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**NI-9205**

## DATASHEET



# NI 9205

16 AI Differential/32 AI Single-Ended,  $\pm 200$  mV to  $\pm 10$  V, 16 Bit, 250 kS/s Aggregate



- DSUB or spring-terminal connectivity
- 250 Vrms, CAT II, channel-to-earth isolation (spring terminal); 60 VDC, CAT I, channel-to-earth isolation (DSUB)

The NI 9205 is a C Series module for use with any CompactDAQ or CompactRIO system. Each channel has programmable input ranges of  $\pm 200$  mV,  $\pm 1$  V,  $\pm 5$  V, and  $\pm 10$  V. To protect against signal transients, the NI 9205 includes  $\pm 30$  V of overvoltage protection between input channels and common (COM). In addition, the NI 9205 also includes a channel-to-earth-ground double isolation barrier for safety, noise immunity, and high common-mode voltage range. The NI 9205 is rated for 1,000 Vrms transient overvoltage protection.

	Kit Contents	<ul style="list-style-type: none"> <li>• NI 9205</li> <li>• NI 9205 Getting Started Guide</li> </ul>
	Accessories	<p><b>Screw-Terminal</b></p> <ul style="list-style-type: none"> <li>• NI 9940 Backshell Kit (779567-01)</li> </ul> <p><b>DSUB</b></p> <p>Front-Mount</p> <ul style="list-style-type: none"> <li>• NI 9923 Screw-Terminal Block (780179-01)</li> </ul> <p>Cable</p> <ul style="list-style-type: none"> <li>• DSUB Cable, 1 m (778621-01)</li> </ul>

C SERIES ANALOG INPUT MODULE COMPARISON						
Product Name	Signal Levels	Channels	Sample Rate	Simultaneous	Resolution	Connectivity
NI 9201	±10 V	8 Single-Ended	500 kS/s	No	12-Bit	Screw-Terminal, Spring-Terminal, DSUB
NI 9205	±200 mV, ±1 V, ±5 V, ±10 V	32 Single-Ended, 16 differential	250 kS/s	No	16-Bit	Spring-Terminal, DSUB
NI 9206	±200 mV, ±1 V, ±5 V, ±10 V	32 Single-Ended, 16 Differential	250 kS/s	No	16-Bit	Spring-Terminal
NI 9207	±10 V	8 Differential	500 S/s	No	24-Bit	DSUB
NI 9209	±10 V	32 Single-Ended, 16 Differential	500 S/s	No	24-Bit	DSUB
NI 9215	±10 V	4 Differential	100 kS/s/ch	Yes	16-Bit	Screw-Terminal, Spring-Terminal, BNC
NI 9220	±10 V	16 Differential	100 kS/s/ch	Yes	16-Bit	Spring-Terminal, DSUB
NI 9221	±60 V	8 Single-Ended	800 kS/s	No	12-Bit	Screw-Terminal, Spring-Terminal, DSUB
NI 9222	±10 V	4 Differential	500 kS/s/ch	Yes	16-Bit	Screw-Terminal, BNC
NI 9223	±10 V	4 Differential	1 MS/s/ch	Yes	16-Bit	Screw-Terminal, BNC

# NI C Series Overview

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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.



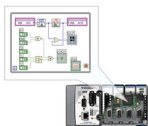
# Software

## LabVIEW Professional Development System for Windows



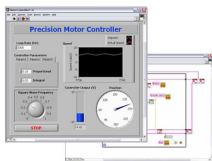
- Use advanced software tools for large project development
- Generate code automatically using DAQ Assistant and Instrument I/O Assistant
- Use advanced measurement analysis and digital signal processing
- Take advantage of open connectivity with DLLs, ActiveX, and .NET objects
- Build DLLs, executables,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

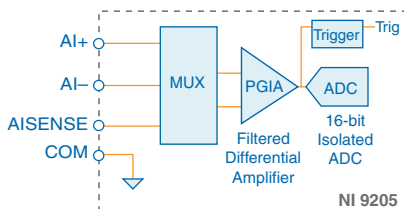


- Design deterministic real-time applications with LabVIEW graphical programming
- Download to dedicated NI or third-party hardware for reliable execution and a wide selection of I/O
- Take advantage of built-in PID control, signal processing, and analysis functions
- Automatically take advantage of 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

# Input Circuitry

The NI 9205 channels share a common ground that is isolated from other modules in the system. All channels share a programmable gain instrumentation amplifier and are multiplexed to an ADC. Each channel also has  $\pm 30$  V overvoltage protection.

**Figure 1.** Input Circuitry for One Analog Input Channel on the NI 9205



## NI 9205 Specifications

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



**Caution** Do not operate the NI 9205 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.

MTBF	775,832 hours at 25 °C; Bellcore Issue 6, Method 1, Case 3, Limited Part Stress Method
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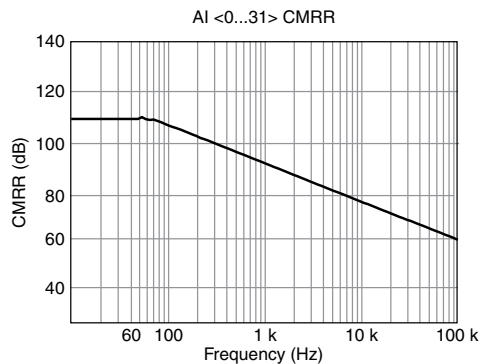
## Analog Input Characteristics

Number of channels	16 differential/32 single-ended channels
ADC resolution	16 bits
DNL	No missing codes guaranteed
Conversion time (maximum sampling rate)	
CompactRIO & CompactDAQ chassis	4.00 $\mu$ s (250 kS/s)
R Series Expansion chassis	4.50 $\mu$ s (222 kS/s)
Input coupling	DC
Nominal input ranges	$\pm 10$ V, $\pm 5$ V, $\pm 1$ V, $\pm 0.2$ V
Minimum overrange, $\pm 10$ V range	4%
Maximum working voltage for analog inputs (signal + common mode)	Each channel must remain within $\pm 10.4$ V of COM
Input impedance (AI-to-COM)	
Powered on	$>10$ G $\Omega$ in parallel with 100 pF
Powered off/overload	4.7 k $\Omega$ minimum
Input bias current	$\pm 100$ pA

Crosstalk, at 100 kHz

Adjacent channels	-65 dB
Non-adjacent channels	-70 dB
Analog bandwidth	370 kHz
Overvoltage protection	
AI channel, 0 to 31	±30 V, one channel only
AISENSE	±30 V
Settling time for multichannel measurements, accuracy, all ranges	
±120 ppm of full-scale step, ±8 LSB	4 μs convert interval
±30 ppm of full-scale step, ±2 LSB	8 μs convert interval
Analog triggers	
Number of triggers	1
Resolution	10 bits, 1 in 1,024
Bandwidth, -3 dB	370 kHz
Accuracy	±1% of full scale
Scaling coefficients	
±10 V range	328 μV/LSB
±5 V range	164.2 μV/LSB
±1 V range	32.8 μV/LSB
±0.2 V range	6.57 μV/LSB
CMRR, DC to 60 Hz	100 dB

**Figure 2. CMRR, AI+ to AI-**



## Analog Input Absolute Accuracy

The following values are based on calibrated scaling coefficients, which are stored in the onboard EEPROM.

Absolute accuracy	
$\pm 10$ V range	
Accuracy at full scale <sup>1</sup>	6,230 $\mu$ V
Random noise, $\sigma$	240 $\mu$ Vrms
Sensitivity <sup>2</sup>	96.0 $\mu$ V
$\pm 5$ V range	
Accuracy at full scale <sup>1</sup>	3,230 $\mu$ V
Random noise, $\sigma$	116 $\mu$ Vrms
Sensitivity <sup>2</sup>	46.4 $\mu$ V
$\pm 1$ V range	
Accuracy at full scale <sup>1</sup>	690 $\mu$ V
Random noise, $\sigma$	26 $\mu$ Vrms
Sensitivity <sup>2</sup>	10.4 $\mu$ V
$\pm 0.2$ V range	
Accuracy at full scale <sup>1</sup>	174 $\mu$ V
Random noise, $\sigma$	10 $\mu$ Vrms
Sensitivity <sup>2</sup>	4.0 $\mu$ V
Residual gain error	
$\pm 10$ V range	115 ppm of reading
$\pm 5$ V range	135 ppm of reading
$\pm 1$ V range	155 ppm of reading
$\pm 0.2$ V range	215 ppm of reading
Gain tempco	11 ppm/ $^{\circ}$ C
Reference tempco	5

<sup>1</sup> Absolute accuracy values at full scale on the analog input channels assume the device is operating within 70  $^{\circ}$ C of the last external calibration and are valid for averaging 100 samples immediately following self-calibration.

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



## Residual offset error

±10 V range	20 ppm of range
±5 V range	20 ppm of range
±1 V range	25 ppm of range
±0.2 V range	40 ppm of range
Offset tempco	
±10 V range	44 ppm of range/°C
±5 V range	47 ppm of range/°C
±1 V range	66 ppm of range/°C
±0.2 V range	162 ppm of range/°C
INL error	76 ppm of range

## Analog Input Accuracy Formulas

*Absolute Accuracy = Reading \* Gain Error + Range \* Offset Error + Noise Uncertainty*

where

*Gain Error = Residual Gain Error + Gain Tempco \* Temp Change from Last Internal Cal + Reference Tempco \* Temp Change from Last External Cal*

*Offset Error = Residual Offset Error + Offset Tempco \* Temp Change from Last Internal Cal + INL Error*

*Noise Uncertainty = (Random Noise \* 3) / √100 for a coverage factor of 3 σ and averaging 100 points*

Absolute accuracy at full scale on the analog input channels is determined using the following assumptions:

*Temp Change from Last External Cal = 70 °C*

*Temp Change from Last Internal Cal = 1 °C*

*Number of Readings = 100*

*Coverage Factor = 3 σ*

For example, on the ±10 V range, the absolute accuracy at full scale is as follows:

*Gain Error = 115 ppm + 11 ppm \* 1 + 5 ppm \* 70*

*Gain Error = 476 ppm*

*Offset Error = 20 ppm + 44 ppm \* 1 + 76 ppm*

*Offset Error = 140 ppm*

*Noise Uncertainty = (240 μV \* 3) / √100*

*Noise Uncertainty = 72 μV*

*Absolute Accuracy = 10 V \* 476 ppm + 10 V \* 140 ppm + 72 μV*

*Absolute Accuracy = 6,232 μV, rounds to 6,230 μV*

## Digital Characteristics

Number of channels	1 digital input channel, 1 digital output channel <sup>3</sup>
Overvoltage protection	±30 V
Digital logic levels	
Input high, $V_{IH}$	
Minimum	2.0 V
Maximum	3.3 V
Input low, $V_{IL}$	
Minimum	0 V
Maximum	0.34 V
Output high, $V_{OH}$ , sourcing 75 $\mu$ A	
Minimum	2.1 V
Maximum	3.3 V
Output low, $V_{OH}$ , sinking 250 $\mu$ A	
Minimum	0 V
Maximum	0.4 V
External digital triggers	
Source	PF10
Delay	100 ns maximum

## Power Requirements

Power consumption from chassis	
Active mode	625 mW maximum
Sleep mode	15 mW
Thermal dissipation (at 70 °C)	
Active mode	625 mW maximum
Sleep mode	15 mW

<sup>3</sup> The digital input and digital output channel are supported only in FPGA Interface mode in software.

# 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](https://ni.com/dimensions) and search by module number.

Spring-terminal wiring	
Gauge	0.8 mm <sup>2</sup> to 1.0 mm <sup>2</sup> (28 AWG to 18 AWG) copper conductor wire
Wire strip length	7 mm (0.276 in.) of insulation stripped from the end
Temperature rating	90 °C minimum
Wires per spring terminal	One wire per spring terminal
Connector securement	
Securement type	Screw flanges provided
Torque for screw flanges	0.2 N · m (1.80 lb · in.)
Weight	
NI 9205 with spring terminal	158 g (5.8 oz)
NI 9205 with DSUB	148 g (5.3 oz)

## Safety Voltages

Connect only voltages that are within the following limits:

Maximum voltage <sup>4</sup>	
Channel-to-COM	±30 VDC

## NI 9205 with Spring Terminal Isolation Voltages

Channel-to-channel	None
Channel-to-earth ground <sup>5</sup>	
Continuous	250 Vrms, Measurement Category II
Withstand	2,300 Vrms, verified by a 5 s dielectric withstand test

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.

<sup>4</sup> The maximum voltage that can be applied or output between AI and COM without creating a safety hazard.

<sup>5</sup> This specification is valid only up to 2,000 m.



**Caution** Do not connect the NI 9205 to signals or use for measurements within Measurement Categories III or IV.

## NI 9205 with DSUB Isolation Voltages

Channel-to-channel	None
Channel-to-earth ground	
Continuous	60 VDC, Measurement Category I
Withstand	
up to 2,000 m	1,000 Vrms, verified by a 5 s dielectric withstand test
up to 5,000 m	500 Vrms, verified by a 5 s dielectric withstand test

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 9205 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 is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:

- EN 61326 EMC requirements; Industrial Immunity
- EN 55011 Emissions; Group 1, Class A
- CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A



**Note** For EMC compliance, operate this device with shielded cabling.

## CE Compliance

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 <sub>rms</sub> , 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](https://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](https://ni.com/environment/weee).

## 电子信息产品污染控制管理办法（中国 RoHS）



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# Calibration

You can obtain the calibration certificate and information about calibration services for the NI 9205 at [ni.com/calibration](http://ni.com/calibration).

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Calibration interval	2 years
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