DATASHEET

# NI 9205

## 16 AI Differential/32 AI Single-Ended, ±200 mV to ±10 V, 16 Bit, 250 kS/s Aggregate

- DSUB or push-in spring terminal connectivity
- 250 V RMS, CAT II, channel-to-earth isolation (spring terminal); 60 V DC, 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 ±200 mV, ±1 V, ±5 V, and ±10 V. To protect against signal transients, the NI 9205 includes ±30 V of overvoltage protection between input channels and common (COM). In addition, the NI 9205 also includes a channel-to-earth-ground isolation barrier for safety, noise immunity, and high common-mode voltage range.

| | |
|---|---|
| Kit Contents | • NI 9205<br>• NI 9205 Getting Started Guide |
| Accessories | **Spring-Terminal**<br>• NI 9940 Backshell Kit (785080-01) |
| | **DSUB**<br>Front-Mount<br>• NI 9923 Screw-Terminal Block (781503-01)<br>Cable<br>• DSUB Cable, 1 m (778621-01)<br>• 37-Pin DSUB to Screw-Terminal Block with Horizontal DIN-Rail Mount (778673-01) |

NATIONAL INSTRUMENTS

# 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

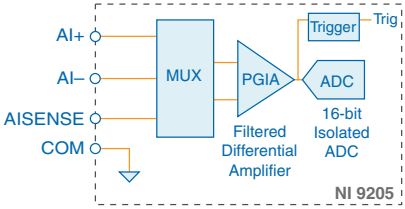
### NI LabVIEW Real-Time Module

- 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

# Input Circuitry

The NI 9205 channels share a common ground (COM) 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 ±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.

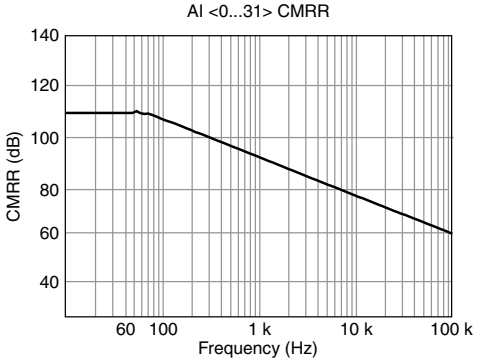
| | |
|---|---|
| MTBF | 775,832 hours at 25 °C; Bellcore Issue 6, Method 1, Case 3, Limited Part Stress Method |

## 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 µs (250 kS/s) |
| R Series Expansion chassis | 4.50 µs (222 kS/s) |
| Input coupling | DC |
| Nominal input ranges | ±10 V, ±5 V, ±1 V, ±0.2 V |
| Minimum overrange, ±10 V range | 4% |
| Maximum working voltage for analog inputs (signal + common mode) | Each channel must remain within ±10.4 V of COM |
| Input impedance (AI-to-COM) | |
| Powered on | >10 GΩ in parallel with 100 pF |
| Powered off/overload | 4.7 kΩ minimum |
| Input bias current | ±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.

**Table 1.** Absolute accuracy

| Range | Accuracy at Full Scale[1] | Random Noise[2], σ | Sensitivity[3] |
|---|---|---|---|
| ±10 V | 6,230 µV | 237 µV RMS | 96.0 µV |
| ±5 V | 3,230 µV | 121 µV RMS | 46.4 µV |
| ±1 V | 692 µV | 29 µV RMS | 10.4 µV |
| ±0.2 V | 175 µV | 15 µV RMS | 4.0 µV |

| | |
|---|---|
| Residual gain error | |
| ±10 V range | 115 ppm of reading |
| ±5 V range | 135 ppm of reading |
| ±1 V range | 155 ppm of reading |
| ±0.2 V range | 215 ppm of reading |
| Gain tempco | 11 ppm/°C |
| Reference tempco | 5 |
| 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 |

[1] Absolute accuracy values at full scale on the analog input channels assume the device is operating within 70 °C of the last external calibration and are valid for averaging 100 samples immediately following self-calibration.

[2] Differential mode

[3] Sensitivity is a function of noise and indicates the smallest voltage change that can be detected.

## 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* = (237 µV * 3) / √100

*Noise Uncertainty* = 72 µV

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

*Absolute Accuracy* = 6,231 µV, rounds to 6,230 µV

# Digital Characteristics

| | |
|---|---|
| Number of channels | 1 digital input channel, 1 digital output channel |
| Overvoltage protection | ±30 V |
| Digital logic levels | |
| Input high, $V_{IH}$ | |
| Minimum | 2.0 V |
| Maximum | 3.3 V |

[4] The digital input and digital output channel are supported only in FPGA Interface mode in software.

| | |
|---|---|
| Input low, $V_{IL}$ | |
| Minimum | 0 V |
| Maximum | 0.34 V |
| Output high, $V_{OH}$, sourcing 75 µA | |
| Minimum | 2.1 V |
| Maximum | 3.3 V |
| Output low, $V_{OH}$, sinking 250 µA | |
| Minimum | 0 V |
| Maximum | 0.4 V |
| External digital triggers | |
| Source | PFI0 |
| 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 |

## 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.

| | |
|---|---|
| Spring terminal wiring | |
| Gauge | 0.13 $mm^2$ to 1.5 $mm^2$ (26 AWG to 16 AWG) copper conductor wire |
| Wire strip length | 10 mm (0.394 in.) of insulation stripped from the end |
| Temperature rating | 90 °C, minimum |
| Wires per spring terminal | One wire per spring terminal; two wires per spring terminal using a 2-wire ferrule |
| Ferrules | 0.14 $mm^2$ to 1.5 $mm^2$ |

| | |
|---|---|
| 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 | 163 g (5.7 oz) |
| NI 9205 with DSUB | 148 g (5.3 oz) |

# Safety Voltages

Connect only voltages that are within the following limits:

| | |
|---|---|
| Maximum voltage[5] | |
| Channel-to-COM | ±30 V DC |

## NI 9205 with Spring Terminal Isolation Voltages

| | |
|---|---|
| Channel-to-channel | None |
| Channel-to-earth ground | |
| Continuous | 250 V RMS, Measurement Category II |
| Withstand up to 5,000 m | 3,000 V RMS, 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.

**Caution** Do not connect the NI 9205 with spring terminal 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 V DC, Measurement Category I |
| Withstand | |
| up to 2,000 m | 1,000 V RMS, verified by a 5 s dielectric withstand test |
| up to 5,000 m | 500 V RMS |

[5] The maximum voltage that can be applied or output between AI and COM without creating a safety hazard.

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 with DSUB to signals or use for measurements within Measurement Categories II, III, or IV.

**Note** Measurement Categories CAT I and CAT O are equivalent. These test and measurement circuits are for other circuits 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 Gc |
| Canada (C-UL) | Class I, Division 2, Groups A, B, C, D, T4; Ex nA IIC T4 Gc |
| 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 C22.2 No. 61010-1
- EN 60079-0:2012, EN 60079-15:2010
- IEC 60079-0: Ed 6, IEC 60079-15; Ed 4
- UL 60079-0; Ed 6, UL 60079-15; Ed 4
- CSA C22.2 No. 60079-0, CSA C22.2 No. 60079-15

**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 61326-1 (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, 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)
- 2014/34/EU; 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 9205 at *ni.com/calibration*.

| | |
|---|---|
| Calibration interval | 2 years |

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