DATASHEET

NI 9234

4 AI, ±5 V, 24 Bit, 51.2 kS/s/ch Simultaneous, AC/DC Coupling, IEPE AC Coupling

- Software-selectable AC/DC coupling (AC coupled at 0.5 Hz)
- Software-selectable IEPE signal conditioning with AC coupling (2 mA)
- -40 °C to 70 °C operating, 5 g vibration, 50 g shock
- 24-bit resolution
- Anti-aliasing filters
- 102 dB dynamic range
- Smart TEDS sensor compatibility

The NI 9234 is a four-channel dynamic signal acquisition module for making high-accuracy measurements from IEPE sensors. The NI 9234 delivers 102 dB of dynamic range and incorporates Integrated Electronics Piezoelectric (IEPE) signal conditioning at 2 mA constant current for accelerometers and microphones. The four input channels simultaneously acquire at rates up to 51.2 kS/s. In addition, the module includes built-in anti-aliasing filters that automatically adjust to your sampling rate. Compatible with a single-module USB carrier and NI CompactDAQ and CompactRIO hardware, the NI 9234 is ideal for a wide variety of mobile or portable applications such as industrial machine condition monitoring and in-vehicle noise, vibration, and harshness testing.

Kit Contents	• NI 9234 • NI 9234 Getting Started Guide
Recommended Accessories	• BNC Cable (x4) (779697-02)

C SERIES ANALOG MODULE COMPARISON							
Product Name	Signal Ranges	Channels	Sample Rate	Input Configurations	Noise at Maximum Sample Rate	Connectivity	Isolation Continuous
NI 9218	±5 V	2	51.2 kS/s/ch	IEPE with AC Coupling	50 µVrms	9-Position DSUB, LEMO	60 VDC Ch-Ch
NI 9230	±30 V	3	12.8 kS/s/ch	IEPE with AC Coupling, AC Coupling, DC Coupling	106 µVrms	Screw Terminal	60 VDC Ch-Earth
NI 9232	±30 V	3	102.4 kS/s/ch	IEPE with AC Coupling, AC Coupling, DC Coupling	251 µVrms	Screw Terminal	60 VDC Ch-Earth
NI 9234	±5 V	4	51.2 kS/s/ch	IEPE with AC Coupling, AC Coupling, DC Coupling	50 µVrms	BNC	None
NI 9251	±4.24 Vpk	2	102.4 kS/s/ch	AC Coupling, DC Coupling	8.8 µVrms	mini XLR	None

NI C Series Overview

NI provides more than 100 C Series modules for measurement, control, and communication applications. C Series modules can connect to any sensor or bus and allow for high-accuracy measurements that meet the demands of advanced data acquisition and control applications.

- Measurement-specific signal conditioning that connects to an array of sensors and signals
- Isolation options such as bank-to-bank, channel-to-channel, and channel-to-earth ground
- -40 °C to 70 °C temperature range to meet a variety of application and environmental needs
- Hot-swappable

The majority of C Series modules are supported in both CompactRIO and CompactDAQ platforms and you can move modules from one platform to the other with no modification.

CompactRIO

CompactRIO combines an open-embedded architecture with small size, extreme ruggedness, and C Series modules in a platform powered by the NI LabVIEW reconfigurable I/O (RIO) architecture. Each system contains an FPGA for custom timing, triggering, and processing with a wide array of available modular I/O to meet any embedded application requirement.

CompactDAQ

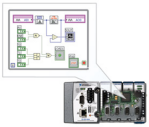
CompactDAQ is a portable, rugged data acquisition platform that integrates connectivity, data acquisition, and signal conditioning into modular I/O for directly interfacing to any sensor or signal. Using CompactDAQ with LabVIEW, you can easily customize how you acquire, analyze, visualize, and manage your measurement data.

Software

LabVIEW Professional Development System for Windows

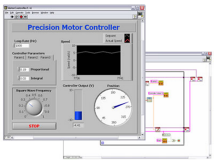
- Use advanced software tools for large project development
- Generate code automatically using DAQ Assistant and Instrument I/O Assistant
- Use advanced measurement analysis and digital signal processing
- Take advantage of open connectivity with DLLs, ActiveX, and .NET objects
- Build DLLs, executables, and MSI installers

NI LabVIEW FPGA Module



- Design FPGA applications for NI RIO hardware
- Program with the same graphical environment used for desktop and real-time applications
- Execute control algorithms with loop rates up to 300 MHz
- Implement custom timing and triggering logic, digital protocols, and DSP algorithms
- Incorporate existing HDL code and third-party IP including Xilinx IP generator functions
- Purchase as part of the LabVIEW Embedded Control and Monitoring Suite

NI LabVIEW Real-Time Module

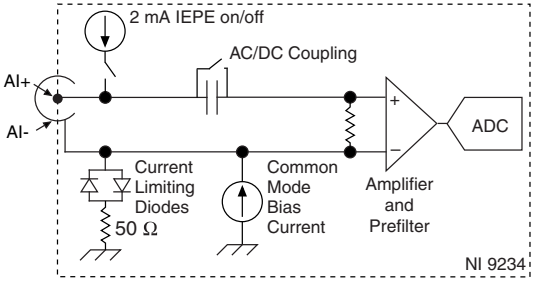


- Design deterministic real-time applications with LabVIEW graphical programming
- Download to dedicated NI or third-party hardware for reliable execution and a wide selection of I/O
- Take advantage of built-in PID control, signal processing, and analysis functions
- Automatically take advantage of multicore CPUs or set processor affinity manually
- Take advantage of real-time OS, development and debugging support, and board support
- Purchase individually or as part of a LabVIEW suite

Circuitry

The input signal on each channel is buffered, conditioned, and then sampled by a 24-bit Delta-Sigma ADC.

Figure 1. NI 9234 Input Circuitry for One Channel



The NI 9234 analog input channels are referenced to chassis ground through a 50 Ω resistor. To minimize ground noise, make sure the chassis ground is connected to earth ground. Each channel is protected from overvoltages.

AC/DC Coupling

You can configure each channel in software for AC or DC coupling. For channels set to AC coupling, you can turn the IEPE excitation current on or off. Refer to your software help for more information about configuring AC/DC coupling and enabling excitation current.

NI 9234 TEDS

The NI 9234 also has TEDS circuitry. For more information about TEDS, visit *ni.com/info* and enter the Info Code `rdteds`.

Filtering

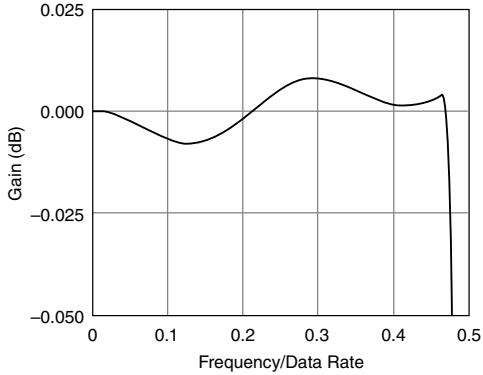
The NI 9234 uses a combination of analog and digital filtering to provide an accurate representation of in-band signals and reject out-of-band signals. The filters discriminate between signals based on the frequency range, or bandwidth, of the signal. The three important bandwidths to consider are the passband, the stopband, and the anti-imaging bandwidth.

The NI 9234 represents signals within the passband, as quantified primarily by passband ripple and phase nonlinearity. All signals that appear in the alias-free bandwidth are either unaliased signals or signals that have been filtered by at least the amount of the stopband rejection.

Passband

The signals within the passband have frequency-dependent gain or attenuation. The small amount of variation in gain with respect to frequency is called the passband flatness. The digital filters of the NI 9234 adjust the frequency range of the passband to match the data rate. Therefore, the amount of gain or attenuation at a given frequency depends on the data rate.

Figure 2. Typical Passband Response for the NI 9234



Stopband

The filter significantly attenuates all signals above the stopband frequency. The primary goal of the filter is to prevent aliasing. Therefore, the stopband frequency scales precisely with the data rate. The stopband rejection is the minimum amount of attenuation applied by the filter to all signals with frequencies within the stopband.

Alias-Free Bandwidth

Any signals that appear in the alias-free bandwidth are not aliased artifacts of signals at a higher frequency. The alias-free bandwidth is defined by the ability of the filter to reject frequencies above the stopband frequency. The alias-free bandwidth is equal to the data rate minus the stopband frequency.

Data Rates

The frequency of a master timebase (f_M) controls the data rate (f_s) of the NI 9234. The NI 9234 includes an internal master timebase with a frequency of 13.1072 MHz, but the module also can accept an external master timebase or export its own master timebase. To synchronize the data rate of an NI 9234 with other modules that use master timebases to control sampling, all of the modules must share a single master timebase source.

The following equation provides the available data rates of the NI 9234:

$$f_s = \frac{f_M \div 256}{n}$$

where n is any integer from 1 to 31.

However, the data rate must remain within the appropriate data rate range. When using the internal master timebase of 13.1072 MHz, the result is data rates of 51.2 kS/s, 25.6 kS/s, 17.067 kS/s, and so on down to 1.652 kS/s, depending on the value of n. When using an external timebase with a frequency other than 13.1072 MHz, the NI 9234 has a different set of data rates.

Note The NI 9151 R Series Expansion chassis does not support sharing timebases between modules.

NI 9234 Specifications

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

Caution To ensure the specified EMC performance, operate this product only with shielded cables and accessories.

Caution Do not operate the NI 9234 in a manner not specified in this document. Product misuse can result in a hazard. You can compromise the safety protection built into the product if the product is damaged in any way. If the product is damaged, return it to NI for repair.

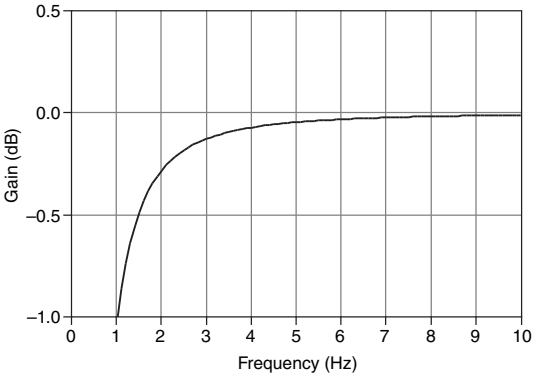
Input Characteristics

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 maximum
Data rate range (f_S)	
Using internal master timebase	
Minimum	1.652 kS/s
Maximum	51.2 kS/s
Using external master timebase	
Minimum	0.391 kS/s
Maximum	52.734 kS/s
Data rates [1] (f_S)	($f_M \div 256$)/n, n = 1, 2, ..., 31
Input coupling	AC/DC (software-selectable)
AC cutoff frequency	
-3 dB	0.5 Hz
-0.1 dB	4.6 Hz maximum

[1] The data rate must remain within the appropriate data range. Refer to the *Data Rates* for more information.

Figure 3. AC Cutoff Frequency Response



Input range	±5 V
AC voltage full-scale range	
Minimum	±5 Vpk
Typical	±5.1 Vpk
Maximum	±5.2 Vpk
Common-mode voltage range (AI- to earth ground)	±2 V maximum
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 maximum

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

$(V_{\text{common-mode}} + V_{\text{bias}} \pm V_{\text{full-scale}})$ must be 0 to 19

Where

$V_{\text{common-mode}}$ is the common-mode voltage applied to the NI 9234

V_{bias} is the bias voltage of the IEPE sensor

$V_{full\text{-}scale}$ 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 V to 30 V
Input delay	(40 + 5/512)/f_s + 2.6 µs

Table 1. Accuracy

Measurement Conditions		Percent of Reading (Gain Error)	Percent of Range[2] (Offset Error)
Calibrated	Maximum (-40 °C to 70 °C)	0.34%, ±0.03 dB	±0.14%, 7.1 mV
	Typical (25 °C ±5 °C)	0.05%, ±0.005 dB	±0.006%, 0.3 mV
Uncalibrated[3]	Maximum (-40 °C to 70 °C)	1.9%, ±0.16 dB	±0.27%, 13.9 mV
	Typical (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	
Phase (f_{in} in kHz)	(f_{in} * 0.045° + 0.04 maximum)
Gain	
Typical	0.01 dB
Maximum	0.04 dB
Passband	
Frequency	0.45 * f_s
Flatness (f_s = 51.2 kS/s)	40 mdB (pk-to-pk maximum)

[2] Range = 5.1 Vpk

[3] Uncalibrated accuracy refers to the accuracy achieved when acquiring in raw or unscaled modes where the calibration constants stored in the module are not applied to the data.

Phase nonlinearity (f_s = 51.2 kS/s)	±0.45° maximum
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 ($f_{in} \leq$ 1 kHz)	
Minimum	40 dB
Typical	47 dB
SFDR (f_{in} = 1 kHz, -60 dBFS)	120 dB

Table 2. 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 µVrms	40 µVrms	25 µVrms
Noise density	310 nV/√Hz	350 nV/√Hz	780 nV/√Hz

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

Table 3. 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

Power Requirements

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

Physical Characteristics

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

Weight	173 g (6.1 oz)

Safety Voltages

Connect only voltages that are within the following limits:

Channel-to-earth ground	±30 V maximum, 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* 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.

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 (ATEX) and International (IECEx)	Ex nA IIC T4 Gc

Safety and Hazardous Locations Standards

This product is designed to meet the requirements of the following electrical equipment safety standards for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1
- EN 60079-0:2012, EN 60079-15:2010
- IEC 60079-0: Ed 6, IEC 60079-15; Ed 4
- UL 60079-0; Ed 5, UL 60079-15; Ed 3
- CSA 60079-0:2011, CSA 60079-15:2012

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 sensitive 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 cabling.

CE Compliance CE

This product meets the essential requirements of applicable European Directives, as follows:

- 2014/35/EU; Low-Voltage Directive (safety)
- 2014/30/EU; Electromagnetic Compatibility Directive (EMC)
- 94/9/EC; Potentially Explosive Atmospheres (ATEX)

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 model 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 Hz to 500 Hz
Sinusoidal (IEC 60068-2-6)	5 g, 10 Hz 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

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 °C to 70 °C
Storage temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 °C to 85 °C
Ingress protection	IP40
Operating humidity (IEC 60068-2-78)	10% RH to 90% RH, noncondensing
Storage humidity (IEC 60068-2-78)	5% RH to 95% RH, noncondensing
Pollution Degree	2
Maximum altitude	5,000 m

Indoor use only.

Environmental Management

NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the *Minimize Our Environmental Impact* 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 the product life cycle, all NI products must be disposed of according to local laws and regulations. For more information about how to recycle NI products in your region, visit *ni.com/environment/weee*.

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 and information about calibration services for the NI 9234 at *ni.com/calibration*.

Calibration interval	1 year

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