

# NI 622x Specifications

Specifications listed below are typical at 25 °C unless otherwise noted.

## Analog Input

### Number of channels

NI 6220/NI 6221 .....	8 differential or 16 single ended
NI 6224/NI 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
Minimum .....	0 S/s
Timing accuracy .....	50 ppm of sample rate
Timing resolution .....	50 ns

Input coupling ..... DC

Input range .....  $\pm 10$  V,  $\pm 5$  V,  
 $\pm 1$  V,  $\pm 0.2$  V

Maximum working voltage for analog inputs  
(signal + common mode) .....  $\pm 11$  V of AI GND

CMRR (DC to 60 Hz) ..... 95 dB

### Input impedance

#### Device on

AI+ to AI GND .....	$>10$ G $\Omega$ in parallel with 100 pF
AI- to AI GND .....	$>10$ G $\Omega$ in parallel with 100 pF

#### Device off

AI+ to AI GND .....	820 $\Omega$
AI- to AI GND .....	820 $\Omega$

Input bias current .....  $\pm 100$  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 ..... DMA (scatter-gather),  
interrupts,  
programmed I/O

### Overvoltage protection (AI <0.79>, AI SENSE, AI SENSE 2)

Device on .....	$\pm 25$ V for up to two AI pins
Device off .....	$\pm 15$ V for up to two AI pins

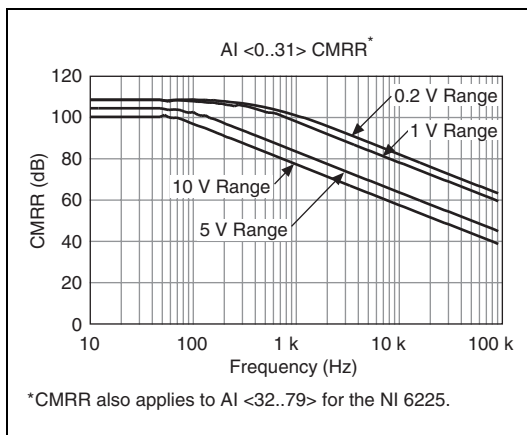
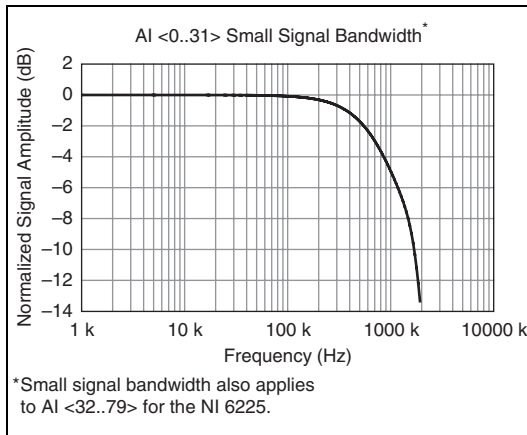
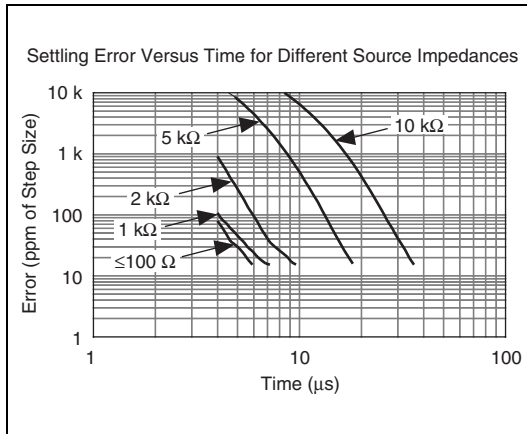
Input current during  
overvoltage condition .....  $\pm 20$  mA max/AI pin

## Settling Time for Multichannel Measurements

Accuracy, full scale step, all ranges

$\pm 90$ ppm of step ( $\pm 6$ LSB) .....	4 $\mu$ s convert interval
$\pm 30$ ppm of step ( $\pm 2$ LSB) .....	5 $\mu$ s convert interval
$\pm 15$ ppm of step ( $\pm 1$ LSB) .....	7 $\mu$ s convert interval

## Typical Performance Graphs



## Analog Output

Number of channels

NI 6220.....	0
NI 6221.....	2
NI 6224.....	0
NI 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

Power-on glitch..... 8.5 V peak for 14.5 ms

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

Data transfers ..... DMA (scatter-gather), interrupts, 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  
Glitch energy  
  Magnitude..... 100 mV  
  Duration..... 2.6  $\mu$ s

## **Calibration (AI and AO)**

Recommended warm-up time ..... 15 minutes  
Calibration interval ..... 1 year

## AI Absolute Accuracy Table

Nominal Range	Positive Full Scale	Negative Full Scale	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, $\sigma$ ( $\mu$ Vrms)	Absolute Accuracy at Full Scale <sup>1</sup> ( $\mu$ V)	Sensitivity <sup>2</sup> ( $\mu$ V)
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 = ResidualGainError + GainTempco · (TempChangeFromLastInternalCal) + ReferenceTempco · (TempChangeFromLastExternalCal)

OffsetError = ResidualOffsetError + OffsetTempco · (TempChangeFromLastInternalCal) + INL\_Error

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

<sup>1</sup> 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

GainError = 150 ppm

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

OffsetError = 153 ppm

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

AbsoluteAccuracy = 10 V · (GainError) + 10 V · (OffsetError) + NoiseUncertainty AbsoluteAccuracy = 3,100  $\mu$ V

<sup>2</sup> 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 <sup>1</sup> (µV)
Positive Full Scale	Negative Full Scale							
10	-10	90	10	5	40	5	128	3,230

<sup>1</sup> 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 + AOffsetTempco · (TempChangeFromLastInternalCal) + INL\_Error

# Digital I/O/PFI

AO Sample Clock,  
Ctr *n* Internal Output,  
and many other signals

## Static Characteristics

Number of channels	
NI 6220/NI 6221 (68-pin)/ NI 6225 .....	24 total 8 (P0.<0..7>) 16 (PFI <0..7>/P1, PFI <8..15>/P2)
NI 6224/NI 6229 .....	48 total 32 (P0.<0..31>) 16 (PFI <0..7>/P1, PFI <8..15>/P2)
NI 6221 (37-pin) .....	10 total 2 (P0.<0, 1>) 8 (PFI <0..7>/P1)
Ground reference .....	D GND
Direction control .....	Each terminal individually programmable as input or output
Pull-down resistor .....	50 kΩ to 75 kΩ
Input voltage protection <sup>1</sup> .....	±20 V on up to two pins

## Waveform Characteristics (Port 0 Only)

Terminals used	
NI 6220/NI 6221 (68-pin)/ NI 6225 .....	Port 0 (P0.<0..7>)
NI 6224/NI 6229 .....	Port 0 (P0.<0..31>)
NI 6221 (37-pin) .....	Port 0 (P0.<0, 1>)

### Port/sample size

NI 6220/NI 6221 (68-pin)/ NI 6225 .....	Up to 8 bits
NI 6224/NI 6229 .....	Up to 32 bits
NI 6221 (37-pin) .....	Up to 2 bits

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

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

### DO or DI Sample Clock

frequency .....0 to 1 MHz

DO or DI Sample Clock source<sup>2</sup> ....Any PFI, RTSI,  
AI Sample or  
Convert Clock,

## PFI/Port 1/Port 2 Functionality<sup>3</sup>

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

## Recommended Operation Conditions

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

## Electrical Characteristics

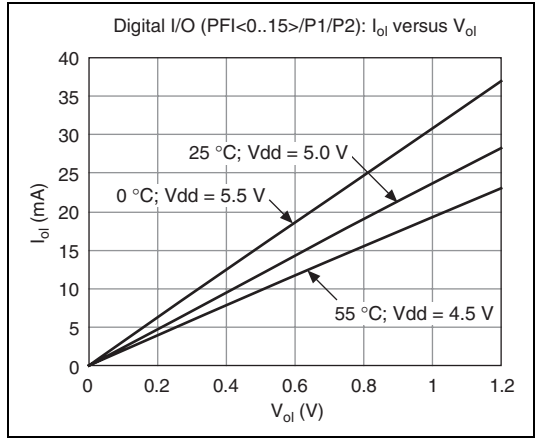
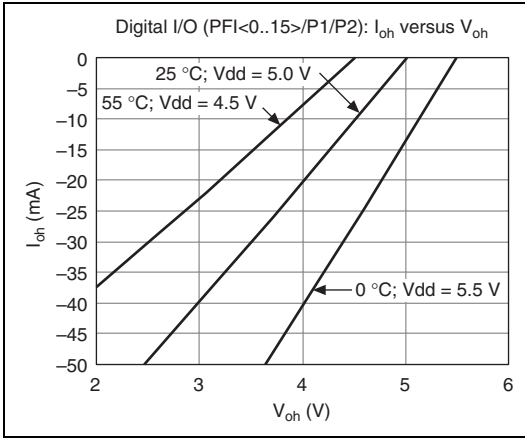
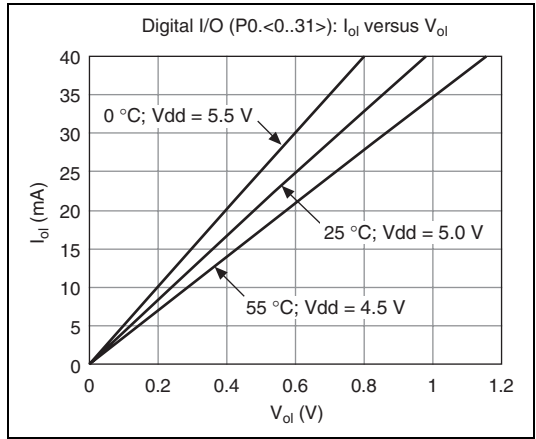
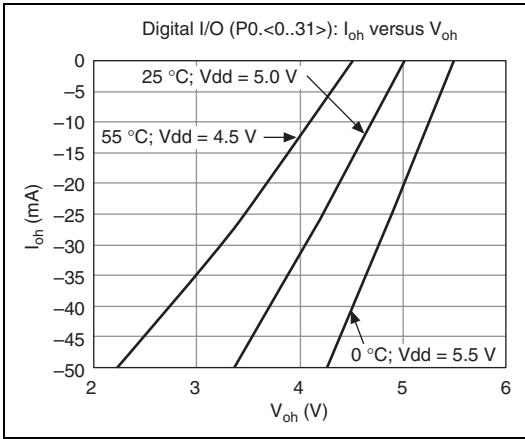
Level	Min	Max
Positive-going threshold (VT+)	—	2.2 V
Negative-going threshold (VT-)	0.8 V	—
Delta VT hysteresis (VT+ - VT-)	0.2 V	—
I <sub>IL</sub> input low current (V <sub>in</sub> = 0 V)	—	-10 μA
I <sub>IH</sub> input high current (V <sub>in</sub> = 5 V)	—	250 μA

<sup>1</sup> Stresses beyond those listed under *Input voltage protection* may cause permanent damage to the device.

<sup>2</sup> 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>3</sup> Port 2 is not available on the NI 6221 (37-pin) device.

# 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.....	Dedicated scatter-gather DMA controller for each counter/timer; interrupts; 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> <sup>1</sup>
PXI devices .....	PXI_TRIG <0..7>, PXI_STAR
Output selections.....	10 MHz Reference Clock; frequency generator output; many internal signals
Debounce filter settings .....	125 ns, 6.425 $\mu$ s, 2.54 ms, disabled; high and low transitions; selectable per input

## Bus Interface

PCI or PXI .....	3.3 V or 5 V signal environment
DMA channels .....	6, analog input, analog output, digital input, digital output, counter/timer 0, counter/timer 1

## Power Requirements

Current draw from bus during no-load condition

+5 V .....	0.02 A <sup>2</sup>
+3.3 V .....	0.25 A <sup>2</sup>
+12 V .....	0.15 A

Current draw from bus during AI and AO overvoltage condition

+5 V .....	0.02 A <sup>2</sup>
+3.3 V .....	0.25 A <sup>2</sup>
+12 V .....	0.25 A

Power available from

+5 V terminal<sup>3</sup>..... 1 A max, each connector,  
with self-resetting fuse

Other power limit for

PXI devices .....

Current drawn from  
+5 V terminals and all  
P0/PFI/P1/P2 terminals  
should not exceed 2 A

## Physical Requirements

Printed circuit board dimensions

NI PCI-6220/6221/6224/ 6225/6229 .....	9.7 cm $\times$ 15.5 cm (3.8 in. $\times$ 6.1 in.)
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NI PXI-6220/6221/6224/ 6225/6229 .....	Standard 3U PXI
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Weight

NI PCI-6220.....	91 g (3.2 oz)
NI PCI-6221 (68-pin).....	92 g (3.2 oz)
NI PCI-6221 (37-pin).....	95 g (3.3 oz)
NI PCI-6224.....	99 g (3.5 oz)
NI PCI-6225.....	103 g (3.6 oz)
NI PCI-6229.....	101 g (3.5 oz)
NI PXI-6220 .....	158 g (5.5 oz)
NI PXI-6221 (68-pin) .....	162 g (5.7 oz)
NI PXI-6224 .....	170 g (5.9 oz)
NI PXI-6225 .....	174 g (6.1 oz)
NI PXI-6229 .....	171 g (6.0 oz)

I/O connector

NI 6220/NI 6221 (68-pin).....	1 68-pin VHDCI
NI 6224/NI 6225/NI 6229.....	2 68-pin VHDCI
NI 6221 (37-pin) .....	1 37-pin D-SUB

## Maximum Working Voltage<sup>4</sup>

NI 6220/NI 6221/NI 6224/NI 6225/NI 6229

Channel to earth ..... 11 V,

Measurement Category I



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

## Environmental

Operating temperature..... 0 to 55 °C

Storage temperature..... -20 to 70 °C

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

Maximum altitude ..... 2,000 m

Pollution Degree  
(indoor use only) ..... 2

<sup>1</sup> In other sections of this document, *RTSI* refers to *RTSI <0..7>* for PCI devices or *PXI\_TRIG <0..7>* for PXI devices.

<sup>2</sup> The NI 6221 (37-pin) does 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.

<sup>3</sup> +5 V terminal is not available on the NI 6221 (37-pin) device.

<sup>4</sup> *Maximum working voltage* refers to the signal voltage plus the common-mode voltage.

## 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
- CAN/CSA-C22.2 No. 61010-1



**Note** For UL and other safety certifications, refer to the product label, or visit [ni.com/certification](http://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

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

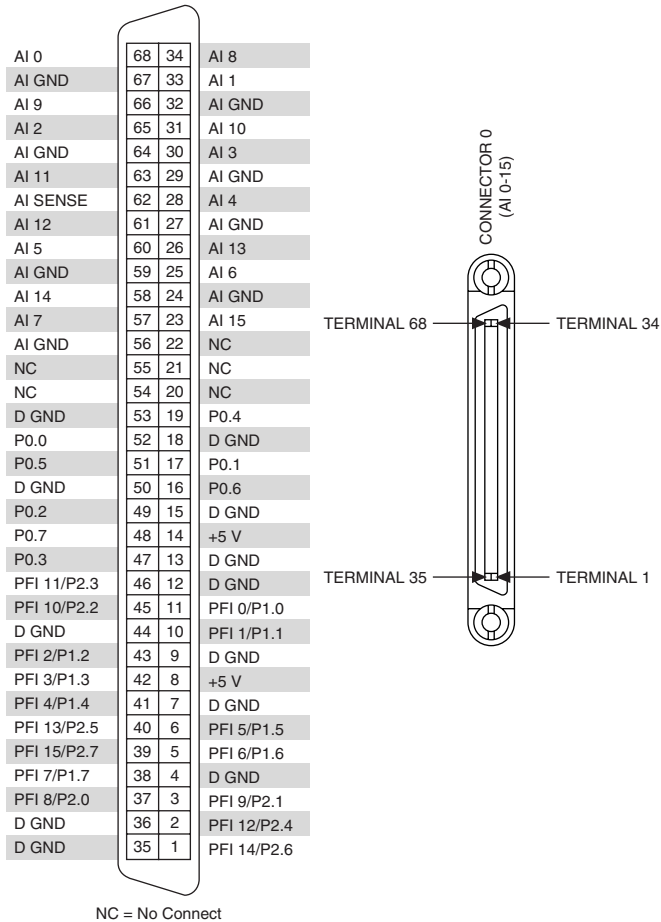
Low-Voltage Directive (safety).....73/23/EEC

Electromagnetic Compatibility

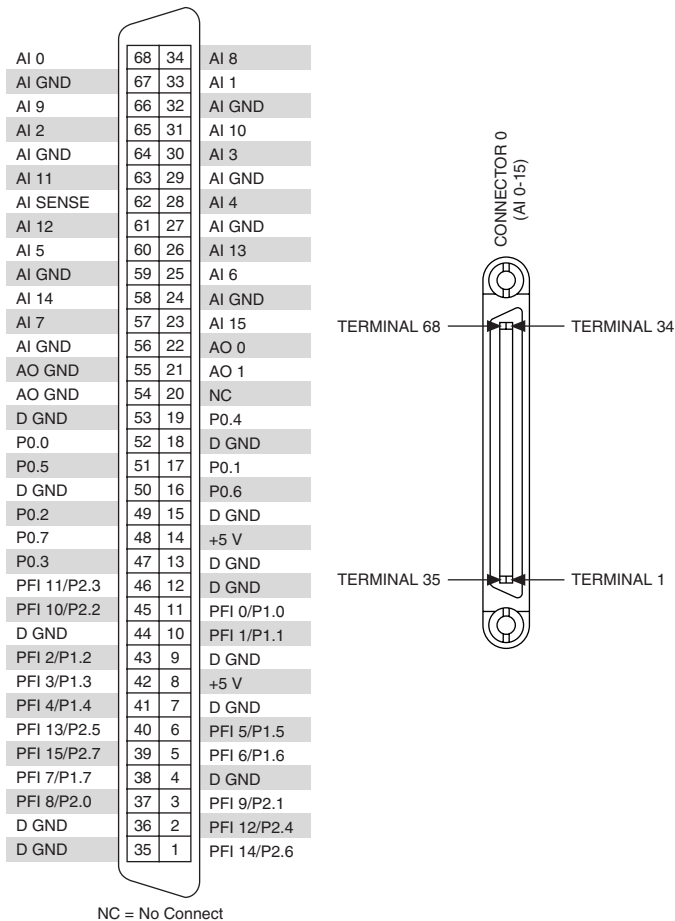
Directive (EMC).....89/336/EEC



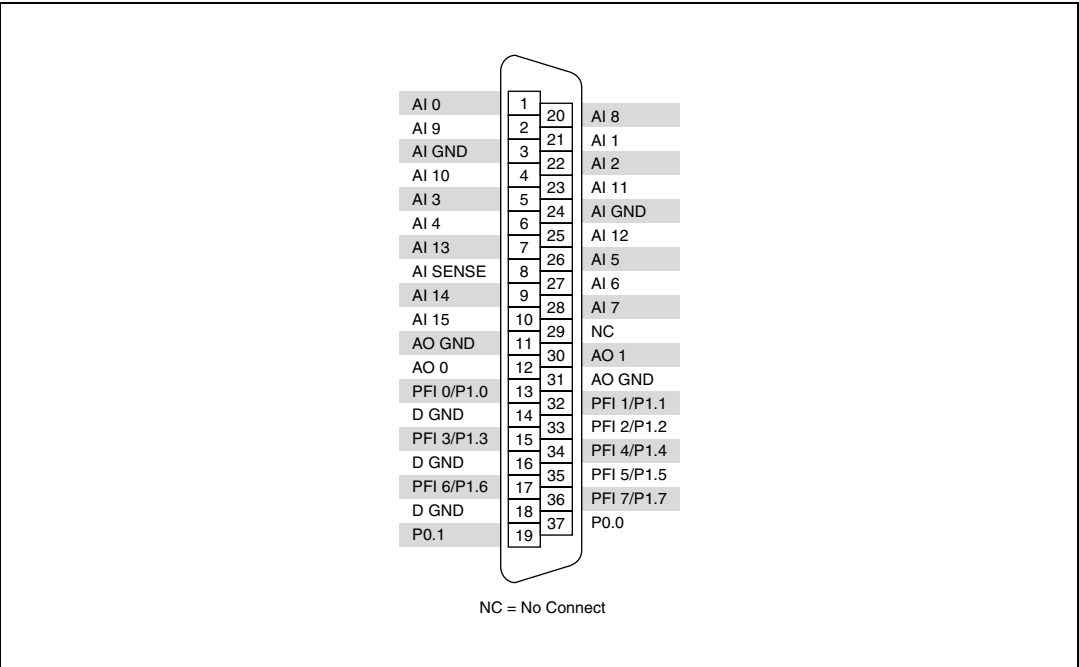
**Note** Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit [ni.com/certification](http://ni.com/certification), search by model number or product line, and click the appropriate link in the Certification column.



**Figure 1.** NI 6220 Pinout



**Figure 2.** NI 6221 (68-Pin) Pinout



**Figure 3.** NI 6221 (37-Pin) Pinout

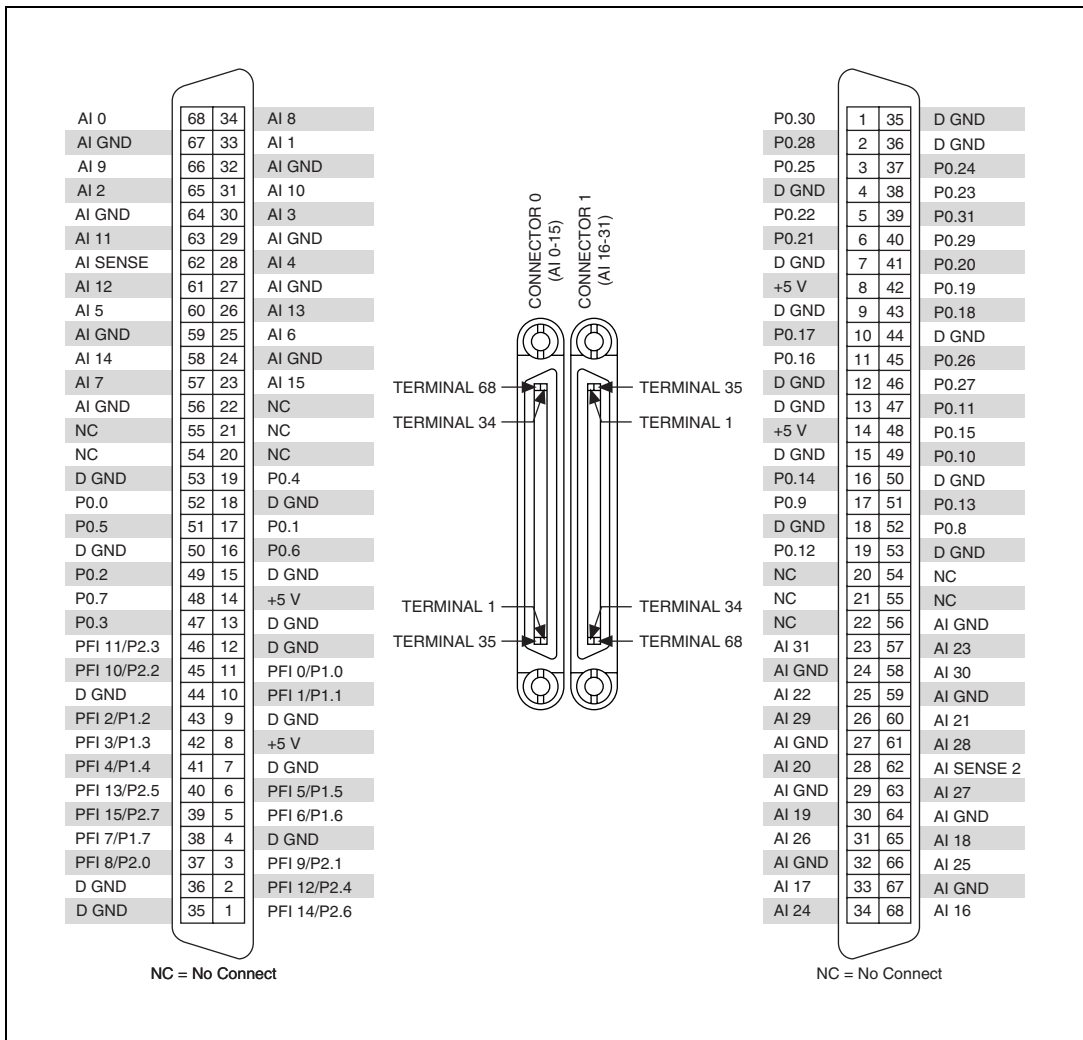


Figure 4. NI 6224 Pinout

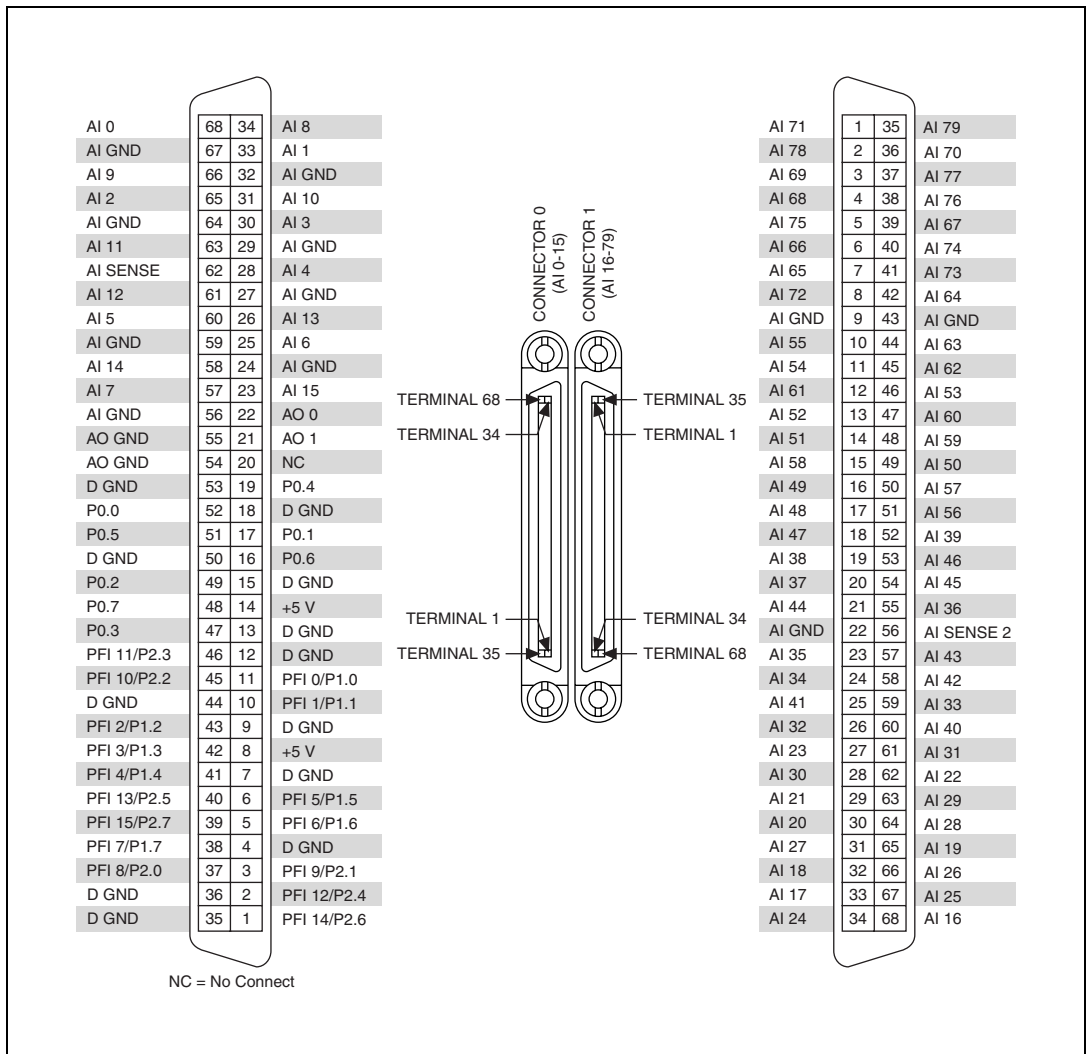


Figure 5. NI 6225 Pinout

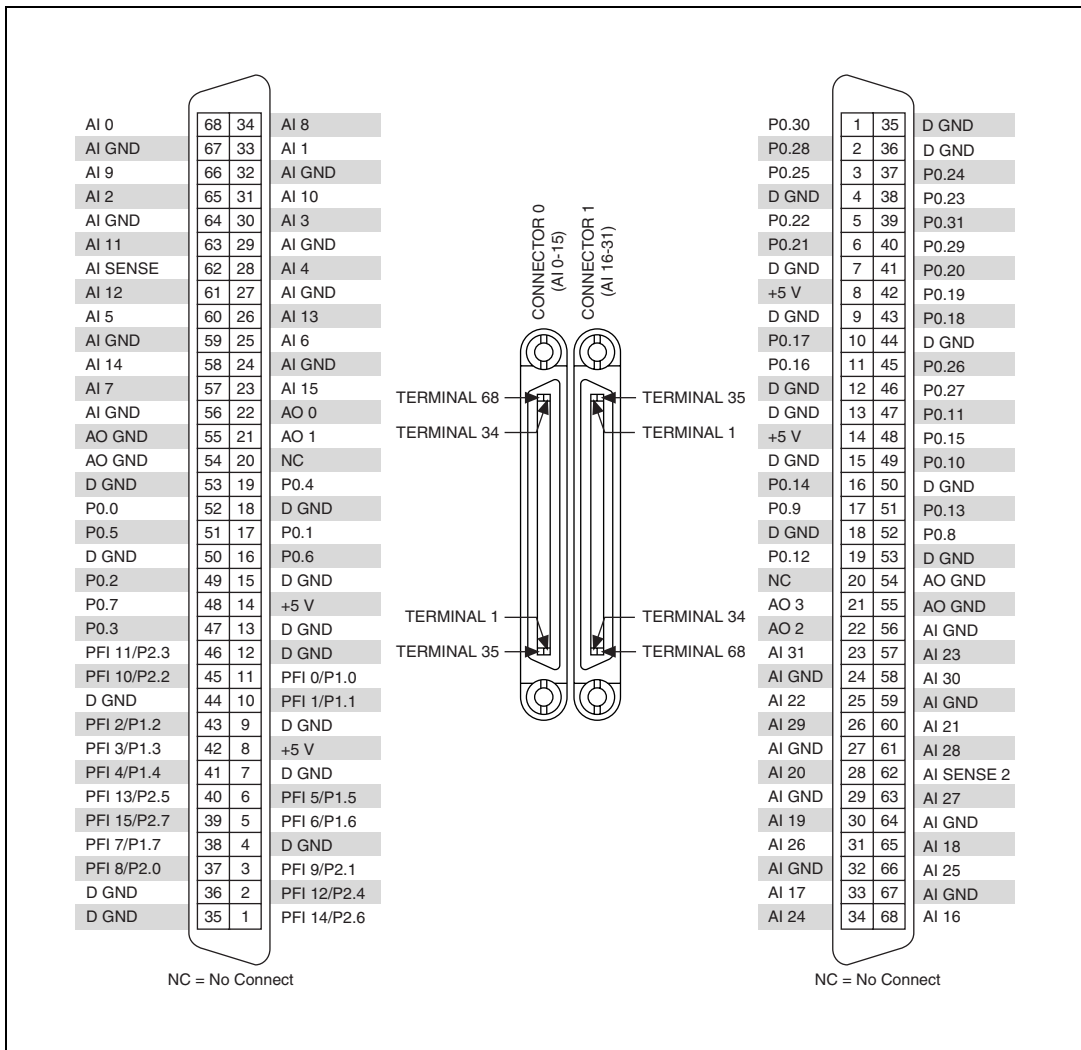


Figure 6. NI 6229 Pinout

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