

# Low-Cost M Series Multifunction DAQ 16-Bit, 250 kS/s, up to 80 Analog Inputs

## M Series – Low Cost

- 16, 32, or 80 analog inputs at 16-bit, 250 kS/s
- Up to 4 analog outputs at 16-bit, 833 kS/s (6  $\mu$ s full-scale settling time)
- Programmable input range ( $\pm 10$ ,  $\pm 5$ ,  $\pm 1$ ,  $\pm 0.2$  V) per channel
- Up to 48 TTL/CMOS digital I/O lines (up to 32 hardware-timed at 1 MHz)
- Two 32-bit, 80 MHz counter/timers
- Digital triggering
- NI-MCal calibration technology for improved measurement accuracy
- 6 DMA channels for fast data throughput
- NI-DAQmx measurement services software for simplified configuration and measurements
- 3-year warranty

### Operating Systems

- Windows 2000/NT/XP

### Recommended Software

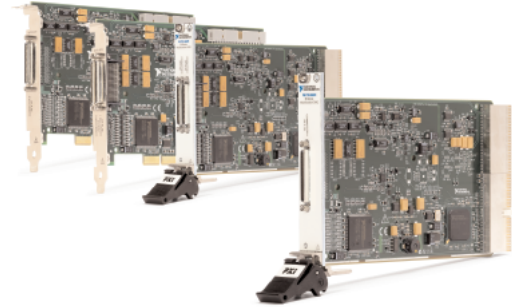
- LabVIEW
- LabWindows/CVI
- Measurement Studio

### Other Compatible Software

- Visual Studio.NET
- C/C++/C#
- NI SignalExpress

### Measurement Services Software (included)

- NI-DAQmx



Family	Bus	Analog Inputs	Analog Input Resolution (bits)	Analog Outputs	Output Resolution (bits)	Max Output Rate (kS/s)	Output Range (V)	Digital I/O	Correlated (Clocked) DIO
NI 6220	PCI, PXI	16	16	–	–	–	–	24	8, up to 1 MHz
NI 6221	PCI, PXI	16	16	2	16	833	$\pm 10$	24	8, up to 1 MHz
NI 6224	PCI, PXI	32	16	–	–	–	–	48	32, up to 1 MHz
NI 6225	PCI, PXI	80	16	2	16	833	$\pm 10$	24	8, up to 1 MHz
NI 6229	PCI, PXI	32	16	4	16	833	$\pm 10$	48	32, up to 1 MHz

Table 1. NI Low-Cost M Series Selection Guide

## Overview and Applications

National Instruments low-cost M Series devices provide optimized functionality for cost-sensitive applications. They are ideal for applications including data logging and control, and measure sensors and high voltages when used in conjunction with NI signal conditioning. Synchronize the operations of multiple devices using the RTSI bus or PXI trigger bus.

## Recommended Accessories

Signal conditioning is required for sensor measurements or voltage inputs greater than 10 V. National Instruments SCXI is a versatile, high-performance signal conditioning platform, optimized for high-channel-count applications. NI SCC provides portable, flexible signal conditioning options on a per-channel basis. For applications not requiring signal conditioning, refer to Table 2 for recommended cabling and accessories.

## Recommended Software

National Instruments recommends using the latest version of NI-DAQmx measurement services software for application development in LabVIEW, LabWindows/CVI, and Measurement Studio. To check for the newest version of NI-DAQmx, go to [ni.com/support/daq/versions](http://ni.com/support/daq/versions). For custom driver development, use the Measurement Hardware DDK or customized register-level programming. M Series devices are compatible with the

following versions (or later ones) of NI application software: LabVIEW, LabWindows/CVI, or Measurement Studio version 7.x; SignalExpress 1.x; VI Logger 2.0; or LabVIEW with the LabVIEW Real-Time Module 7.1. M Series devices do not work with the legacy Traditional NI-DAQ driver.

System Description	Terminal Block $\Omega$	Cable
High Performance	SCB-68, BNC-2110, TBX-68	SHC68-68-EPM
Basic Shielding	SCB-68, BNC-2110, TBX-68	SHC68-68

Table 2. Recommended Accessories (Two cables and accessories are required to access all pins on the NI 6224, 6225, and 6229 devices)

## Ordering Information

### PCI

NI PCI-6220 .....	779065-01
NI PCI-6221 .....	779066-01
NI PCI-6224 .....	779067-01
NI PCI-6225 .....	779295-01
NI PCI-6229 .....	779068-01

### PXI

NI PXI-6220 .....	779112-01
NI PXI-6221 .....	779113-01
NI PXI-6224 .....	779114-01
NI PCI-6225 .....	779296-01
NI PXI-6229 .....	779115-01
Includes NI-DAQmx software..	

# Low-Cost M Series Multifunction DAQ

## 16-Bit, 250 kS/s, up to 80 Analog Inputs

### Specifications

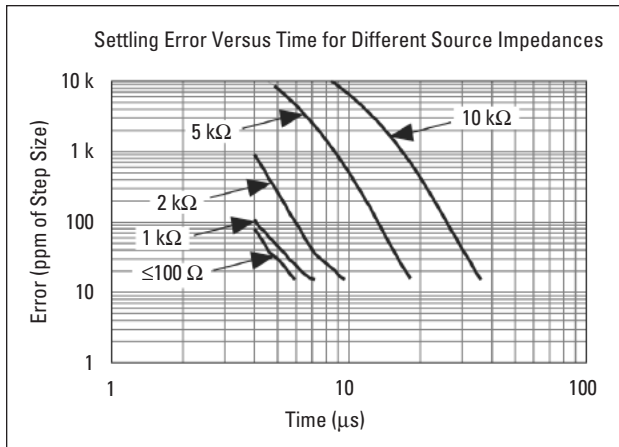
Typical at 25 °C unless otherwise noted.

#### Analog Input

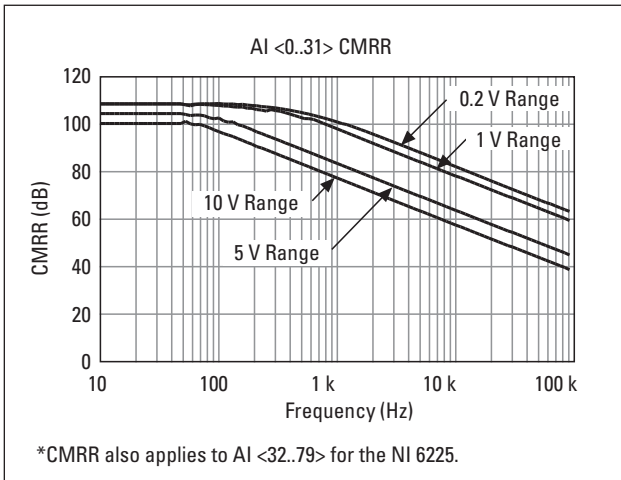
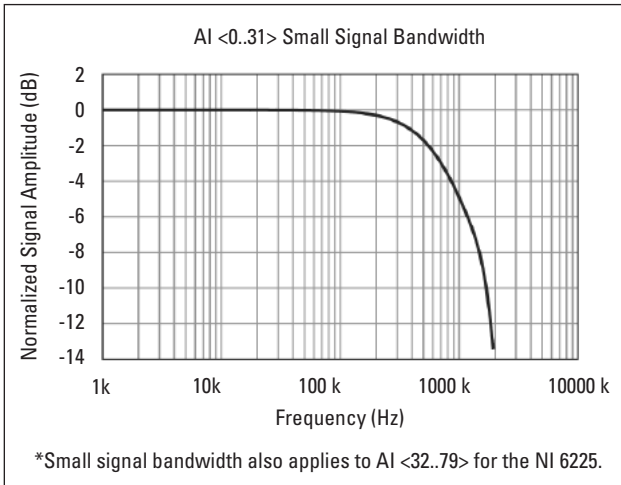
Number of channels	
NI 6220/NI 6221 .....	8 differential or 16 single ended
NI 6224/NI 6229 .....	16 differential or 32 single ended
NI 6225 .....	40 differential or 80 single ended
ADC resolution .....	
	16 bits
DNL .....	
	No missing codes guaranteed
INL .....	
	Refer to the <i>AI Absolute Accuracy Table</i>
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 .....	
	$\pm 10, \pm 5, \pm 1, \pm 0.2$ 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	
AI+ to AI GND .....	$>10$ G $\Omega$ in parallel with 100 pF
AI- to AI GND .....	$>10$ G $\Omega$ in parallel with 100 pF
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 .....	
	$\pm 1$ 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 .....	
	$\pm 10$ V
Output coupling .....	
	DC
Output impedance .....	
	0.2 $\Omega$
Output current drive .....	
	$\pm 5$ mA

# Low-Cost M Series Multifunction DAQ

## 16-Bit, 250 kS/s, up to 80 Analog Inputs

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.....	Aperiodic waveform Periodic waveform regeneration 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.....	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, $\sigma$ ( $\mu\text{V}_{\text{rms}}$ )	Absolute Accuracy at Full Scale <sup>1</sup> ( $\mu\text{V}$ )	Sensitivity <sup>2</sup> ( $\mu\text{V}$ )
Positive Full Scale	Negative Full Scale									
10	-10	75	25	5	20	57	76	244	3100	97.6
5	-5	85	25	5	20	60	76	122	1620	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

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

<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

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

AbsoluteAccuracy = 10 V · (GainError) + 10 V · (OffsetError) + NoiseUncertainty

AbsoluteAccuracy = 3100  $\mu\text{V}$

<sup>2</sup>Sensitivity is the smallest voltage change that can be detected. It is a function of noise.

### 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> ( $\mu\text{V}$ )
Positive Full Scale	Negative Full Scale							
10	-10	90	10	5	40	5	128	3230

<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.

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/NI 6221/NI 6225.....	24 total 8 (PO.<0..7>) 16 (PFI <0..15>/P1/P2)
NI 6224/NI 6229.....	48 total 32 (PO.<0..31>) 16 (PFI <0..15>/P1/P2)
Ground reference.....	D GND
Direction control.....	Each terminal individually programmable as input or output
Pull-down resistor.....	50 k $\Omega$ to 75 k $\Omega$
Input voltage protection <sup>1</sup> .....	±20 V on up to two pins

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

#### Waveform Characteristics (Port 0 Only)

Terminals used	
NI 6220/NI 6221/NI 6225.....	Port 0 (PO.<0..7>)
NI 6224/NI 6229.....	Port 0 (PO.<0..31>)
Port/sample size	
NI 6220/NI 6221/NI 6225.....	Up to 8 bits
NI 6224/NI 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.....	0 to 1 MHz
DO or DI Sample Clock source.....	Any PFI, RTSI, AI Sample or Convert Clock, AO Sample Clock, Ctr <i>n</i> 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 µs, 2.54 ms, disable; high and low transitions; selectable per input

# Low-Cost M Series Multifunction DAQ

## 16-Bit, 250 kS/s, up to 80 Analog Inputs

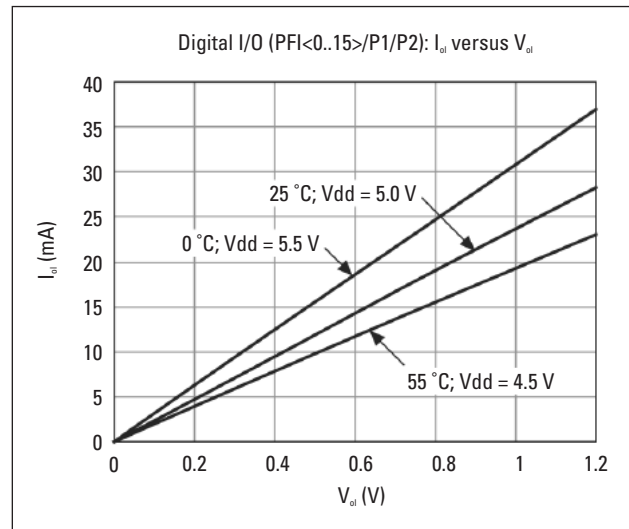
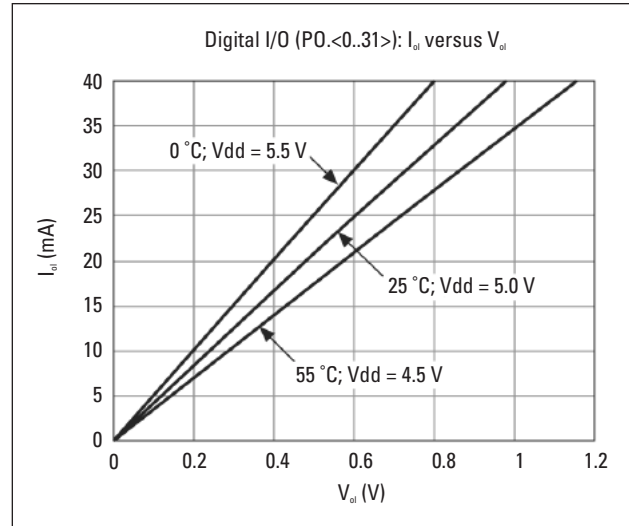
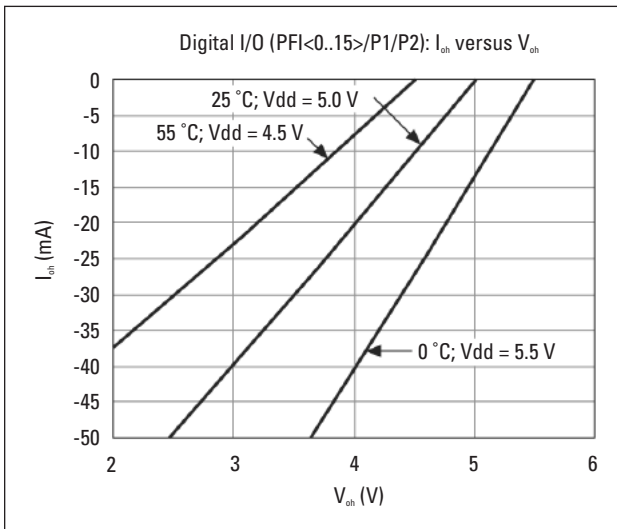
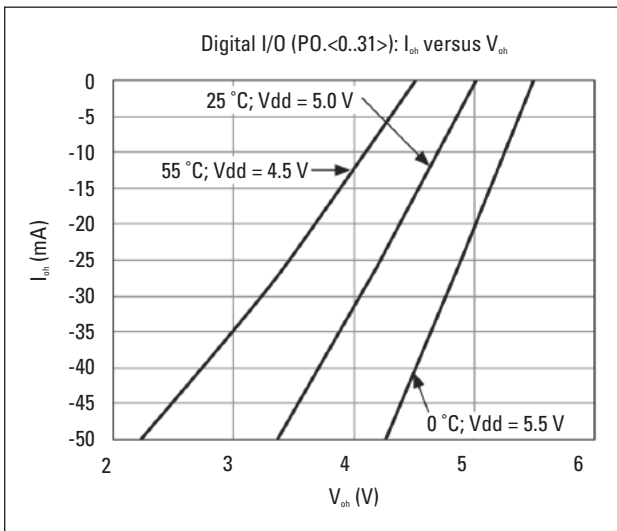
### Recommended Operation Conditions

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..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

### Electrical Characteristics

Level	Minimum	Maximum
Positive-going threshold ( $V_{T+}$ )	–	2.2 V
Negative-going threshold ( $V_{T-}$ )	0.8 V	–
Delta VT hysteresis ( $V_{T+} - V_{T-}$ )	0.2 V	–
$I_{IH}$ input low current ( $V_{in} = 0$ V)	–	–10 $\mu$ A
$I_{IH}$ input high current ( $V_{in} = 5$ V)	–	250 $\mu$ A

### 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, 20, 0.1 MHz
External base clock frequency .....	0 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, PXL_TRIG, PXL_STAR, analog trigger, many internal signals
FIFO .....	2 samples
Data transfers .....	Dedicated scatter-gather DMA controller for each counter/timer; interrupts; programmed I/O

# Low-Cost M Series Multifunction DAQ

## 16-Bit, 250 kS/s, up to 80 Analog Inputs

### 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.....	PXL_STAR, PXL_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, PXL_TRIG, PXL_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.....	PXL_TRIG <0..7>, PXL_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

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

### 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
+3.3 V.....	0.25 A
+12 V.....	0.15 A
Current draw from bus during AI and AO overvoltage condition	
+5 V.....	0.02 A
+3.3 V.....	0.25 A
+12 V.....	0.25 A

Power available from +5 V terminal.....	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

Dimensions	
PCI.....	9.7 by 15.5 cm (3.8 by 6.1 in.)
PXI.....	Standard 3U PXI
I/O connector	
NI 6220/NI 6221.....	1 68-pin VHDCI
NI 6224/NI 6225/NI 6229.....	2 68-pin VHDCI

### Maximum Working Voltage<sup>1</sup>

Channel-to-earth.....	11 V, Installation Category I
Channel-to-channel.....	11 V, Installation Category I

<sup>1</sup> Maximum working voltage refers to the signal voltage plus the common-mode voltage.

### Environmental

Operating temperature.....	0 to 55 °C
Storage temperature.....	-20 to 70 °C
Relative Humidity.....	10 to 90%, noncondensing
Maximum altitude.....	2,000 m
Pollution Degree (indoor use only).....	2

### 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

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	
For EMC compliance, operate this device with shielded cabling.	

### CE Compliance $\text{CE}$

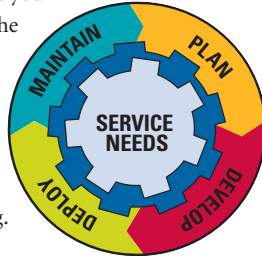
This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

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

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.

# NI Services and Support

NI has the services and support to meet your needs around the globe and through the application life cycle – from planning and development through deployment and ongoing maintenance. We offer services and service levels to meet customer requirements in research, design, validation, and manufacturing. Visit [ni.com/services](http://ni.com/services).



## Training and Certification

NI training is the fastest, most certain route to productivity with our products. NI training can shorten your learning curve, save development time, and reduce maintenance costs over the application life cycle. We schedule instructor-led courses in cities worldwide, or we can hold a course at your facility. We also offer a professional certification program that identifies individuals who have high levels of skill and knowledge on using NI products. Visit [ni.com/training](http://ni.com/training).

## Professional Services

Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide NI Alliance Partner Program of more than 600 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit [ni.com/alliance](http://ni.com/alliance).



## OEM Support

We offer design-in consulting and product integration assistance if you want to use our products for OEM applications. For information about special pricing and services for OEM customers, visit [ni.com/oem](http://ni.com/oem).

## Local Sales and Technical Support

In offices worldwide, our staff is local to the country, giving you access to engineers who speak your language. NI delivers industry-leading technical support through online knowledge bases, our applications engineers, and access to 14,000 measurement and automation professionals within NI Developer Exchange forums. Find immediate answers to your questions at [ni.com/support](http://ni.com/support).

We also offer service programs that provide automatic upgrades to your application development environment and higher levels of technical support. Visit [ni.com/ssp](http://ni.com/ssp).

## Hardware Services

### NI Factory Installation Services

NI Factory Installation Services (FIS) is the fastest and easiest way to use your PXI or PXI/SCXI combination systems right out of the box. Trained NI technicians install the software and hardware and configure the system to your specifications. NI extends the standard warranty by one year on hardware components (controllers, chassis, modules) purchased with FIS. To use FIS, simply configure your system online with [ni.com/pxiadvisor](http://ni.com/pxiadvisor).

### Calibration Services

NI recognizes the need to maintain properly calibrated devices for high-accuracy measurements. We provide manual calibration procedures, services to recalibrate your products, and automated calibration software specifically designed for use by metrology laboratories. Visit [ni.com/calibration](http://ni.com/calibration).

### Repair and Extended Warranty

NI provides complete repair services for our products. Express repair and advance replacement services are also available. We offer extended warranties to help you meet project life-cycle requirements. Visit [ni.com/services](http://ni.com/services).



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