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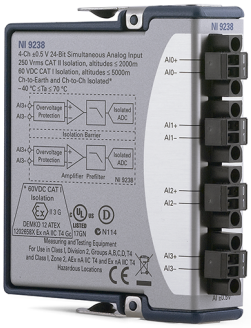
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Find the *National Instruments NI 9238* at our website: ***Click HERE***

DATASHEET

NI 9238 Datasheet

4 AI, ±500 mV, 24 Bit, 50 kS/s/ch Simultaneous



- Screw-terminal connectivity
- Anti-alias filters
- 250 Vrms, CAT II, channel-to-channel isolation

The NI 9238 is a 4-channel analog input module for NI CompactDAQ and NI CompactRIO chassis. The measurement range of 500 mV can be used with many low-voltage sensors such as current shunts and current transducers in high-current applications.

Kit Contents	• NI 9238 • NI 9238 Getting Started Guide
Accessories	• NI 9971 Backshell Connector Kit

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C SERIES LOW VOLTAGE ANALOG INPUT MODULE COMPARISON							
Product Name	Signal Levels	Channels	Sample Rate	Simultaneous	Connectivity	Resolution	Isolation
NI 9205	±200 mV, ±1 V, ±5 V, ±10 V	32 single-ended, 16 differential	250 kS/s	No	Spring Terminal, DSUB	16-bit	250 Vrms Ch-Earth (Spring), 60 VDC Ch-Earth (DSUB)
NI 9206	±200 mV, ±1 V, ±5 V, ±10 V	32 single-ended, 16 differential	250 kS/s	No	Spring Terminal	16-bit	600 VDC Ch-Earth
NI 9238	±500 mV	4 differential	50 kS/s	Yes	Screw Terminal	24-bit	250 Vrms Ch-Ch

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.

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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.



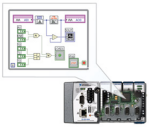
Software

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

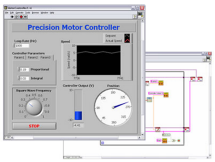
NI LabVIEW FPGA Module



- 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

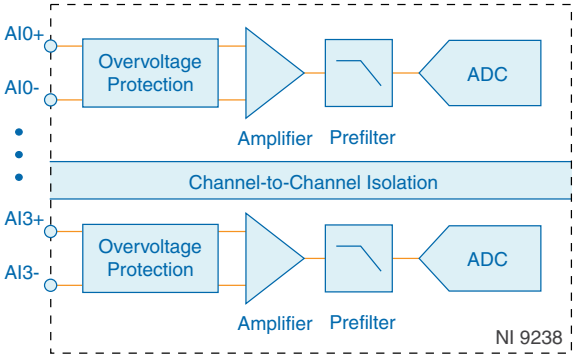
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NI LabVIEW Real-Time Module



- 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

NI 9238 Circuitry



- Input signals on each channel are buffered, conditioned, and then sampled by an ADC.
- Each AI channel provides an independent signal path and ADC, enabling you to sample all channels simultaneously.

Filtering

The NI 9238 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.

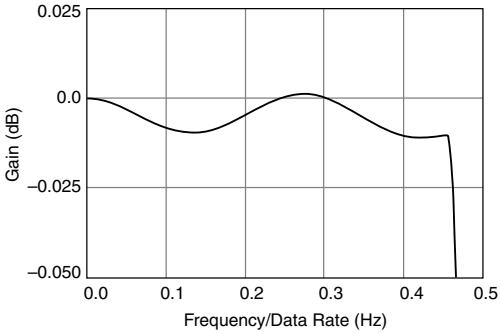
The NI 9238 represents signals within the passband, as quantified primarily by passband ripple and phase nonlinearity. All signals that appear in the alias-free bandwidth are either unaliased signals or signals that have been filtered by at least the amount of the stopband rejection.

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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 9238 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 1. Typical Passband Response for the NI 9238



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 9238. The NI 9238 includes an internal master timebase with a frequency of 12.8 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 9238 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 9238:

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

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 12.8 MHz, the result is data rates of 50 kS/s, 25 kS/s, 16.667 kS/s, and so on down to 1.613 kS/s depending on the value of n. When using an external timebase with a frequency other than 12.8 MHz, the NI 9238 has a different set of data rates.

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

NI 9238 Specifications

The following specifications are typical for the range -40 °C to 70 °C unless otherwise noted. All voltages are relative to the AI- signal on each channel unless otherwise noted.

Caution Do not operate the NI 9238 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
Internal master timebase (f_M)	
Frequency	12.8 MHz
Accuracy	±100 ppm maximum
Data rate range (f_s) using internal master timebase	
Minimum	1.613 kS/s
Maximum	50 kS/s
Data rate range (f_s) using external master timebase	
Minimum	390.625 S/s
Maximum	51.36 kS/s
Data rates (f_s)	$\frac{f_M \div 256}{n}$, n = 1, 2, …, 31

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Input voltage range (AI+ to AI-)	
Nominal	±0.5 V
Minimum	±0.496 V
Typical scaling coefficient	74.506 nV/LSB
Overvoltage protection	±30 V
Input coupling	DC
Input impedance (AI+ to AI-)	>1 GΩ

Table 1. Accuracy

Measurement Conditions		Percent of Reading (Gain Error)	Percent of Range[1] (Offset Error)
Calibrated	Maximum (-40 °C to 70 °C)	±0.20%	±0.06%
	Typical (23 °C ±5 °C)	±0.07%	±0.005%
Uncalibrated[2]	Maximum (-40 °C to 70 °C)	±1.8%	±0.3%
	Typical (23 °C ±5 °C)	±0.7%	±0.1%

Input noise	3.9 µVrms
Stability	
Gain drift	±7 ppm/°C
Offset drift	1.3 µV/°C
Post calibration gain match (ch-to-ch, 20 kHz)	100 mdB maximum
Phase mismatch (ch-to-ch, 20 kHz)	0.13°/kHz maximum
Phase mismatch (module-to-module, maximum)	$(0.13°/\text{kHz} \cdot f_{in}) + (360° \cdot f_{in}/f_M)$
Phase nonlinearity (f_s = 50 kS/s)	0.12° maximum
Input delay	$40\frac{5}{512}/f_s + 3.5$ µs
Passband	
Frequency	$0.453 \cdot f_s$
Flatness (f_s = 50 kS/s)	0.11 dB peak-to-peak maximum

[1] Range equals 0.5 V.

[2] 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.

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Stopband	
Frequency	0.547 · f_s
Rejection	100 dB
Alias-free bandwidth	0.453 · f_s
-3 dB bandwidth (f_s = 50 kS/s)	24.6 kHz
Crosstalk (0 kHz to 24.6 kHz)	-115 dB
CMRR (f_{in} = 60 Hz)	140 dB
Spurious-Free Dynamic Range (SFDR) 1 kHz, -60 dB FS	110 dB
Total Harmonic Distortion (THD) 1 kHz, -1 dB FS	-85 dB

Power Requirements

Power consumption from chassis	
Active mode	730 mW maximum
Sleep mode	50 µW maximum
Thermal dissipation	
Active mode	1.48 W maximum
Sleep mode	0.5 W maximum

Physical Characteristics

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

Tip For two-dimensional drawings and three-dimensional models of the C Series module and connectors, visit *ni.com/dimensions* and search by module number.

Screw-terminal wiring	
Gauge	0.05 mm^2 to 1.5 mm^2 (30 AWG to 14 AWG) copper conductor wire
Wire strip length	6 mm (0.24 in.) of insulation stripped from the end
Temperature rating	90 °C minimum
Torque for screw terminals	0.22 N · m to 0.25 N · m (1.95 lb · in. to 2.21 lb · in.)
Wires per screw terminal	One wire per screw terminal; two wires per screw terminal using a 2-wire ferrule
Ferrules	0.25 mm^2 to 1.5 mm^2

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Connector securement	
Securement type	Screw flanges provided
Torque for screw flanges	0.2 N · m (1.80 lb · in.)
Weight	146 g (5.15 oz)

Safety Voltages

Connect only voltages that are within the following limits.

Channel-to-channel isolation	
Up to 2,000 m altitude	
Continuous	250 Vrms, Measurement Category II
Withstand	1,500 Vrms, verified by a 5 s dielectric test
2,001 m to 5,000 m altitude	
Continuous	60 VDC, Measurement Category I
Withstand	1,000 VDC
Channel-to-earth ground isolation	
Up to 2,000 m altitude	
Continuous	250 Vrms, Measurement Category II
Withstand	3,000 Vrms, verified by a 5 s dielectric test
2,001 m to 5,000 m altitude	
Continuous	60 VDC, Measurement Category I
Withstand	1,000 VDC
Division 2 and Zone 2 hazardous locations applications (Channel-to-channel and channel-to-earth ground)	60 VDC, Measurement Category I

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 If using in Division 2 or Zone 2 hazardous locations applications, do not connect the NI 9238 to signals or use for measurements within Measurement Categories II, III, or IV.

Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet, for example, 115 V for U.S. or 230 V for Europe.

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Caution Do not connect the NI 9238 to signals or use for measurements within Measurement Categories III or IV.

Note Measurement Categories CAT I and CAT O are equivalent. These test and measurement circuits are not intended for direct connection to the MAINS building installations of Measurement Categories CAT II, CAT III, or CAT 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 61326-1 (IEC 61326-1): Class A emissions; Industrial immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- EN 55022 (CISPR 22): Class A emissions
- EN 55024 (CISPR 24): Immunity
- AS/NZS CISPR 11: Group 1, Class A emissions
- AS/NZS CISPR 22: Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions

Note In the United States (per FCC 47 CFR), Class A equipment is intended for use in commercial, light-industrial, and heavy-industrial locations. In Europe,

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Canada, Australia and New Zealand (per CISPR 11) Class A equipment is intended for use only in heavy-industrial locations.

Note Group 1 equipment (per CISPR 11) is any industrial, scientific, or medical equipment that does not intentionally generate radio frequency energy for the treatment of material or inspection/analysis purposes.

Note For EMC declarations and certifications, and additional information, refer to the *Online Product Certification* section.

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

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Storage humidity (IEC 60068-2-78)	5% RH to 95% RH, noncondensing
Pollution Degree	2
Maximum altitude[3]	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 9238 at *ni.com/calibration*.

Calibration interval	1 year

[3] Refer to the *Safety Voltages* section for more information about altitude.

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