NI 6232/6233 Specifications

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

Analog Input

Number of channels ..... 8 differential or 16 single ended

Channel type ..... Voltage input

Ground reference ..... AI GND

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 ..... ±10 V, ±5 V, ±1 V, ±0.2 V

Maximum working voltage for analog inputs ..... Refer to the *Maximum Working Voltage* section

CMRR (DC to 60 Hz) ..... 95 dB (with respect to AI GND)

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 ..... DMA (scatter-gather), interrupts, programmed I/O

Overvoltage protection (AI <0..7> with respect to AI GND)

- 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

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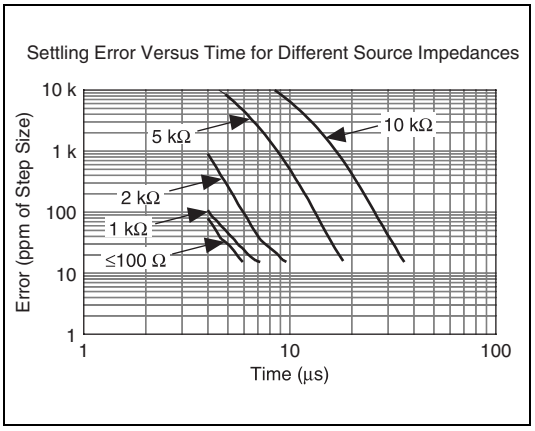
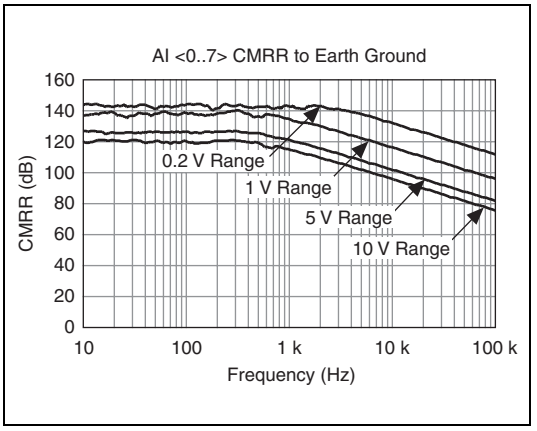
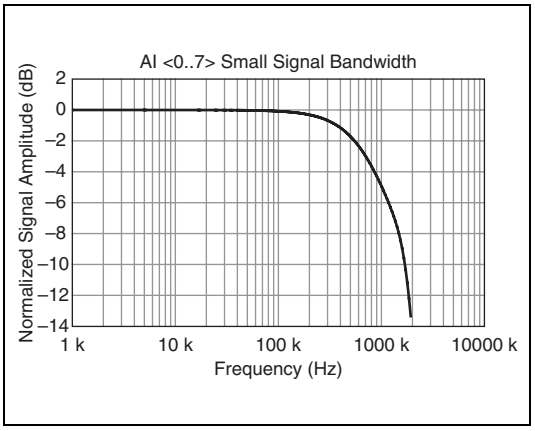
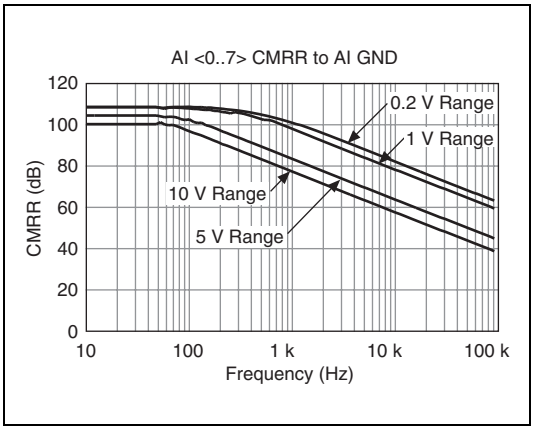
Typical Performance Graphs









Analog Output

Number of channels 2

Channel type ..... Voltage output

Ground reference ..... AO GND

DAC resolution ..... 16 bits

DNL ..... ±1 LSB

Monotonicity ..... 16 bit guaranteed

Maximum update rate

- 1 channel ..... 500 kS/s
- 2 channels ..... 450 kS/s per channel

Timing accuracy ..... 50 ppm of sample rate

Timing resolution ..... 50 ns

Output range ..... ±10 V

Output coupling ..... DC

Output impedance ..... 0.4 Ω

Output current drive ..... ±5 mA

Overdrive protection ..... ±25 V

Overdrive current ..... 10 mA

Power-on state ..... ±20 mV

Power-on glitch ..... 0.25 V for 1 ms

Power-off glitch ..... ±100 mV for 350 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 µs

Slew rate ..... 15 V/µs

Glitch energy

- Magnitude ..... 100 mV
- Duration ..... 3 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

$$\text{NoiseUncertainty} = \frac{\text{RandomNoise} \cdot 3}{\sqrt{100}}$$ 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 + 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 μV

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.....10 total
- Input.....6 (PFI <0..5>/P0.<0..5>)
- Output.....4 (PFI <6..9>/P1.<0..3>)

Direction control.....Fixed, lines are unidirectional

PFI/Port 0/Port 1 Functionality

PFI <0..5>/P0.<0..5>.....Static digital input, timing input

PFI <6..9>/P1.<0..3>.....Static digital output, timing output

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

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

Digital Input (Port 0)

Number of channels.....6

Ground reference.....P0.GND

Input voltage range.....0 to 30 V

Minimum pulse width for timing signal.....0.5 µs

Logic “0” level.....0 to 4 V

Logic “1” level.....10 to 30 V

Minimum input impedance.....3.3 kΩ

Typical input current.....7 mA at 24 V input
2.5 mA at 8 V input

Maximum input current.....9 mA

Propagation delay
- Low to high.....150 ns, typ
- High to low.....100 ns, typ

Digital Output (Port 1)

Number of channels.....4

Ground reference.....P1.GND

Digital output type[1]
- NI 6232.....DO source
- NI 6233.....DO sink

[1] Refer to Figures 1 and 2.

Figures 1 and 2 show P0.<0..5> and P1.<0..3> on the NI 6232 and NI 6233 devices, respectively.

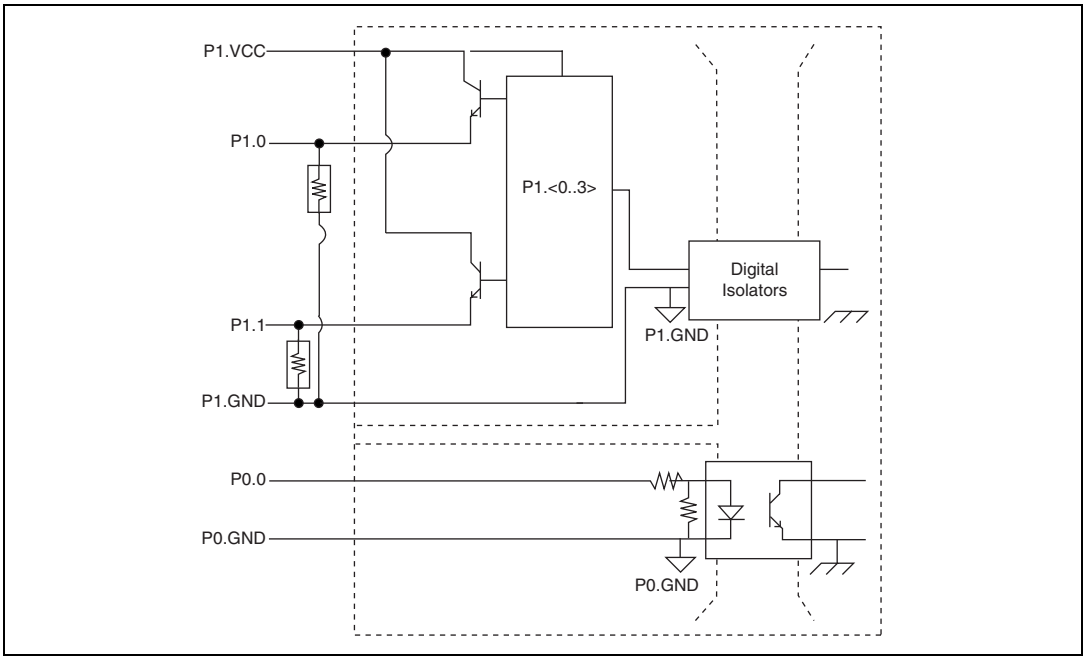


Figure 1. NI 6232 Digital I/O Connections

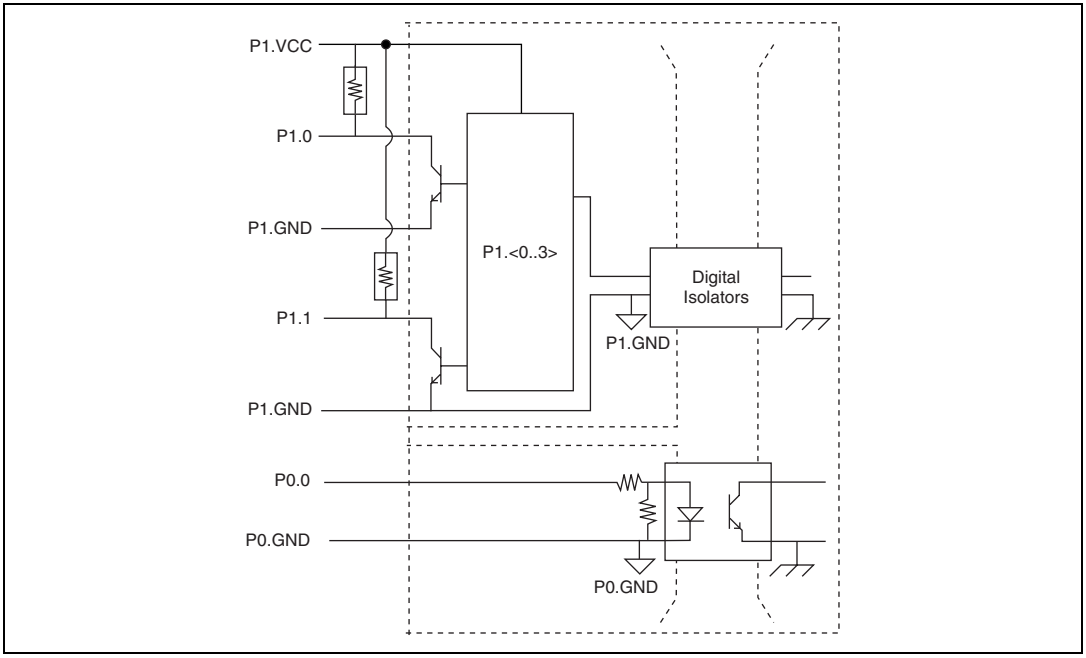


Figure 2. NI 6233 Digital I/O Connections

Max external supply voltage (P1.VCC) ..... 30 V

On state saturation voltage ..... 1.6 V maximum at 350 mA

Off state leakage ..... 50 µA

Maximum current ..... 100 mA for each line for simultaneous usage, 350 mA for single line usage

Minimum pulse width for timing signal

- NI 6232 (source output) ..... 5 µs
- NI 6233 (sink output) ..... 1.25 µs

Propagation delay

- NI 6232 (source output)
  - Open to close ..... 0.45 µs
  - Close to open ..... 2.15 µs
- NI 6233 (sink output)
  - Open to close ..... 0.4 µs
  - Close to open ..... 0.4 µs

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 input PFI, RTSI, PXI_TRIG, PXI_STAR, 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 output 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 input 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

Device-To-Device Trigger Bus

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

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 µs, 2.54 ms, disabled; high and low transitions; selectable per input

Bus Interface

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

PXI-6232/6233 devices can be installed in PXI slots or PXI Express hybrid slots.

DMA channels ..... 4, analog input, analog output, counter/timer 0, counter/timer 1

Power Requirements

Current draw from bus during no-load condition

+5 V ..... 0.7 A

+12 V ..... 20 mA

Current draw from bus during AI and AO overvoltage condition

+5 V ..... 0.95 A

+12 V ..... 20 mA

Physical Requirements

Printed circuit board dimensions

NI PCI-6232/6233 ..... 9.7 cm × 15.5 cm (3.8 in. × 6.1 in.)

NI PXI-6232/6233 ..... Standard 3U PXI

Weight

NI PCI-6232/6233 ..... 103 g (3.6 oz)

NI PXI-6232/6233 ..... 142 g (5.0 oz)

I/O connector ..... 37-pin D-SUB

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

Maximum Working Voltage[1]

Channel-to-earth ground[2]

Continuous .....≤30 Vrms/60 VDC
Measurement Category I[3]

Withstand .....≤840 Vrms/1200 VDC, verified by a 5 s dielectric withstand test

Channel-to-bus[4]

Continuous .....≤30 Vrms/60 VDC
Measurement Category I[4]

Withstand .....≤1,400 Vrms/1,950 VDC, verified by a 5 s dielectric withstand test

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

Digital channel to P1.GND/P0.GND
(in Figure 3, $V_c - V_d$ or $V_e - V_f$) .....≤30 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 3 shows the maximum working voltage specifications.

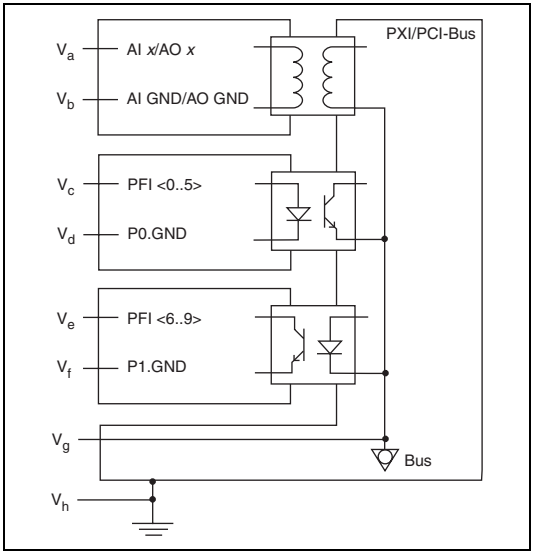

Figure 3. NI 6232/6233 Maximum Working Voltage

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

[2] In Figure 3, $|V_a - V_h|$, $|V_c - V_h|$, and $|V_e - V_h|$.

[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.

[4] In Figure 3, $|V_a - V_g|$, $|V_c - V_g|$, and $|V_e - V_g|$.

Environmental

Maximum altitude ..... 2,000 m (at 25 °C ambient temperature)

Pollution Degree 2

Indoor use only.

Operating Environment

Ambient temperature range ..... 0 to 55 °C (Tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.)

Relative humidity range ..... 10% to 90%, noncondensing (Tested in accordance with IEC-60068-2-56.)

Storage Environment

Ambient temperature range ..... –40 to 70 °C (Tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.)

Relative humidity range ..... 5% to 95% noncondensing (Tested in accordance with IEC-60068-2-56.)

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.)

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, CAN/CSA-C22.2 No. 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`.

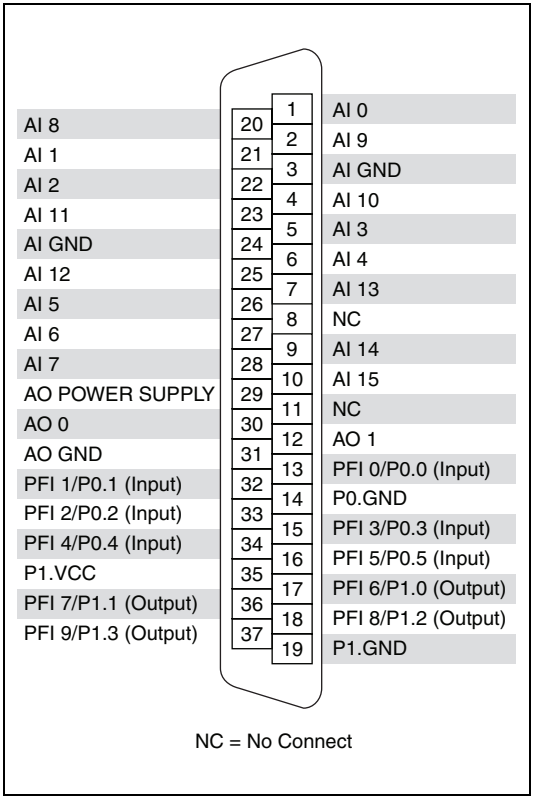

Figure 4. NI 6232 Pinout

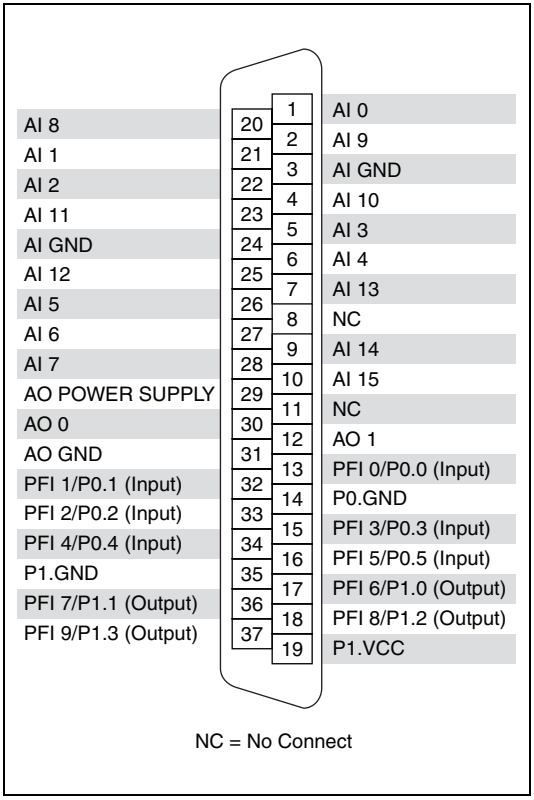

Figure 5. NI 6233 Pinout