Low-Cost M Series Multifunction DAQ
16-Bit, 250 kS/s, up to 32 Analog Inputs

M Series – Low Cost

- 16 or 32 analog inputs at 16-bit, 250 kS/s
- Up to 4 analog outputs at 16-bit, 833 kS/s (6 µs full-scale settling time)
- Programmable input range (±10, ±5, ±1, ±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 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 Signal Express

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	±10	24	8, up to 1 MHz
NI 6224	PCI, PXI	32	16	–	–	–	–	48	32, up to 1 MHz
NI 6229	PCI, PXI	32	16	4	16	833	±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.

System Description	Terminal Block Ω	Cable
High Performance	SCB-68, BNC-2110, TBX-68	SHC68-68-EP
Basic Shielding	SCB-68, BNC-2110, TBX-68	SHC68-68-S

Table 2. Recommended Accessories

Ordering Information

PCI

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

PXI

NI PXI-6220 779112-01
NI PXI-6221 779113-01
NI PXI-6224 779114-01
NI PXI-6229 779115-01

Includes NI-DAQmx software and calibration certificate.

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Specifications

Typical at 25 °C unless otherwise noted.

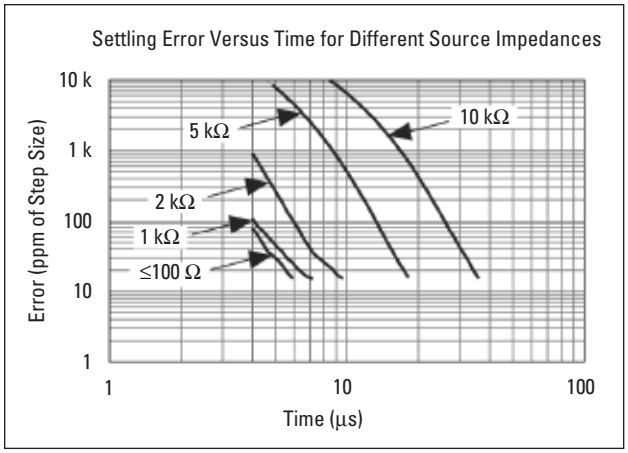
Analog Input

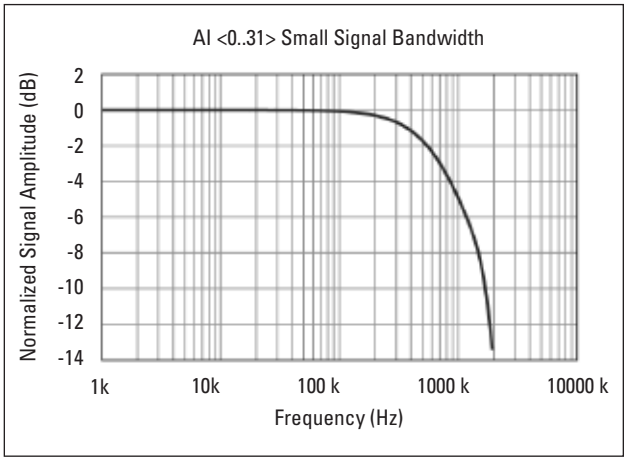
Number of channels	
NI 6220/NI 6221	8 differential or 16 single ended
NI 6224/NI 6229	16 differential or 32 single ended
ADC resolution	16 bits
DNL	No missing codes guaranteed
INL	Refer to the *AI Absolute Accuracy Table*
Sampling rate	
Maximum	250 KS/s
Minimum	0 S/s
Timing accuracy	50 ppm of sample 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 (signal + common mode)	±11 V of AI GND
CMRR (DC to 60 Hz)	95 dB
Input impedance	
AI+ to AI GND	>10 GΩ in parallel with 100 pF
AI– to AI GND	>10 GΩ in parallel with 100 pF
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..31>, 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

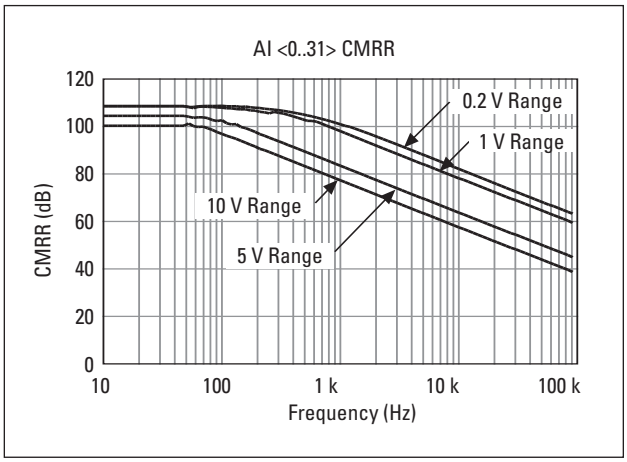
Settling Time for Multichannel Measurements

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

Typical Performance Graphs







Analog Output

Number of channels	
NI 6220	0
NI 6221	2
NI 6224	0
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

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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 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	2.6 µs

Calibration (AI and AO)

Recommended warm-up time	15 minutes
Calibration interval	1 year

AI Absolute Accuracy Table

Nominal Range		Residual			Residual	Offset			Absolute	
Positive Full Scale	Negative Full Scale	Gain Error (ppm of Reading)	Gain Tempco (ppm/°C)	Reference Tempco	Offset Error (ppm of Range)	Tempco (ppm of Range/°C	INLError (ppm of Range)	Random Noise, σ (μV_{rms})	Accuracy at Full Scale[1] (µV)	Sensitivity[2] (µV)
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 = 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

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

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

AbsoluteAccuracy = 3100 µV

[2]Sensitivity is the smallest voltage change that can be detected. It is a function of noise.

AO Absolute Accuracy Table

Nominal Range		Residual			Residual	Offset		Absolute
Positive Full Scale	Negative Full Scale	Gain Error (ppm of Reading)	Gain Tempco (ppm/°C)	Reference Tempco	Offset Error (ppm of Range)	Tempco (ppm of Range/°C	INLError (ppm of Range)	Accuracy at Full Scale[1] (µV)
10	–10	90	10	5	40	5	128	3230

[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.

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	24 total
	8 (P0.<0..7>)
	16 (PFI <0..15>/P1/P2)
NI 6224/NI 6229	48 total
	32 (P0.<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 kΩ to 75 kΩ
Input voltage protection[1]	±20 V on up to two pins

[1] 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	Port 0 (P0.<0..7>)
NI 6224/NI 6229	Port 0 (P0.<0..31>)
Port/sample size	
NI 6220/NI 6221	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, DI Change Event, 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 µs, 2.54 ms, disable; high and low transitions; selectable per input

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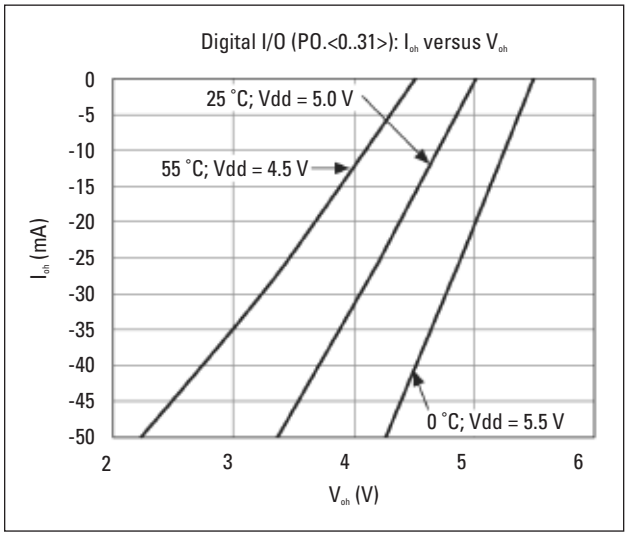
Recommended Operation Conditions

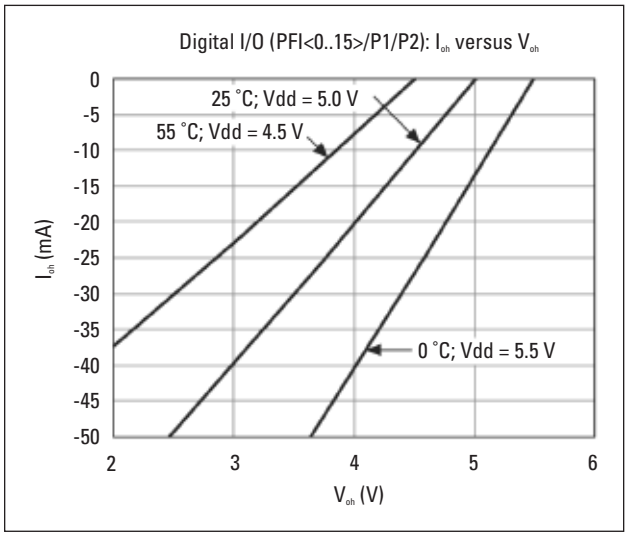
Level	Minimum	Maximum
Input high voltage (V_{IH})	2.2 V	5.25 V
Input low voltage (V_{IL})	0 V	0.8 V
Output high current (I_{OH})		
P0.<0..31>	–	–24 mA
PFI <0..15>/ P1/P2	–	–16 mA
Output low current (I_{OL})		
P0.<0..31>	–	24 mA
PFI <0..15>/P1/P2	–	16 mA

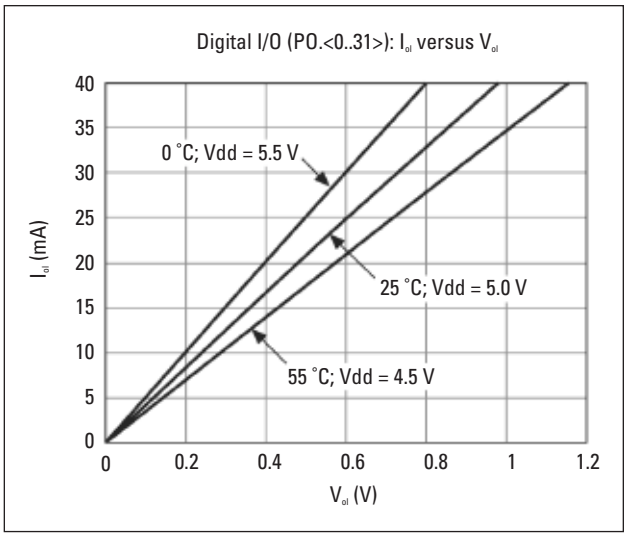
Electrical Characteristics

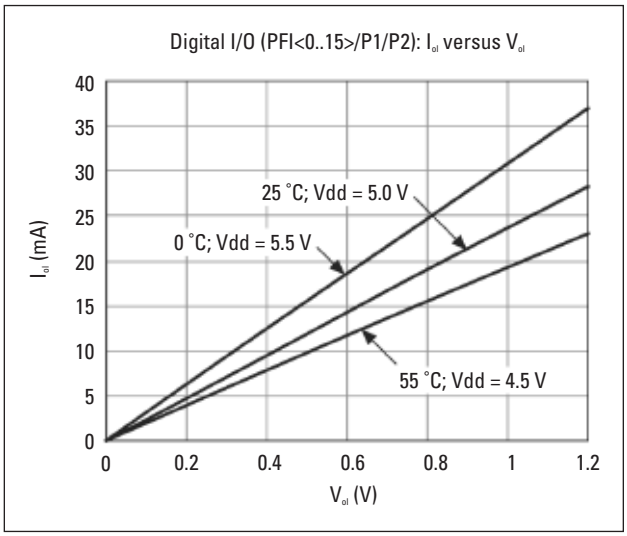
Level	Minimum	Maximum
Positive-going threshold (VT+)	–	2.2 V
Negative-going threshold (VT–)	0.8 V	–
Delta VT hysteresis (VT+ – VT–)	0.2 V	–
I_{IL} input low current (V_{in} = 0 V)	–	–10 µA
I_{IH} input high current (V_{in} = 5 V)	–	250 µA

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	Dedicated scatter-gather DMA controller for each counter/timer; interrupts; programmed I/O

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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
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

[1] In other sections of this document, RTSI refers to RTSI <0..7> for PCI devices or PXI_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 6229	2 68-pin VHDCI

Maximum Working Voltage[1]

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

[1] 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***, 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 CE

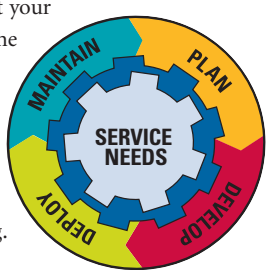
This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

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***, 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.



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.

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.

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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.

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.

We also offer service programs that provide automatic upgrades to your application development environment and higher levels of technical support. Visit 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.

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.

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.

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