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# PCI/PXI/ USB-6225 Specifications

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2022-10-07

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# NI 6225 Specifications

## Analog Input

Number of channels	40 differential or 80 single ended
ADC resolution	16 bits
DNL	No missing codes guaranteed
INL	Refer to the <a href="#">AI Absolute Accuracy</a> section
<b>Sample rate</b>	
Single channel maximum	250 kS/s
Multichannel maximum (aggregate)	250 kS/s
Minimum	No minimum
Timing accuracy	50 ppm of sample rate
Timing resolution	50 ns
Input coupling	DC
Input range	$\pm 0.2$ V, $\pm 1$ V, $\pm 5$ V, $\pm 10$ V
Maximum working voltage for analog inputs (signal + common mode)	$\pm 11$ V of AI GND

CMRR (DC to 60 Hz)	92 dB
<b>Input impedance</b>	
<b>Device on</b>	
AI+ to AI GND	>10 G $\Omega$ in parallel with 100 pF
AI- to AI GND	>10 G $\Omega$ in parallel with 100 pF
<b>Device off</b>	
AI+ to AI GND	820 $\Omega$
AI- to AI GND	820 $\Omega$
Input bias current	$\pm$ 100 pA
<b>Crosstalk (at 100 kHz)</b>	
Adjacent channels	-75 dB
Non-adjacent channels	-90 dB <sup>[1]</sup>
Small signal bandwidth (-3 dB)	700 kHz
Input FIFO size	4,095 samples
Scan list memory	4,095 entries
<b>Data transfers</b>	
PCI/PXI	DMA (scatter-gather), interrupts, programmed I/O

USB	USB Signal Stream, programmed I/O	
<b>Overvoltage protection for all analog input and sense channels</b>		
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 maximum/AI pin	

## Settling Time for Multichannel Measurements

<b>Accuracy, full-scale step, all ranges</b>		
±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	

## Typical Performance Graphs

Figure 1. Settling Error versus Time for Different Source Impedances

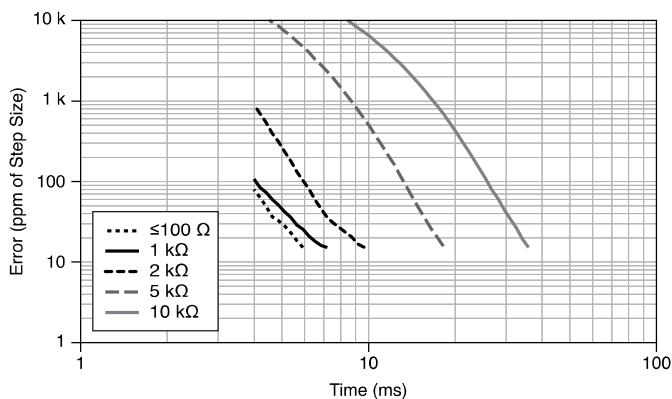


Figure 2. AI Small Signal Bandwidth

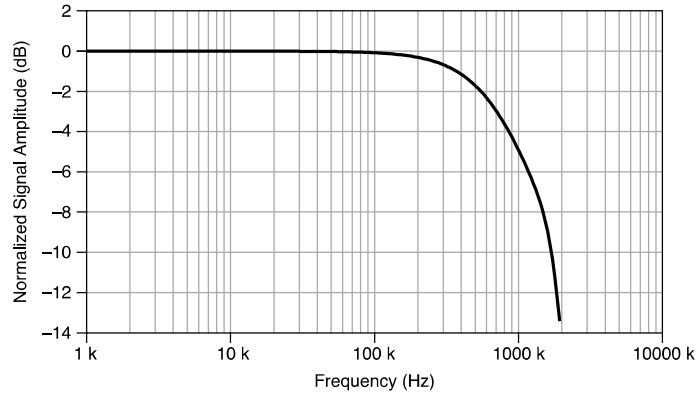
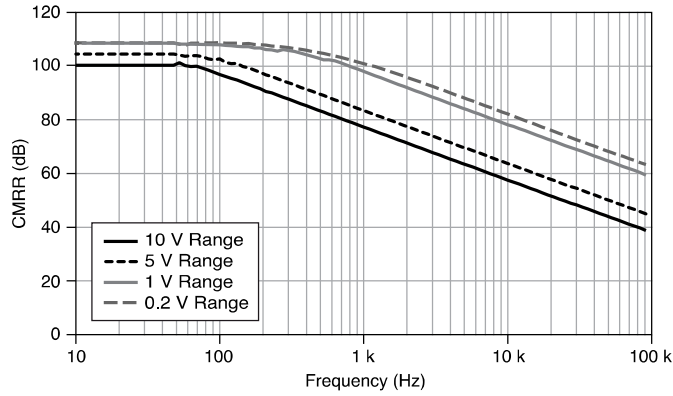


Figure 3. AI CMRR



## AI Absolute Accuracy

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

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, $\sigma$ ( $\mu\text{Vrms}$ )	Absolute Accuracy at Full Scale ( $\mu\text{V}$ )	Sensitivity ( $\mu\text{V}$ )
10	-10	75	20	57	244	3,100	97.6
5	-5	85	20	60	122	1,620	48.8
1	-1	95	25	79	30	360	12.0

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, $\sigma$ ( $\mu\text{Vrms}$ )	Absolute Accuracy at Full Scale ( $\mu\text{V}$ )	Sensitivity ( $\mu\text{V}$ )
0.2	-0.2	135	80	175	13	112	5.2

Table 3. AI Absolute Accuracy

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

Gain tempco	25 ppm/°C
Reference tempco	5 ppm/°C
INL error	76 ppm of range

### AI Absolute Accuracy Equation

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

- **GainError = ResidualAIGainError + GainTempco · (TempChangeFromLastInternalCal) + ReferenceTempco · (TempChangeFromLastExternalCal)**
- **OffsetError = ResidualAIOffsetError + OffsetTempco · (TempChangeFromLastInternalCal) + INLError**
- **NoiseUncertainty =  $\frac{\text{Random Noise} \cdot 3}{\sqrt{100}}$**   
for a coverage factor of 3  $\sigma$  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  $\sigma$

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 = 150 ppm
- OffsetError = 20 ppm + 57 ppm · 1 + 76 ppm = 153 ppm
- NoiseUncertainty =  

$$\frac{244 \mu\text{V} \cdot 3}{\sqrt{100}}$$
 = 73  $\mu\text{V}$
- AbsoluteAccuracy = 10 V · (GainError) + 10 V · (OffsetError) +  
 NoiseUncertainty = 3,100  $\mu\text{V}$

## Analog Output

Number of channels	2
DAC resolution	16 bits
DNL	$\pm 1$ LSB
Monotonicity	16 bit guaranteed
<b>Maximum update rate</b>	
1 channel	833 kS/s



2 channels	740 kS/s per channel
Timing accuracy	50 ppm of sample rate
Timing resolution	50 ns
Output range	$\pm 10$ V
Output coupling	DC
Output impedance	0.2 $\Omega$
Output current drive	$\pm 5$ mA
Overdrive protection	$\pm 25$ V
Overdrive current	10 mA
Power-on state	$\pm 20$ mV
Power-off glitch	400 mV for 200 ms
Output FIFO size	8,191 samples shared among channels used
<b>Data transfers</b>	
Data transfers	DMA (scatter-gather), interrupts, programmed I/O
USB	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)	6 $\mu$ s
Slew rate	15 V/ $\mu$ s
<b>Glitch energy</b>	
Magnitude	100 mV
Duration	2.6 $\mu$ s

## 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.

Nominal Range Positive Full Scale	Nominal Range Negative Full Scale	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 ( $\mu$ V)
10	-10	90	10	40	5	3,230

Table 3. AO Absolute Accuracy

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

## AO Absolute Accuracy Equation

$$\text{AbsoluteAccuracy} = \text{OutputValue} \cdot (\text{GainError}) + \text{Range} \cdot (\text{OffsetError})$$

- **GainError = ResidualGainError + GainTempco**  
 · (TempChangeFromLastInternalCal) + ReferenceTempco ·  
 (TempChangeFromLastExternalCal)
- **OffsetError = ResidualOffsetError + AOffsetTempco** ·  
 (TempChangeFromLastInternalCal) + INLError

## Digital I/O/PFI

### Static Characteristics

Number of channels	24 total, 8 (P0.<0..7>), 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	±20 V on up to two pins <sup>[2]</sup>

### Waveform Characteristics (Port 0 Only)

Terminals used	Port 0 (P0.<0..7>)
Port/sample size	Up to 8 bits
Waveform generation (DO) FIFO	2,047 samples

Waveform acquisition (DI) FIFO	2,047 samples
DI or DO Sample Clock frequency	0 MHz to 1 MHz, system and bus activity dependent
Data transfers	DMA (scatter-gather), interrupts, programmed I/O
DI or DO Sample Clock source <sup>[3]</sup>	Any PFI, RTSI, AI Sample or Convert Clock, Ctr n Internal Output, and many other signals

## PFI/Port 1/Port 2 Functionality

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 $\mu$ s, 2.56 ms, disable; high and low transitions; selectable per input

## Recommended Operating Conditions

Level	Minimum	Maximum
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..7>	—	-24 mA
Output high current ( $I_{OH}$ ) PFI <0..15>/P1/P2	—	-16 mA
Output low current ( $I_{OL}$ ) P0.<0..7>	—	24 mA
Output low current ( $I_{OL}$ ) PFI <0..15>/P1/P2	—	16 mA

## Electrical Characteristics

Level	Minimum	Maximum
Positive-going threshold (VT+)	—	2.2 V
Negative-going threshold (VT-)	0.8 V	—
Delta VT hysteresis (VT+ - VT-)	0.2 V	—
I <sub>IL</sub> input low current (V <sub>in</sub> = 0 V)	—	-10 μA
I <sub>IH</sub> input high current (V <sub>in</sub> = 5 V)	—	250 μA

## Digital I/O Characteristics

Figure 4. DIO Port 0: I<sub>oh</sub> versus V<sub>oh</sub>

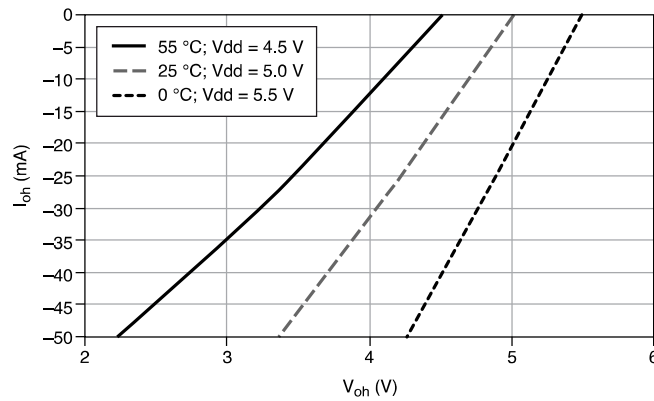


Figure 5. DIO PFI/Port 1/Port 2: I<sub>oh</sub> versus V<sub>oh</sub>

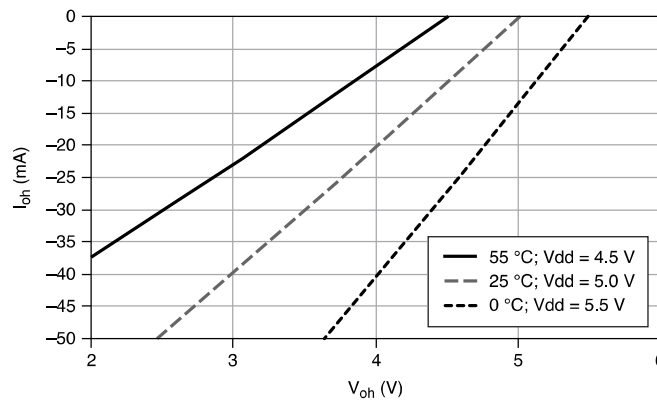


Figure 6. DIO Port 0:  $I_{OL}$  versus  $V_{OL}$

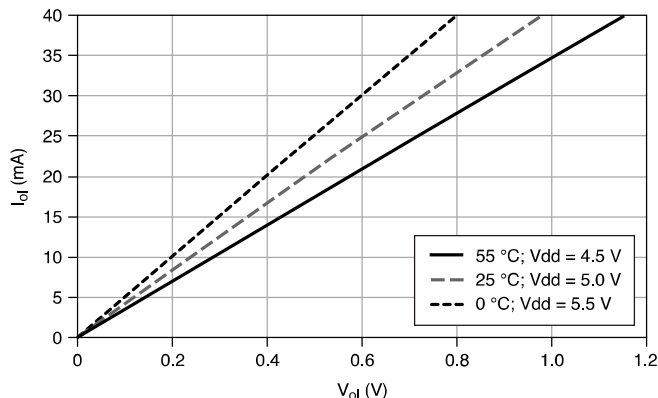
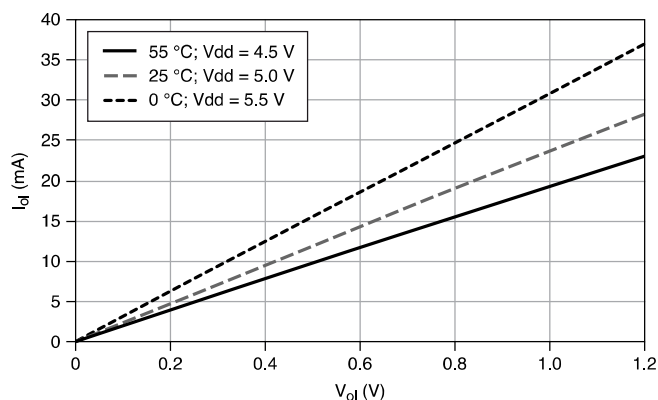


Figure 7. DIO PFI/Port 1/Port 2:  $I_{OL}$  versus  $V_{OL}$



## 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	Any PFI, RTSI, PXI_TRIG, PXI_STAR, analog trigger, many internal signals
FIFO	2 samples
<p><b>Data transfers</b></p> <p>PCI/PXI Dedicated scatter-gather DMA controller for each counter/timer; interrupts, programmed I/O</p> <p>USB USB Signal Stream, programmed I/O</p>	

## 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 or RTSI terminal.

## Phase-Locked Loop (PLL)

**Note** PCI/PXI devices only.

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 function	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	RTSI <0..7> <sup>[4]</sup>
PXI	PXI_TRIG <0..7>, PXI_STAR
USB source	None
Output selections	10 MHz Clock, frequency generator output, many internal signals
Debounce filter settings	125 ns, 6.425 $\mu$ s, 2.56 ms, disable; high and low transitions; selectable per input

## Bus Interface

PCI/PXI	3.3 V or 5 V signal environment
USB	USB 2.0 Hi-Speed or full-speed <sup>[5], [6]</sup>
DMA channels (PCI/PXI)	6, can be used for analog input, analog output, digital input, digital output, counter/timer 0, counter/timer 1
USB Signal Stream	4, can be used for analog input, analog output, counter/timer 0, counter/timer 1

The PXI device can be installed in PXI Express hybrid slots. It cannot be used to control SCXI in PXI/SCXI combo chassis.

## Power Requirements

**Current draw from bus during no-load condition<sup>[7]</sup>**

+5 V	0.02 A
+3.3 V	0.25 A
+12 V	0.15 A

**Current draw from bus during AI and AO overvoltage condition<sup>[7]</sup>**

+5 V	0.02 A
+3.3 V	0.25 A
+12 V	0.25 A

**Caution** USB devices must be powered with an 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, locking or non-locking power jack with 0.080 in. diameter center pin, 5/16-32 thread for locking collars
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## Current Limits

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

<b>PCI</b>	
+5 V terminal (connector 0)	1 A maximum <sup>[8]</sup>

+5 V terminal (connector 1)	1 A maximum <sup>[8]</sup>
<b>PXI</b>	
+5 V terminal (connector 0)	1 A maximum <sup>[8]</sup>
+5 V terminal (connector 1)	1 A maximum <sup>[8]</sup>
P0/PFI/P1/P2 and +5 V terminals combined	2 A maximum
<b>USB</b>	
+5 V terminal	1 A maximum <sup>[8]</sup>
P0/PFI/P1/P2 and +5 V terminals combined	2 A maximum
Power supply fuse	2 A, 250 V

## Physical Characteristics

<b>Dimensions</b>	
PCI printed circuit board	10.6 cm × 15.5 cm(4.2 in. × 6.1 in.)
PXI printed circuit board	Standard 3U PXI
Screw Terminal (includes connectors)	26.67 cm × 17.09 cm × 4.45 cm(10.5 in. × 6.73 in. × 1.75 in.)
Mass Termination enclosure (includes connectors)	18.8 cm × 17.09 cm × 4.45 cm (7.4 in. × 6.73 in. × 1.75 in.)

USB OEM	Refer to the <b>NI USB-622x/625x/628x OEM User Guide</b>
<b>Weight</b>	
PCI	103 g (3.6 oz)
PXI	174 g (6.1 oz)
USB Screw Terminal	1.24 kg (2 lb11 oz)
USB Mass Termination	907 g (2 lb)
USB OEM	162 g (5.7 oz)
<b>I/O connectors</b>	
Mass Termination	2 68-pin SCSI

## Calibration

<b>Recommended warm-up time</b>	
PCI/PXI	15 minutes
USB	30 minutes
Calibration interval	1 year

## Maximum Working Voltage

Connect only voltages that are below these limits.

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

## Environmental

<b>Operating temperature</b>	
PCI/PXI	0 °C to 55 °C
USB	0 °C to 45 °C
Storage temperature	-20 °C to 70 °C
Humidity	10% RH to 90% RH, noncondensing
Maximum altitude	2,000 m
Pollution Degree (indoor use only)	2

Indoor use only.

## Shock and Vibration (PXI 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.)
<b>Random vibration</b>	
Operating	5 Hz to 500 Hz, 0.3 g <sub>rms</sub>
Nonoperating	5 Hz to 500 Hz, 2.4 g <sub>rms</sub> (Tested in accordance with IEC 60068-2-64. Nonoperating test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

## Safety Compliance Standards

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 C22.2 No. 61010-1

**Note** For safety certifications, refer to the product label or the [Product Certifications and Declarations](#) section.

## Electromagnetic Compatibility

## CE Compliance

- 2011/65/EU; Restriction of Hazardous Substances (RoHS)

## Product Certifications and Declarations


Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for NI products, visit [ni.com/product-certifications](https://ni.com/product-certifications), search by model number, and click the appropriate link.

## 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 **Engineering a Healthy Planet** web page at [ni.com/environment](https://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.

## EU and UK Customers

-  **Waste Electrical and Electronic Equipment (WEEE)**—At the end of the product life cycle, all NI products must be disposed of according to local laws and regulations. For more information about how to recycle NI products in your region, visit [ni.com/environment/weee](https://ni.com/environment/weee).

## 电子信息产品污染控制管理办法（中国 RoHS）

-  **中国 RoHS**—NI 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 NI 中国 RoHS 合规性信息，请登录 [ni.com/environment/rohs\\_china](https://ni.com/environment/rohs_china)。(For information about China RoHS compliance, go to [ni.com/environment/rohs\\_china](https://ni.com/environment/rohs_china).)

# Device Pinouts

Figure 8. NI PCI/PXI-6225 Pinout

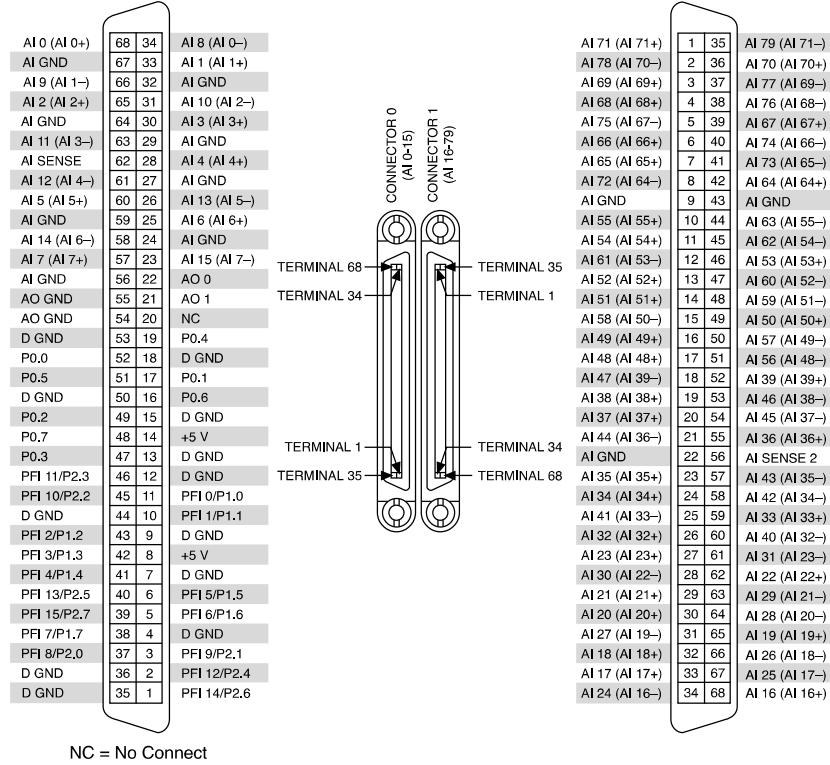




Figure 9. NI USB-6225 Screw Terminal Pinout

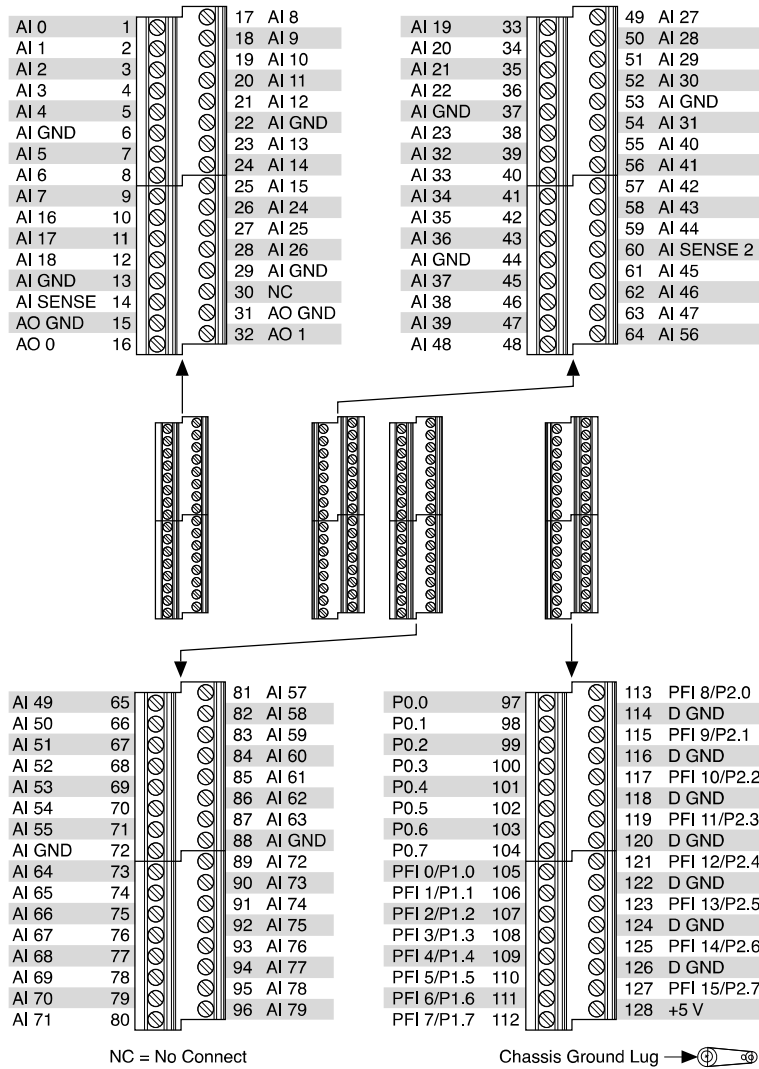
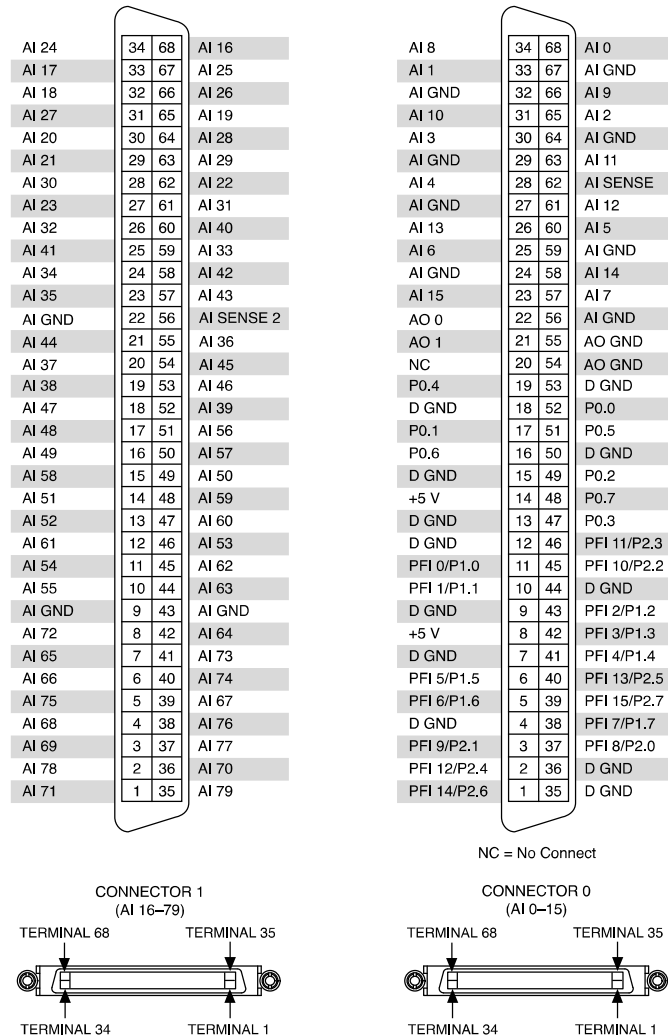


Figure 10. NI USB-6225 Mass Termination Pinout



1 Channel AI <0..15> crosstalk to channel AI <64..79> is -71 dB. This applies to channels with 64-channel separation. Example: AI (x) and AI (x + 64).

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

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.

<sup>4</sup> In other sections of this document, RTSI refers to RTSI <0..7> for the PCI devices or PXI\_TRIG <0..7> for PXI devices.

<sup>5</sup> 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.

<sup>6</sup> Operating on a full-speed bus may result in lower performance.

<sup>7</sup> Does not include P0/PFI/P1/P2 and +5 V terminals.

<sup>8</sup> Older revisions have a self-resetting fuse that opens when current exceeds this specification. Newer revisions have a traditional fuse that opens when current exceeds this specification. This fuse is not customer-replaceable; if the fuse permanently opens, return the device to NI for repair.