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4-Channel, ±5 V, 51.2 kS/s per Channel, 24-Bit IEPE

NI 9234

- 24-bit resolution
- 102 dB dynamic range
- 4 simultaneous analog inputs
- ±5 V input range
- Antialiasing filters
- TEDS read/write
- Supported in NI CompactDAQ, CompactRIO, and Hi-Speed USB carrier

Overview

The National Instruments 9233 and 9234 are four-channel dynamic signal acquisition modules for making high-accuracy measurements from IEPE sensors. The NI 9233 and 9234 C Series analog input modules deliver 102 dB of dynamic range and incorporate IEPE (2 mA constant current) signal conditioning for accelerometers and microphones. The four input channels simultaneously acquire at rates from 2 to 50 kHz or, with the NI 9234, up to 51.2 kS/s. In addition, the modules include built-in antialiasing filters that automatically adjust to your sampling rate. Compatible with a single-module USB carrier and NI CompactDAQ and CompactRIO hardware, the NI 9233 and 9234 are ideal for a wide variety of mobile/portable applications such as industrial machine condition monitoring and in-vehicle noise, vibration, and harshness testing.

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Comparison Tables

Model	Max Sampling Rate	IEPE	Coupling
NI 9233	50 kS/s	Always enabled (2 mA)	AC coupling
NI 9234	51.2 kS/s	Software selectable (0 or 2 mA)	Software selectable AC/DC coupling

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Application and Technology

Hardware

Each simultaneous signal is buffered, analog prefiltered, and sampled by a 24-bit deltasigma analog-to-digital converter (ADC) that performs digital filtering with a cutoff frequency that automatically adjusts to your data rate. The NI 9233 and 9234 feature a voltage range of ±5 V and a dynamic range of more than 100 dB. In addition, the modules include the capability to read and write to transducer electronic data sheet (TEDS) Class 1 smart sensors. The NI 9233 and 9234 provide ±30 V of overvoltage protection (with respect to chassis ground) for IEPE sensor connections. The NI 9234 has three software-selectable modes of measurement operation: IEPE-on with AC coupling, IEPE-off with AC coupling, and IEPE-off with DC coupling. IEPE excitation and AC coupling are not software-selectable and are always enabled for the NI 9233.

The NI 9233 and 9234 use a method of A/D conversion known as delta-sigma modulation. If, for example, the data rate is 25 kS/s, then each ADC actually samples its input signal at 3.2 MS/s (128 times the data rate) and produces samples that are applied to a digital filter. This filter then expands the data to 24 bits, rejects signal components greater than 12.5 kHz (the Nyquist frequency), and digitally resamples the data at the chosen data rate of 25 kS/s. This combination of analog and digital filtering provides an accurate representation of desirable signals while rejecting out-of-band signals. The built-in antialiasing filters automatically adjust themselves to discriminate between signals based on the frequency range, or bandwidth, of the signal.

USB Platform

The NI Hi-Speed USB carrier makes portable data acquisition easy. Simply plug the NI 9233 or 9234 into the USB carrier and begin acquiring data. Communication to the USB carrier is over Hi-Speed USB, guaranteeing data throughput.

NI CompactDAQ Platform

NI CompactDAQ delivers the simplicity of USB to sensor and electrical measurements on the benchtop, in the field, and on the production line. By combining the ease of use and low cost of a data logger with the performance and flexibility of modular instrumentation, NI CompactDAQ offers fast, accurate measurements in a small, simple, and affordable system. Flexible software options make it easy to use NI CompactDAQ to log data for simple experiments or to develop a fully automated test or control system. The modular design can measure up to 256 channels of electrical, physical, mechanical, or acoustical signals in a single system. In addition, per-channel ADCs and individually isolated modules ensure fast, accurate, and safe measurements.

NI CompactRIO Platform

When used with the small, rugged CompactRIO embedded control and data acquisition system, NI C Series analog input modules connect directly to reconfigurable I/O (RIO) field-programmable gate array (FPGA) hardware to create high-performance embedded systems. The reconfigurable FPGA hardware within CompactRIO provides a variety of options for custom timing, triggering, synchronization, filtering, signal processing, and high-speed decision making for all C Series analog input modules. For instance, with CompactRIO, you can implement custom triggering for any analog sensor type on a per-channel basis using the flexibility and performance of the FPGA and the numerous arithmetic and comparison function blocks built into NI LabVIEW FPGA.

Analysis Software

The NI 9233 and 9234 are well-suited for noise and vibration analysis applications. The NI Sound and Vibration Measurement Suite, which specifically addresses these applications, has two components: the NI Sound and Vibration Assistant and LabVIEW analysis VIs (functions) for power spectra, frequency response (FRF), fractional octave analysis, sound-level measurements, order spectra, order maps, order extraction, sensor calibration, human vibration filters, and torsional vibration.

NI Sound and Vibration Assistant

The Sound and Vibration Assistant is interactive software designed to simplify the process of acquiring and analyzing noise and vibration signals by offering:

A drag-and-drop, interactive analysis and acquisition environment
Rapid measurement configuration
Extended functionality through LabVIEW

Interactive Analysis Environment

The Sound and Vibration Assistant introduces an innovative approach to configuring your measurements using intuitive drag-and-drop steps. Combining the functionality of traditional noise and vibration analysis software with the flexibility to customize and automate routines, the Sound and Vibration Assistant can help you streamline your application.

Rapid Measurement Configuration

There are many built-in steps available for immediate use in the Sound and Vibration Assistant. You can instantly configure a measurement and analysis application with:

Hardware I/O – generation and acquisition of signals from a variety of devices, including data acquisition devices and modular instruments
Signal processing – filtering, windowing, and averaging
Time-domain analysis – sound- and vibration-level measurements
ANSI and IEC fractional-octave analysis

Frequency-domain analysis – power spectrum, frequency response, power-in-band, peak search, and distortion
Order analysis – tachometer processing, order power spectrum, order tracking, and order extraction
Report generation – ability to drag and drop signals to Microsoft Excel or export data to Microsoft Word or UFF58 files

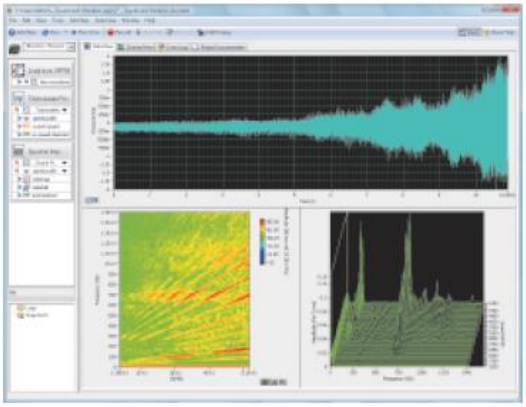

Figure 1. NI Sound and Vibration Assistant Performing Engine Run-up Test

Extended Functionality through LabVIEW

Reuse your measurement applications developed with the Sound and Vibration Assistant in LabVIEW by converting projects into LabVIEW block diagrams. With the LabVIEW full-featured graphical programming environment, you can further automate your application or customize your analysis.

Sound and Vibration Analysis VIs for LabVIEW

With the sound and vibration analysis VIs in LabVIEW, you can develop a variety of custom audio, acoustic, and vibration applications. Functionality includes:

Full, 1/3, 1/6, 1/12, and 1/24 octave analysis with linear A, B, or C weighting
Baseband, zoom, and subset power spectrum
Peak search and Power in band
Frequency response (FRF)
Filtering
Swept sine
Distortion analysis (THD, THD+N, IMD)
Noise measurements (SNR)
Human vibration weighting filters
Torsional vibration
Tachometer signal processing
Order tracking, spectrum, and Order extraction
Waterfall display for power, octave, and order spectra
Shaft centerline, orbit, Bode, and order spectra
Shaft centerline, orbit, Bode, and polar plot format
File input and output to UFF58

Recommended Hardware

The Sound and Vibration Measurement Suite includes more than 50 examples that work with both dynamic signal acquisition (DSA) and multifunction data acquisition devices. For sound and vibration data acquisition, National Instruments recommends DSA devices. With 24-bit ADCs and digital-to-analog converters (DACs) and integrated antialiasing filters, DSA devices are ideal for acoustic, noise, and vibration measurements.

There are numerous system requirements to consider when selecting data acquisition hardware for measuring or generating sound and vibration signals. From IEPE signal conditioning for accelerometers and microphones to high dynamic range (up to 118 dB) and multichannel synchronization (up to 13,000 channels), National Instruments offers a wide range of hardware products for your applications.

Product	Bus	Input Resolution (bits)	Dynamic Range (dB)	Sampling Rate per Channel	Analog Inputs	Input Range	Gain Settings	Coupling	TEDS Support	Analog Outputs
High Performance										
NI 4461	PXI, PCI	24	118	204.8 kS/s	2	±42 V to 316 mV	-20 to 30 dB in 10 dB increments	AC/DC	✓	2
NI 4462	PXI, PCI	24	118	204.8 kS/s	4	±42 V to 316 mV	-20 to 30 dB in 10 dB increments	AC/DC	✓	–
High Density										
NI 4495	PXI	24	114	204.8 kS/s	16	±10 to 1 V	0 to 20 dB	DC	–	–
NI 4496	PXI	24	114	204.8 kS/s	16	±10 to 1 V	0 to 20 dB	AC	✓	–
NI 4498	PXI	24	114	204.8 kS/s	16	±10 V to 316 mV	0 to 20 dB	AC	✓	–
Low Cost										
NI 4472	PXI, PCI	24	110	102.4 kS/s	8	±10 V	–	AC/DC	–	–
NI 4474	PCI	24	110	102.4 kS/s	4	±10 V	–	AC/DC	–	–
Ultraportable										
NI 9233	USB	24	102	50 kS/s	4	±5 V	–	AC	✓	–
NI 9234	USB	24	102	51.2 kS/s	4	±5 V	–	AC/DC	✓	–

Table 2. Additional NI Dynamic Signal Acquisition Devices

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Ordering Information

For a complete list of accessories, visit the product page on ni.com.

Products	Part Number	Recommended Accessories	Part Number
NI 9234			
NI 9234 with Sound and Vibration Measurement Suite	779680-02	No accessories required.	
NI 9234 with BNC	779680-01	No accessories required.	

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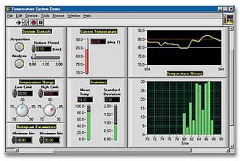
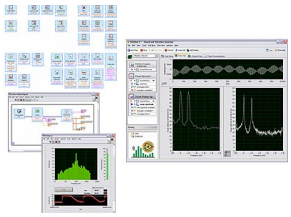
Software Recommendations

LabVIEW Professional Development System for Windows



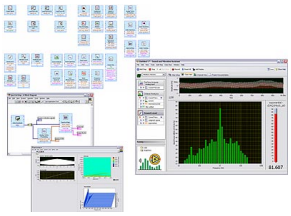
Advanced software tools for large project development
Automatic code generation using DAQ Assistant and Instrument I/O Assistant
Tight integration with a wide range of hardware
Advanced measurement analysis and digital signal processing
Open connectivity with DLLs, ActiveX, and .NET objects
Capability to build DLLs, executables, and MSI installers

NI Sound and Vibration Toolkit



Stand-alone configuration-based analysis and data logging with the Sound and Vibration Assistant
AES17-compliant audio filter signal processing
Easy-to-use power spectrum, swept sine, and octave analysis steps
Sound level with A-, B-, or C-weighting and vibration level with integration
Audio measurements including THD, SNR, SINAD, and swept-sine analysis
Universal File Format (UFF58) file I/O support

NI Sound and Vibration Measurement Suite



Minimize development time with ready-to-run application examples
Get started quickly with the Sound and Vibration Assistant (LabVIEW not required)
Build custom data acquisition systems faster than ever with DAQ configuration XControl
Avoid the expense of verification with NI ANSI- and IEC-compliant octave and sound-quality analysis
Decrease test time with parallel processing

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Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Calibration

NI measurement hardware is calibrated to ensure measurement accuracy and verify that the device meets its published specifications. To ensure the ongoing accuracy of your measurement hardware, NI offers basic or detailed recalibration service that provides ongoing ISO 9001 audit compliance and confidence in your measurements. To learn more about NI calibration services or to locate a qualified service center near you, contact your local sales office or visit ni.com/calibration.

Technical Support

Get answers to your technical questions using the following National Instruments resources.

Support - Visit ni.com/support to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.
Discussion Forums - Visit forums.ni.com for a diverse set of discussion boards on topics you care about.
Online Community - Visit community.ni.com to find, contribute, or collaborate on customer-contributed technical content with users like you.

Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit ni.com/repair.

Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

Classroom training in cities worldwide - the most comprehensive hands-on training taught by engineers.
On-site training at your facility - an excellent option to train multiple employees at the same time.
Online instructor-led training - lower-cost, remote training if classroom or on-site courses are not possible.
Course kits - lowest-cost, self-paced training that you can use as reference guides.
Training memberships and training credits - to buy now and schedule training later.
Visit ni.com/training for more information.

Extended Warranty

NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit ni.com/warranty.

OEM

NI offers design-in consulting and product integration assistance if you need NI products for OEM applications. For information about special pricing and services for OEM customers, visit ni.com/oem.

Alliance

Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide National Instruments Alliance Partner program of more than 700 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit ni.com/alliance.

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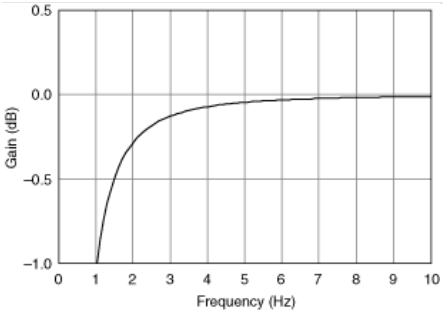
Detailed Specifications

The following specifications are typical for the range –40 to 70 °C unless otherwise noted.

Input Characteristics	
Number of channels	4 analog input channels
ADC resolution	24 bits
Type of ADC	Delta-Sigma (with analog prefiltering)
Sampling mode	Simultaneous
Type of TEDS supported	IEEE 1451.4 TEDS Class I
Internal master timebase (f_M)	
Frequency	13.1072 MHz
Accuracy	±50 ppm max
Data rate range (f_s) using internal master timebase	
Minimum	1.652 kS/s
Maximum	51.2 kS/s
Data rate range (f_s) using external master timebase	
Minimum	0.391 kS/s
Maximum	52.734 kS/s
Data rates [1] (f_s)	$\frac{f_M \div 256}{n}, n = 1, 2, \ldots, 31$
Input coupling	AC/DC (software-selectable)
AC cutoff frequency	
–3 dB	0.5 Hz
–0.1 dB	4.6 Hz max
AC cutoff frequency response	



Input range	±5 V
AC voltage full-scale range	
Minimum	±5 V_{pk}
Typical	±5.1 V_{pk}
Maximum	±5.2 V_{pk}
Common-mode voltage range (AI– to earth ground)	±2 V max
IEPE excitation current (software-selectable on/off)	
Minimum	2.0 mA
Typical	2.1 mA
Power-on glitch	90 µA for 10 µs
IEPE compliance voltage	19 V max

If you are using an IEPE sensor, use the following equation to make sure your configuration meets the IEPE compliance voltage range.

($V_{common\text{-}mode}$ + V_{bias} ± $V_{full\text{-}scale}$) must be 0 to 19, where $V_{common\text{-}mode}$ is the common-mode voltage applied to the NI 9234, V_{bias} is the bias voltage of the IEPE sensor, and $V_{full\text{-}scale}$ is the full-scale voltage of the IEPE sensor.

Overvoltage protection (with respect to chassis ground)	
For a signal source connected to AI+ and AI–	±30 V
For a low-impedance source connected to AI+ and AI–	–6 to 30 V
Input delay	$38.4/f_s$ + 3.2 µs

Accuracy [2]		
Measurement Conditions	**Percent of Reading (Gain Error)**	**Percent of Range [3] (Offset Error)**
Calibrated max (–40 to 70 °C)	0.34%, ±0.03 dB	±0.14%, 7.1 mV
Calibrated typ (25 °C ±5 °C)	0.05%, ±0.005 dB	±0.006%, 0.3 mV
Uncalibrated max (–40 to 70 °C)	1.9%, ±0.16 dB	±0.27%, 13.9 mV
Uncalibrated typ (25 °C ±5 °C)	0.48%, ±0.04 dB	±0.04%, 2.3 mV

Gain drift	
Typical	0.14 mdB/°C (16 ppm/°C)
Maximum	0.45 mdB/°C (52 ppm/°C)
Offset drift	
Typical	19.2 µV/°C
Maximum	118 µV/°C
Channel-to-channel matching	
Gain	
Typical	0.01 dB
Maximum	0.04 dB
Phase (f_{in} in kHz)	f_{in} · 0.045° + 0.04 max
Passband	
Frequency	0.45 · f_s

Flatness (f_s = 51.2 kS/s)	±40 mdB (pk-to-pk max)
Phase nonlinearity (f_s = 51.2 kS/s)	±0.45° max
Stopband	
Frequency	0.55 · f_s
Rejection	100 dB
Alias-free bandwidth	0.45 · f_s
Oversample rate	64 · f_s
Crosstalk (1 kHz)	–110 dB
CMRR (f_{in} ≤ 1 kHz)	
Minimum	40 dB
Typical	47 dB
SFDR (f_{in} = 1 kHz, – 60 dBFS)	120 dB

Idle channel noise and noise density			
Idle Channel	**51.2 kS/s**	**25.6 kS/s**	**2.048 kS/s**
Noise	97 dBFS	99 dBFS	103 dBFS
	50 μV_{rms}	40 μV_{rms}	25 μV_{rms}
Noise density	310 nV/√Hz	350 nV/√Hz	780 nV/√Hz

Input impedance	
Differential	305 kΩ
AI– (shield) to chassis ground	50 Ω

Total harmonic distortion (THD)		
Input Amplitude	**1 kHz**	**8 kHz**
–1 dBFS	–95 dB	–87 dB
–20 dBFS	–95 dB	–80 dB

Intermodulation distortion (–1 dBFS)	
DIN 250 Hz/8 kHz, 4:1 amplitude ratio	–80 dB
CCIF 11 kHz/12 kHz, 1:1 amplitude ratio	–93 dB
MTBF	390,362 hours at 25 °C; Bellcore Issue 2, Method 1, Case 3, Limited Part Stress Method

Note Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

Power Requirements

Power consumption from chassis	
Active mode	900 mW max
Sleep mode	25 µW max
Thermal dissipation (at 70 °C)	
Active mode	930 mW max
Sleep mode	25 µW max

Physical Characteristics

Weight	173 g (6.1 oz)

Safety

If you need to clean the module, wipe it with a dry towel.

Safety Voltages

Connect only voltages that are within the following limits.

Channel-to-earth ground	±30 V max, Measurement Category I
Isolation	
Channel-to-channel	None
Channel-to-earth ground	None

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS [4] voltage. 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* connect the NI 9234 to signals or use for measurements within Measurement Categories II, III, or IV.

Hazardous Locations	
U.S. (UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nA IIC T4
Canada (C-UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nA IIC T4
Europe (DEMKO)	Ex nA IIC T4

Safety Standards

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, CSA 61010-1

Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:
EN 61326 (IEC 61326): Class A emissions; Basic immunity
EN 55011 (CISPR 11): Group 1, Class A emissions
AS/NZS CISPR 11: Group 1, Class A emissions
FCC 47 CFR Part 15B: Class A emissions
ICES-001: Class A emissions

Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

Note For EMC compliance, operate this device with shielded cables.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:
2006/95/EC; Low-Voltage Directive (safety)
2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit ni.com/certification, search by module number or product line, and click the appropriate link in the Certification column.

Shock and Vibration

To meet these specifications, you must panel mount the system.

Operating vibration	
Random (IEC 60068-2-64)	5 g_{rms}, 10 to 500 Hz
Sinusoidal (IEC 60068-2-6)	5 g, 10 to 500 Hz
Operating shock (IEC 60068-2-27)	30 g, 11 ms half sine, 50 g, 3 ms half sine, 18 shocks at 6 orientations

Environmental

National Instruments C Series modules are intended for indoor use only but may be used outdoors if installed in a suitable enclosure. Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature (IEC 60068-2-1, IEC 60068-2-2)	–40 to 70 °C
Storage temperature (IEC 60068-2-1, IEC 60068-2-2)	–40 to 85 °C
Ingress protection	IP 40
Operating humidity (IEC 60068-2-56)	10 to 90% RH, noncondensing
Storage humidity (IEC 60068-2-56)	5 to 95% RH, noncondensing
Maximum altitude	2,000 m
Pollution Degree (IEC 60664)	2

Environmental Management

National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at 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.

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.

电子信息产品污染控制管理办法 （中国 RoHS）

中国客户 National Instruments 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 National Instruments 中国 RoHS 合规性信息，请登录 ni.com/environment/rohs_china。
(For information about China RoHS compliance, go to ni.com/environment/rohs_china.)

Calibration

You can obtain the calibration certificate for this device at ni.com/calibration.

Calibration interval	1 year

[1] The data rate must remain within the appropriate data range. Refer to the *Understanding NI 9234 Data Rates* section of *NI 9234 Operating Instructions and Specifications* for more information.

[2] Refer to the *NI 9234 Circuitry* section of the *NI 9234 Operating Instructions and Specifications* for information regarding grounded signal sources and measurement accuracy.

[3] Range = 5.1 V_{pk}

[4] MAINS is defined as the (hazardous live) electrical supply system to which equipment is designed to be connected for the purpose of powering the equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

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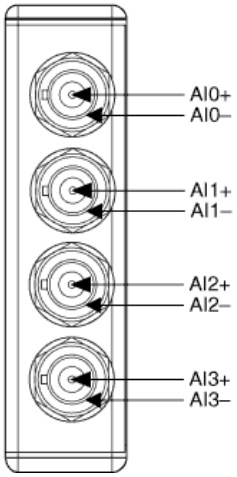
Pinouts/Front Panel Connections



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