ±1 LSB

Monotonicity ..... 16 bit guaranteed

Maximum update rate
- 1 channel ..... 833 kS/s
- 2 channels ..... 740 kS/s per channel
- 3 channels ..... 666 kS/s per channel
- 4 channels ..... 625 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 ..... ±5 mA

Overdrive protection ..... ±25 V

Overdrive current ..... 10 mA

Power-on state ..... ±20 mV[1]

Power-off glitch ..... 400 mV for 200 ms

Output FIFO size ..... 8,191 samples shared among channels used

Data transfers
- PCI/PXI devices ..... DMA (scatter-gather), interrupts, programmed I/O
- USB devices ..... 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

[1] For all USB-6221/6229 devices, when powered on, the analog output signal is not defined until after USB configuration is complete.

Settling time, full scale step
15 ppm (1 LSB) ..... 6 µs

Slew rate ..... 15 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

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	25	5	20	57	76	244	3,100	97.6
5	–5	85	25	5	20	60	76	122	1,620	48.8
1	–1	95	25	5	25	79	76	30	360	12.0
0.2	–0.2	135	25	5	80	175	76	13	112	5.2

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

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

OffsetError = ResidualAIOffsetError + OffsetTempco · (TempChangeFromLastInternalCal) + INL_Error

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

[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 + 25 ppm · 1 + 5 ppm · 10 GainError = 150 ppm

OffsetError = 20 ppm + 57 ppm · 1 + 76 ppm OffsetError = 153 ppm

$$\text{NoiseUncertainty} = \frac{244\ \mu\text{V} \cdot 3}{\sqrt{100}}$$ NoiseUncertainty = 73 μ

AbsoluteAccuracy = 10 V · (GainError) + 10 V · (OffsetError) + NoiseUncertainty AbsoluteAccuracy = 3,100 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	10	5	40	5	128	3,230

[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

NI 6220/6221 (68-pin)/6225 ..... 24 total
8 (P0.<0..7>)
16 (PFI <0..7>/P1, PFI <8..15>/P2)

PCI-6221 (37-pin) ..... 10 total
2 (P0.<0, 1>)
8 (PFI <0..7>/P1)

NI 6224/6229 ..... 48 total
32 (P0.<0..31>)
16 (PFI <0..7>/P1, PFI <8..15>/P2)

Ground reference ..... D GND

Direction control ..... Each terminal individually programmable as input or output

Pull-down resistor ..... 50 kΩ typical, 20 kΩ minimum

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

Waveform Characteristics (Port 0 Only)

Terminals used

NI 6220/6221 (68-pin)/ PCI-6221 (37-pin) ..... Port 0 (P0.<0, 1>)

NI 6224/6229 ..... Port 0 (P0.<0..31>)

NI 6225 ..... Port 0 (P0.<0..7>)

Port/sample size

NI 6220/6221 (68-pin)/6225 ..... Up to 8 bits

PCI-6221 (37-pin) ..... Up to 2 bits

NI 6224/6229 ..... Up to 32 bits

Waveform generation (DO) FIFO ... 2,047 samples

Waveform acquisition (DI) FIFO .... 2,047 samples

DO or DI Sample Clock frequency[2] ..... 0 to 1 MHz

DO or DI Sample Clock source[3] ..... Any PFI, RTSI, AI Sample or Convert Clock, AO Sample Clock, Ctr *n* Internal Output, and many other signals

PFI/Port 1/Port 2 Functionality[4]

Functionality ..... Static digital input, static digital output, timing input, timing output

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

Debounce filter settings ..... 125 ns, 6.425 µs, 2.54 ms, disable; high and low transitions; selectable per input

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

[2] Performance can be dependent on bus latency and volume of bus activity.

[3] The digital subsystem does not have its own dedicated internal timing engine. Therefore, a sample clock must be provided from another subsystem on the device or an external source.

[4] Port 2 is not available on PCI-6221 (37-pin) devices.

Recommended Operation Conditions

PCI/PXI devices

Level	Min	Max
Input high voltage (V_{IH})	2.2 V	5.25 V
Input low voltage (V_{IL})	0 V	0.8 V
Output high current (I_{OH})		
P0.<0..31>	—	–24 mA
PFI <0..15>/P1/P2	—	–16 mA
Output low current (I_{OL})		
P0.<0..31>	—	24 mA
PFI <0..15>/P1/P2	—	16 mA

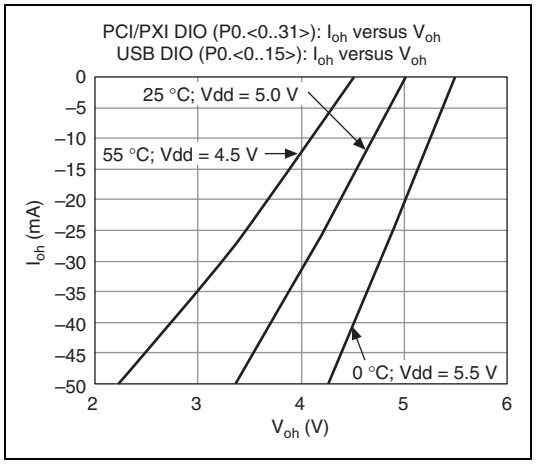
USB devices

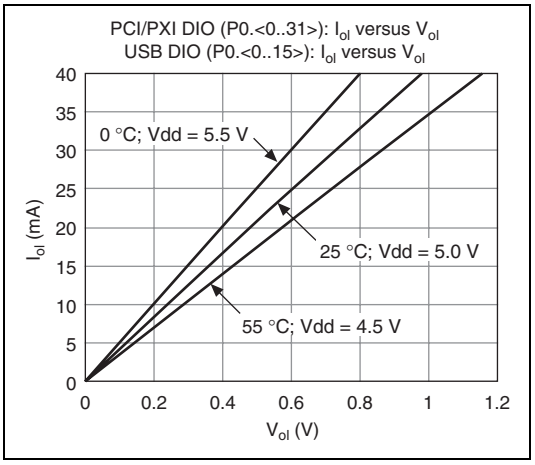
Level	Min	Max
Input high voltage (V_{IH})	2.2 V	5.25 V
Input low voltage (V_{IL})	0 V	0.8 V
Output high current (I_{OH})		
P0.<0..15>	—	–24 mA
P0.<16..31>	—	–16 mA
PFI <0..15>/P1/P2	—	–16 mA
Output low current (I_{OL})		
P0.<0..15>	—	24 mA
P0.<16..31>	—	16 mA
PFI <0..15>/P1/P2	—	16 mA

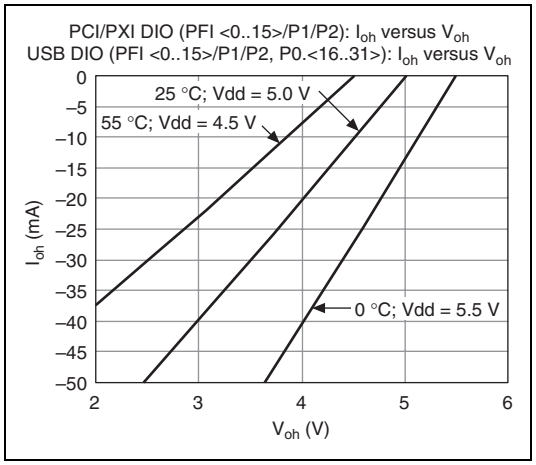
Electrical Characteristics

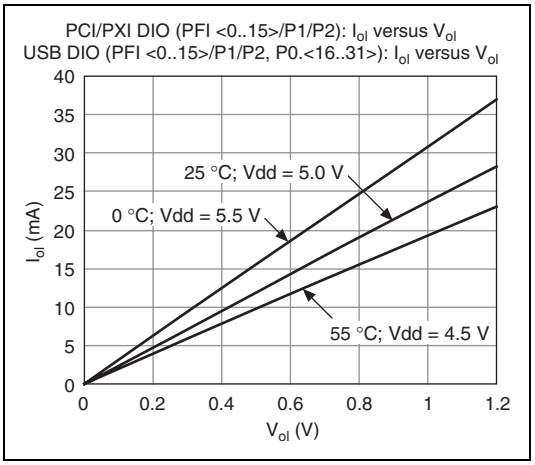
Level	Min	Max
Positive-going threshold (VT+)	—	2.2 V
Negative-going threshold (VT–)	0.8 V	—
Delta VT hysteresis (VT+ – VT–)	0.2 V	—
I_{IL} input low current (V_{in} = 0 V)	—	–10 µA
I_{IH} input high current (V_{in} = 5 V)	—	250 µA

Digital I/O Characteristics









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 ..... Any PFI, RTSI, PXI_TRIG, PXI_STAR, analog trigger, many internal signals

FIFO ..... 2 samples

Data transfers

- PCI/PXI devices ..... Dedicated scatter-gather DMA controller for each counter/timer; interrupts; programmed I/O
- USB devices ..... 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 PFI or RTSI terminal.

Phase-Locked Loop (PLL)

Number of PLLs 1

Reference signal ..... PXI_STAR, PXI_CLK10, RTSI <0..7>

Output of PLL ..... 80 MHz Timebase; other signals derived from 80 MHz Timebase including 20 MHz and 100 kHz Timebases

External Digital Triggers

Source ..... Any PFI, RTSI, PXI_TRIG, PXI_STAR

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,

Digital waveform generation (DO) function ..... Sample Clock

Digital waveform acquisition (DI) function ..... Sample Clock

Device-To-Device Trigger Bus

PCI devices.....RTSI <0..7>[1]

PXI devices.....PXI_TRIG <0..7>, PXI_STAR

USB devices .....None

Output selections .....10 MHz Clock; frequency generator output; many internal signals

Debounce filter settings.....125 ns, 6.425 µs, 2.54 ms, disabled; high and low transitions; selectable per input

Bus Interface

PCI/PXI devices .....3.3 V or 5 V signal environment

USB devices .....USB 2.0 Hi-Speed or full-speed[2]

DMA channels (PCI/PXI devices).....6, analog input, analog output, digital input, digital output, counter/timer 0, counter/timer 1

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

All PXI-622*x* devices support one of the following features:

- May be installed in PXI Express hybrid slots
- Or, may be used to control SCXI in PXI/SCXI combo chassis

Table 1. PXI and PXI Express Chassis

Device	Part Number	SCXI Control in PXI/SCXI Combo Chassis	PXI Express Hybrid Slot Compatible
PXI-6220	191332B-04	No	Yes
PXI-6221	191332B-03	No	Yes
	191332B-13	Yes	No
PXI-6224	191332B-02	No	Yes
PXI-6225	192227A-01	No	Yes
PXI-6229	191332B-01	No	Yes
	191332B-11	Yes	No
Earlier versions of PXI-6220, PXI-6221, PXI-6224, and PXI-6229	191332A-0*x*	Yes	No

Power Requirements

Current draw from bus during no-load condition[3]

+5 V..... 0.02 A[4]

+3.3 V..... 0.25 A[4]

+12 V..... 0.15 A

Current draw from bus during AI and AO overvoltage condition[3]

+5 V..... 0.02 A[4]

+3.3 V..... 0.25 A[4]

+12 V..... 0.25 A

[1] In other sections of this document, *RTSI* refers to RTSI <0..7> for PCI devices or PXI_TRIG <0..7> for PXI devices.

[2] 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.

[3] Does not include P0/PFI/P1/P2 and +5 V terminals.

[4] PCI-6221 (37-pin) devices do not use +3.3 V from the bus. The 3.3 V current draw, shown in the *Power Requirements* section, comes from the +5 V instead.

Caution USB-622*x* devices must be powered with NI offered AC adapter or a National Electric Code (NEC) Class 2 DC source that meets the power requirements for the device and has appropriate safety certification marks for country of use.

USB power supply requirements .... 11 to 30 VDC, 20 W

Power Limits

Caution Exceeding the power limits may cause unpredictable behavior by the device and/or PC/chassis.

PCI devices
- +5 V terminal (connector 0) ..... 1 A max[1]
- +5 V terminal (connector 1) ..... 1 A max[1]

PXI devices
- +5 V terminal (connector 0) ..... 1 A max[1]
- +5 V terminal (connector 1) ..... 1 A max[1]
- P0/PFI/P1/P2 and +5 V terminals combined ..... 2 A max

USB devices
- +5 V terminal..... 1 A max[1]
- P0/PFI/P1/P2 and +5 V terminals combined ..... 2 A max
- Power supply fuse ..... 2 A, 250 V

Physical Requirements

Printed circuit board dimensions
- PCI-6220/6221/6224/6225/6229 ..... 9.7 cm × 15.5 cm (3.8 in. × 6.1 in.)
- PXI-6220/6221/6224/6225/6229 ..... Standard 3U PXI

Enclosure dimensions (includes connectors)
USB-6221/6229 ..... 26.67 × 17.09 × 4.45 cm (10.5 × 6.73 × 1.75 in.)

Weight
- PCI-6220 ..... 91 g (3.2 oz)
- PCI-6221 (68-pin) ..... 92 g (3.2 oz)
- PCI-6221 (37-pin) ..... 95 g (3.3 oz)
- PCI-6224 ..... 99 g (3.5 oz)
- PCI-6225 ..... 103 g (3.6 oz)
- PCI-6229 ..... 101 g (3.5 oz)
- PXI-6220..... 158 g (5.5 oz)
- PXI-6221..... 162 g (5.7 oz)
- PXI-6224..... 170 g (5.9 oz)
- PXI-6225..... 174 g (6.1 oz)
- PXI-6229..... 171 g (6.0 oz)
- USB-6221 ..... 1.2 kg (2 lb 10 oz)
- USB-6229 ..... 1.24 kg (2 lb 11 oz)
- USB-6221 OEM ..... 86 g (3.0 oz)
- USB-6229 OEM ..... 107 g (3.8 oz)

I/O connector
- PCI/PXI-6220/6221 (68-pin) ..... 1 68-pin VHDCI
- PCI/PXI-6224/6225/6229 ..... 2 68-pin VHDCI
- PCI-6221 (37-pin)..... 1 37-pin D-SUB
- USB-6221 ..... 64 screw terminals
- USB-6229 ..... 128 screw terminals

Maximum Working Voltage[2]

NI 6220/6221/6224/6225/6229
Channel to earth ..... 11 V, Measurement Category I

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

Environmental

Operating temperature
- PCI/PXI devices..... 0 to 55 °C
- USB devices..... 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

Shock and Vibration (PXI Devices Only)

Operational shock..... 30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC-60068-2-27. Test profile developed in accordance with MIL-PRF-28800F.)

[1] Has a self-resetting fuse that opens when current exceeds this specification.

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

Random vibration

Operating .....5 to 500 Hz, 0.3 g_{rms}

Nonoperating .....5 to 500 Hz, 2.4 g_{rms} (Tested in accordance with IEC-60068-2-64. Nonoperating test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

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

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

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

- EN 61326 EMC requirements; Minimum Immunity
- EN 55011 Emissions; Group 1, Class A
- CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A

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

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 73/23/EEC; Low-Voltage Directive (safety)
- 89/336/EEC; Electromagnetic Compatibility Directive (EMC)

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.

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`.

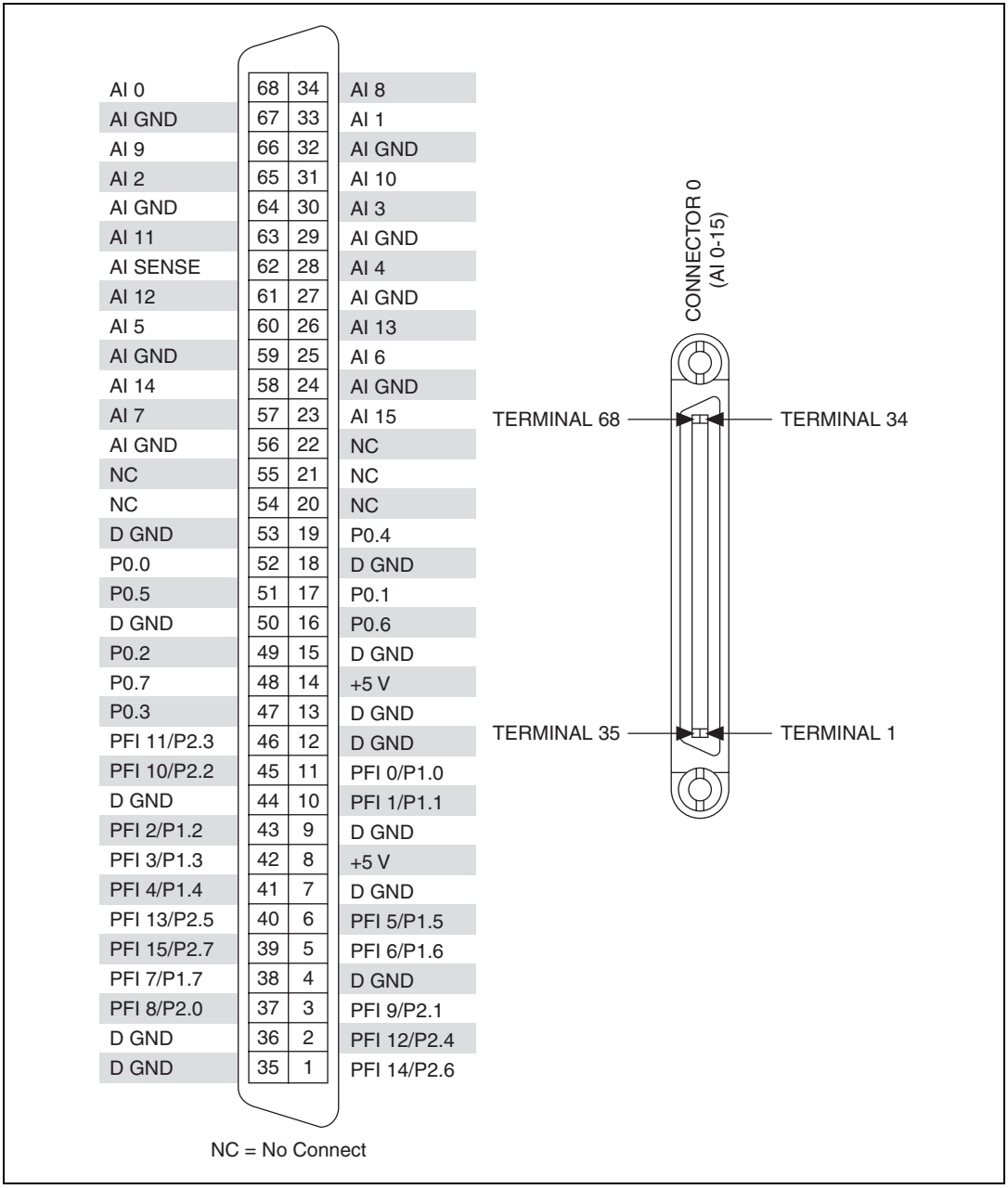


Figure 1. PCI/PXI-6220 Pinout

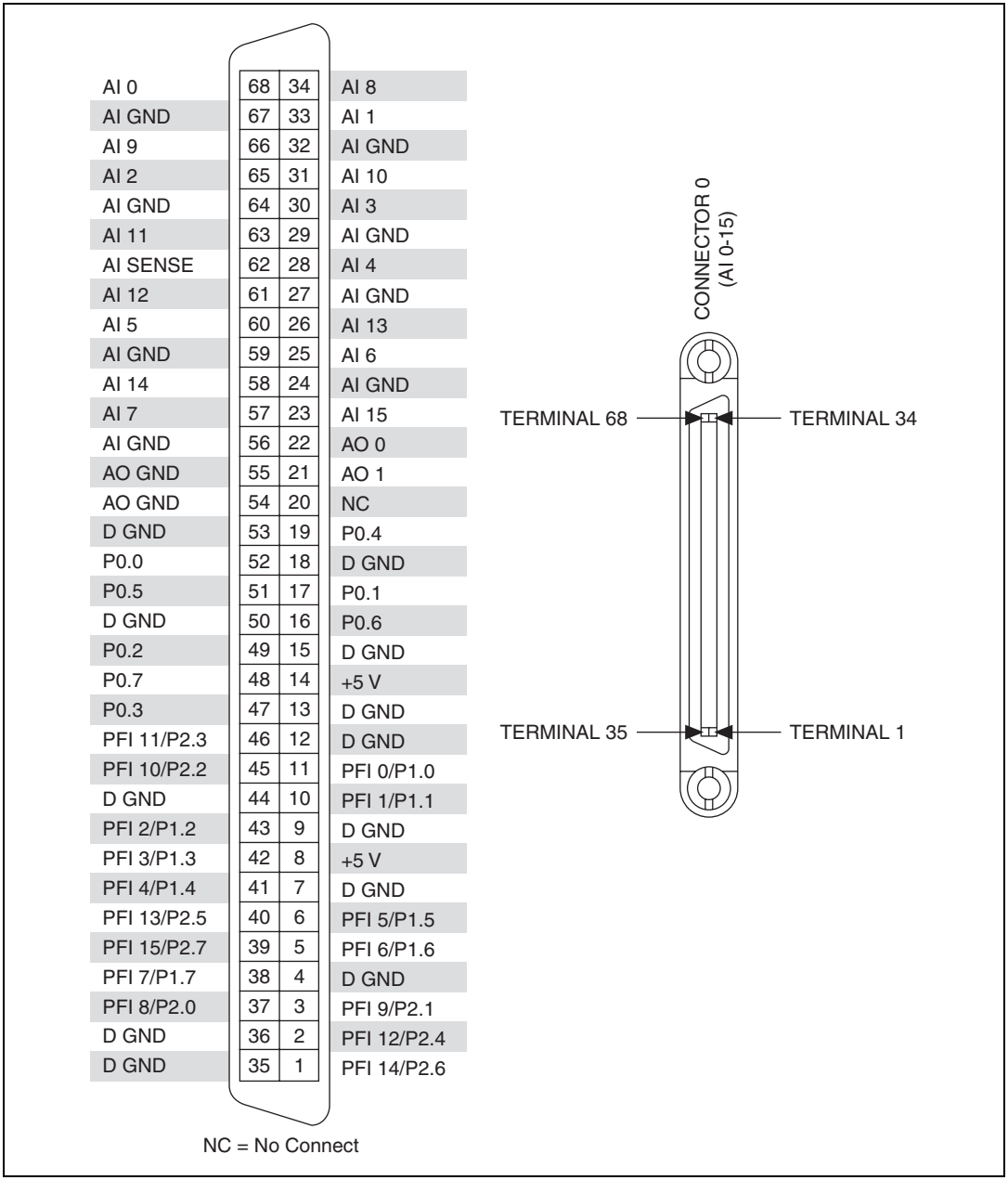


Figure 2. PCI/PXI-6221 (68-Pin) Pinout

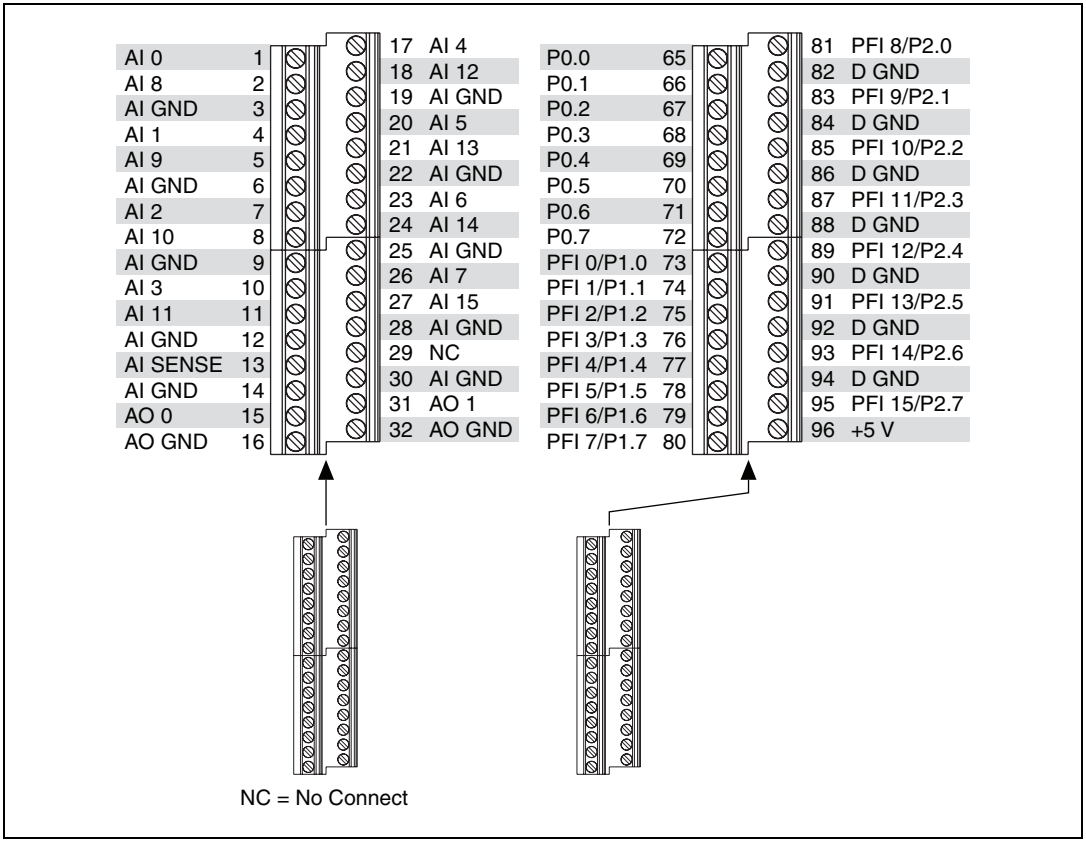


Figure 3. USB-6221 Pinout

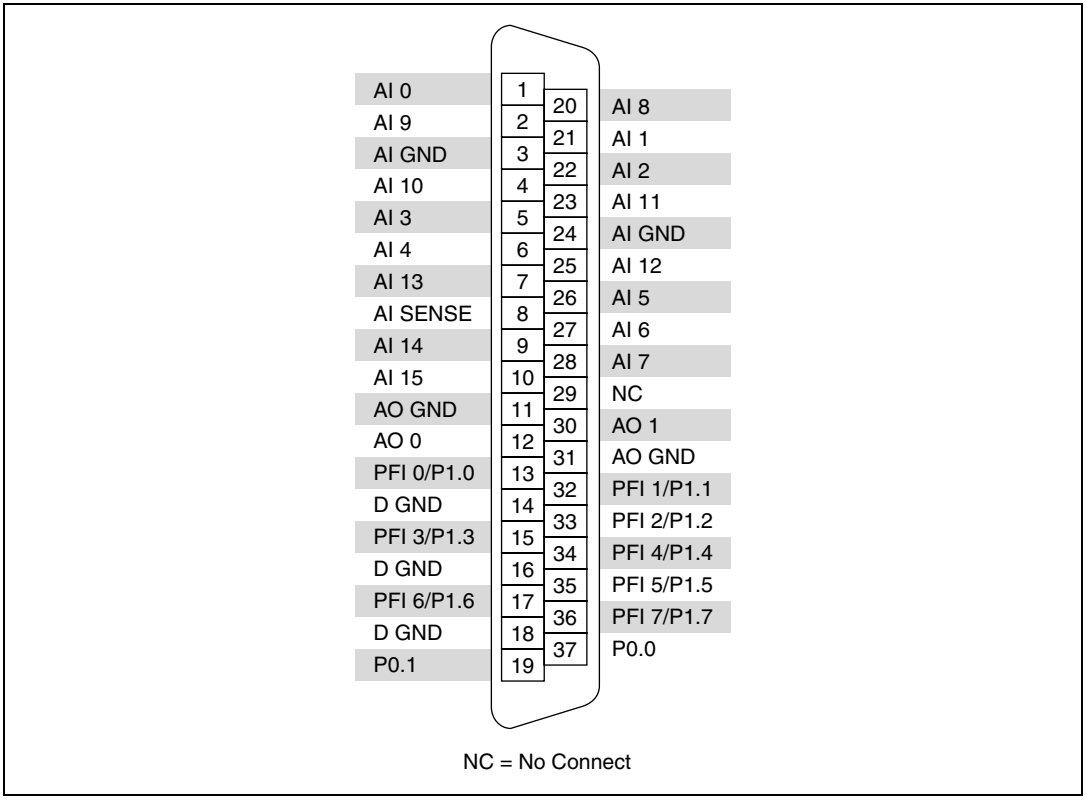


Figure 4. PCI-6221 (37-Pin) Pinout

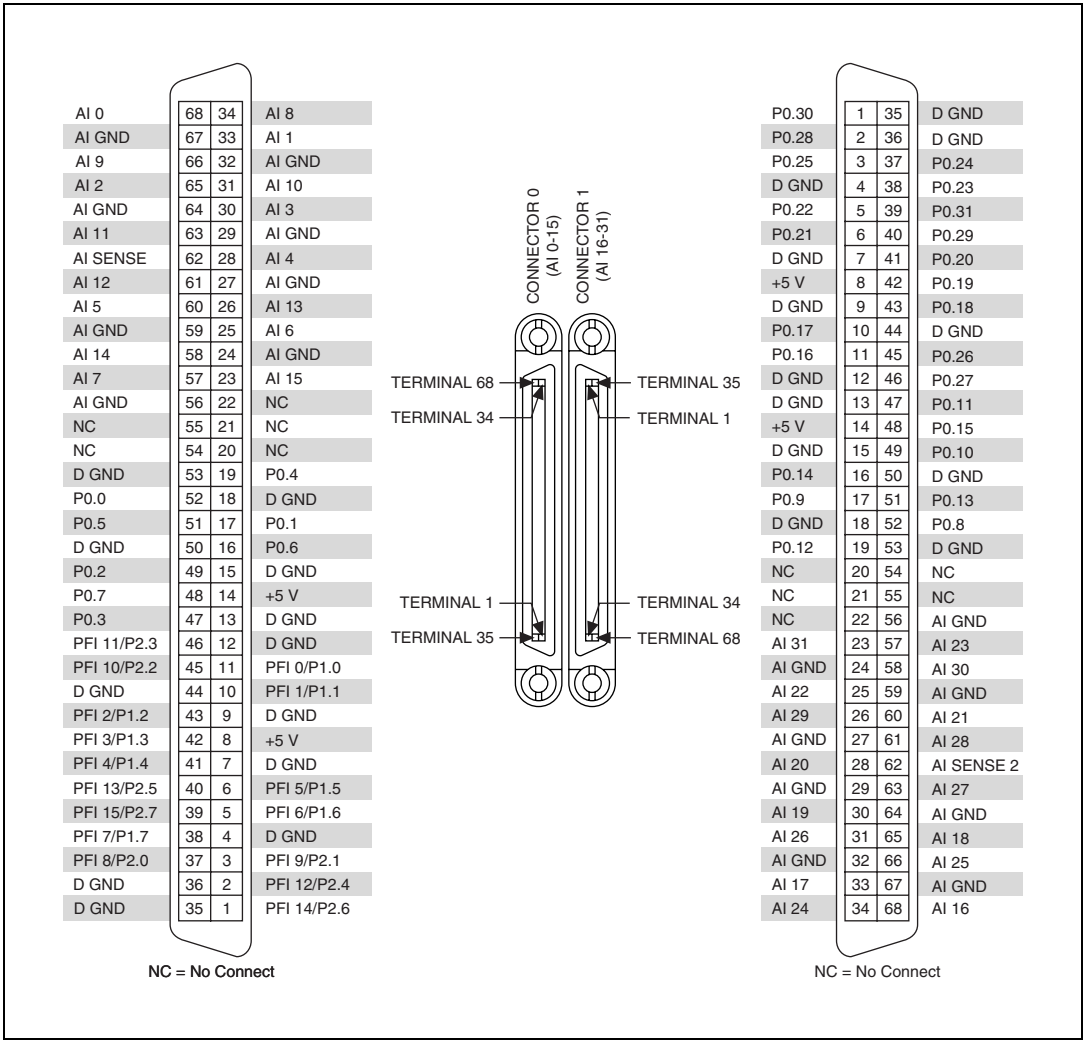


Figure 5. PCI/PXI-6224 Pinout

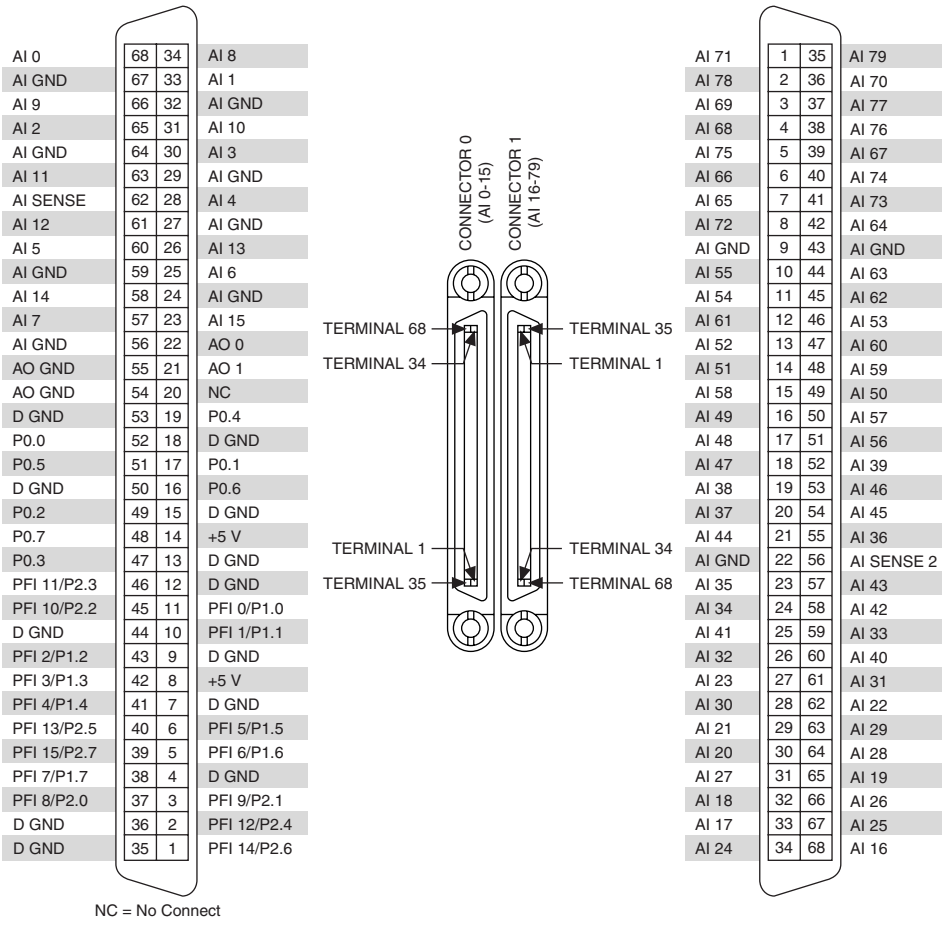


Figure 6. PCI/PXI-6225 Pinout

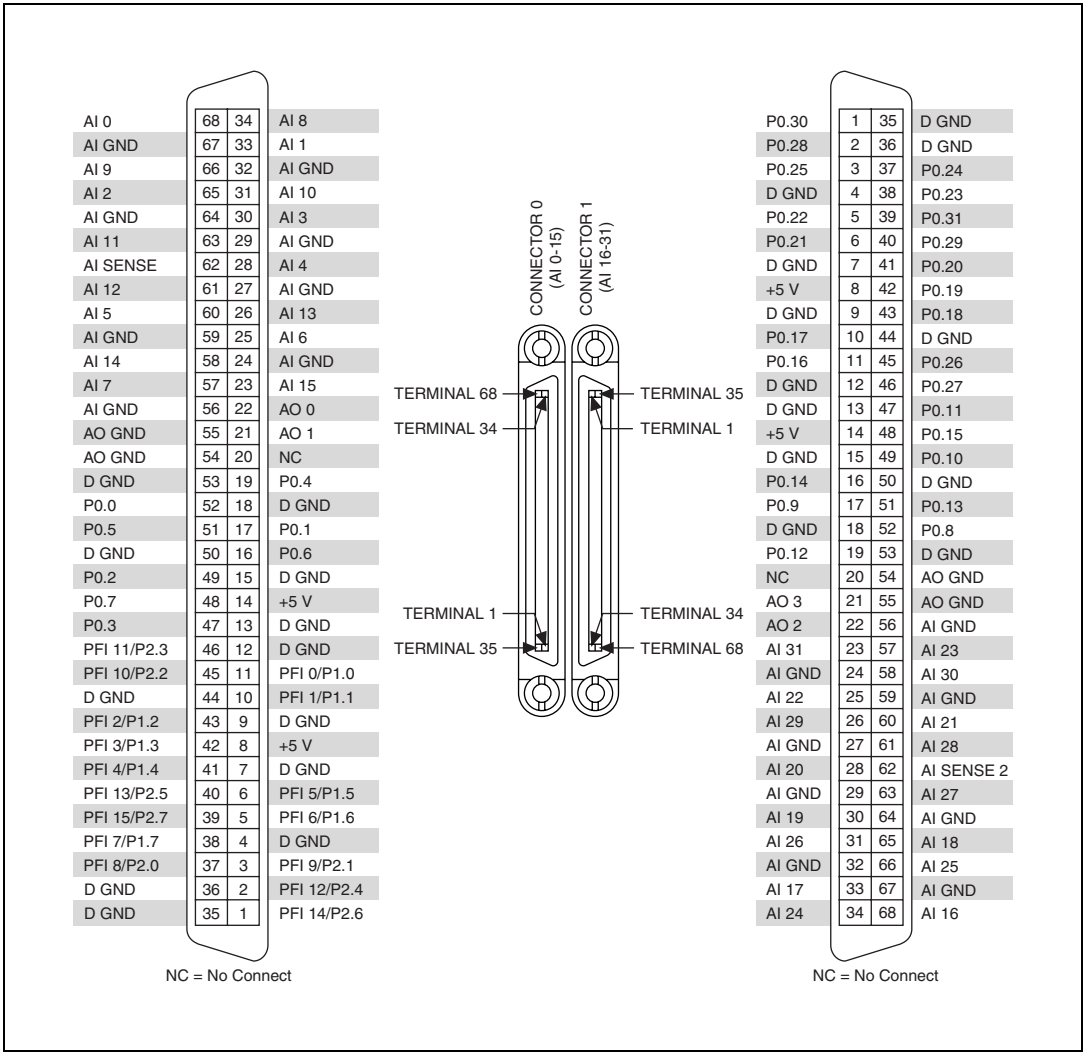


Figure 7. PCI/PXI-6229 Pinout

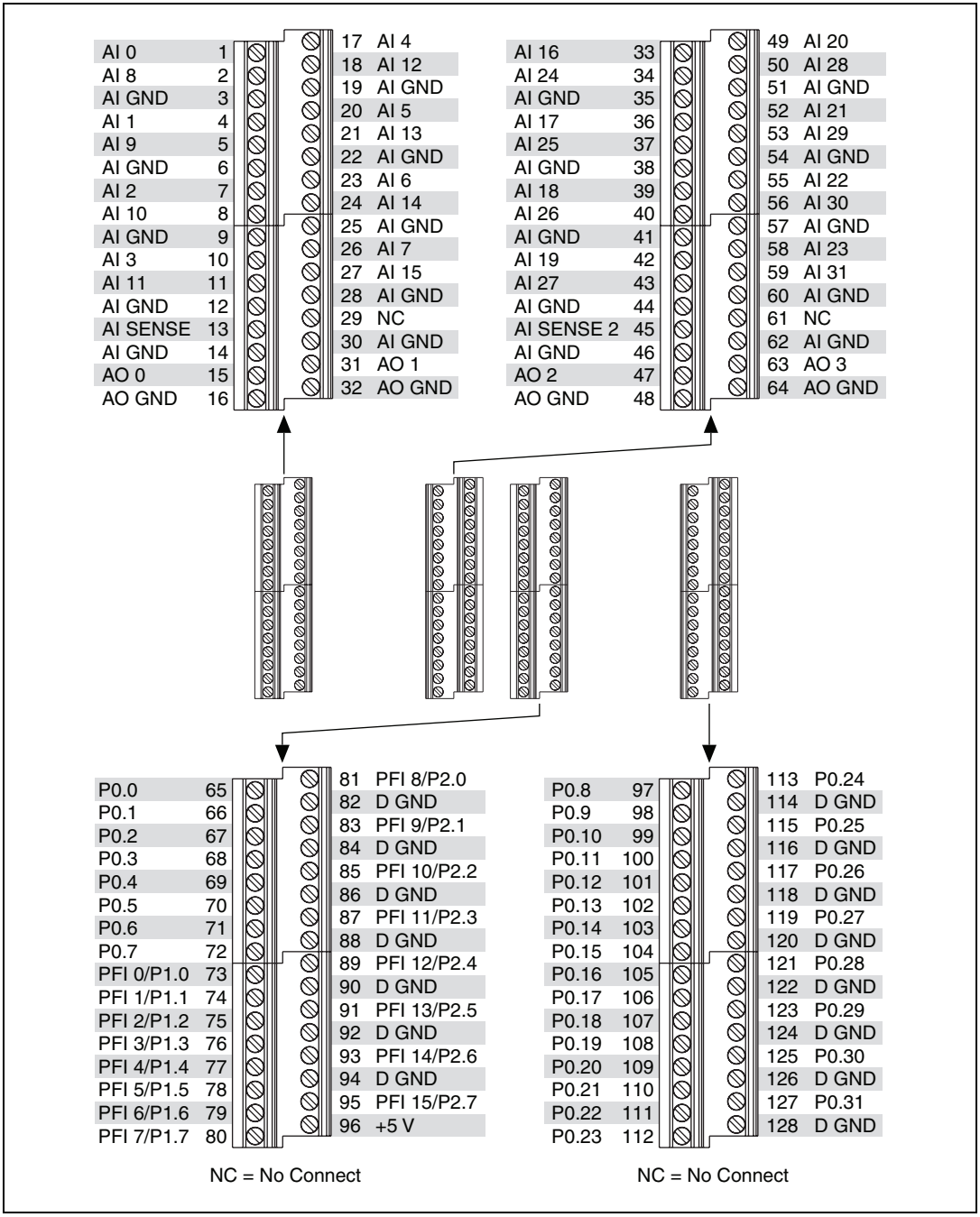


Figure 8. USB-6229 Pinout