# NI-9205 and sbRIO-9205 Specifications

2025-03-10

# Contents

# NI-9205 and sbRIO-9205 Specifications

## NI-9205 and sbRIO-9205 Specifications

These specifications apply to the NI-9205 and sbRIO-9205.

## Revision History

| Version | Date changed | Description |
|---|---|---|
| 378861B-01 | February 2025 | Updated analog input absolute accuracy and residual gain error tables. |
| 378861A-01 | December 2022 | Initial release. |

## Looking For Something Else?

For information not found in the specifications for your product, such as operating instructions, browse ***Related Information***.

**Related information:**

- NI-9205 Getting Started
- Software Support for CompactRIO, CompactDAQ, Single-Board RIO, R Series, and EtherCAT
- NI-9205/9206 Calibration Procedure
- Calibration Services
- Software and Driver Downloads
- Dimensional Drawings
- Product Certifications
- Letter of Volatility
- Discussion Forums
- NI Learning Center

## Connector Types

The NI-9205 has more than one connector type: NI-9205 with spring terminal and NI-9205 with DSUB. Unless the connector type is specified, NI-9205 refers to all connector types.

The NI-9205 with spring terminal is available in two types: push-in spring terminal and spring terminal. The push-in type spring terminal connector is black and orange. The spring terminal connector is black. NI-9205 with spring terminal refers to both types unless the two types are specified. Differences between the two types of spring terminal connectors are noted by the connector color.

## Definitions

***Warranted*** specifications describe the performance of a model under stated operating conditions and are covered by the model warranty.

***Characteristics*** describe values that are relevant to the use of the model under stated operating conditions but are not covered by the model warranty.

- ***Typical*** specifications describe the performance met by a majority of models.
- ***Nominal*** specifications describe an attribute that is based on design, conformance testing, or supplemental testing.

Specifications are ***Typical*** unless otherwise noted.

## Conditions

Specifications are valid for the range -40 °C to 70 °C unless otherwise noted. All voltages are relative to COM unless otherwise noted.

## NI-9205 with Spring Terminal (Black Connector) Pinout

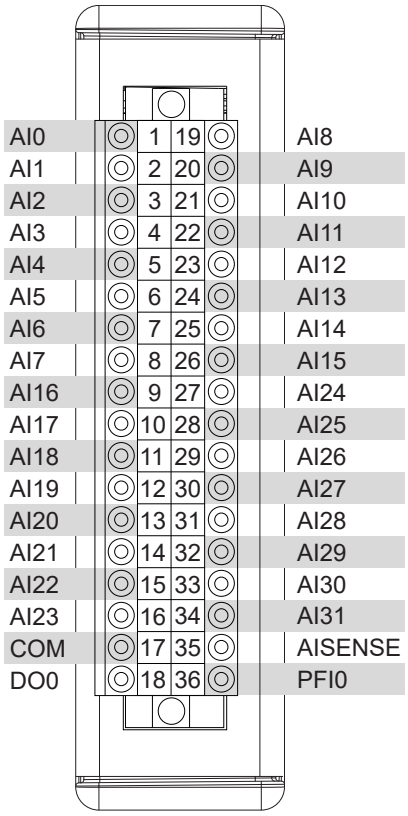



Table 1. Signal Descriptions

| Signal | Description |
|---|---|
| AI | Analog input signal connection |
| AISENSE | Reference connection for NRSE measurements |
| COM | Common reference connection to isolated ground |
| DO | Digital output signal connection |
| PFI | Programmable function interface, digital input signal connection |

# NI-9205 with Push-in Style Spring Terminal (Black/Orange Connector) Pinout

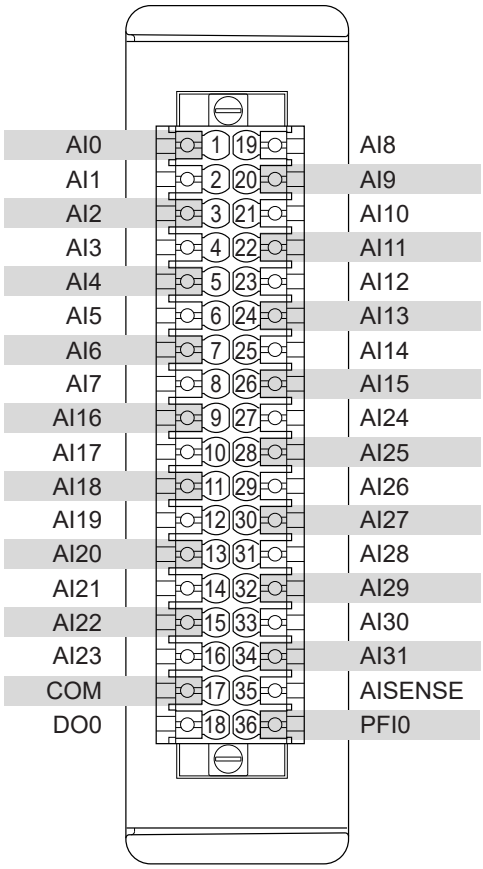



Table 2. Signal Descriptions

| Signal | Description |
|---|---|
| AI | Analog input signal connection |
| AISENSE | Reference connection for NRSE measurements |
| COM | Common reference connection to isolated ground |
| DO | Digital output signal connection |
| PFI | Programmable function interface, digital input signal connection |

# NI-9205 with DSUB Pinout

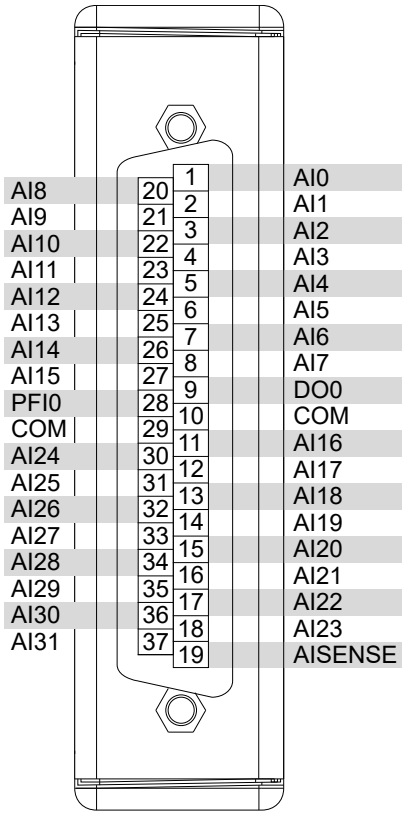



Table 3. Signal Descriptions

| Signal | Description |
|---|---|
| AI | Analog input signal connection |
| AISENSE | Reference connection for NRSE measurements |
| COM | Common reference connection to isolated ground |
| DO | Digital output signal connection |
| PFI | Programmable function interface, digital input signal connection |

# Analog Input Characteristics

| | |
|---|---|
| Number of channels | 16 differential/32 single-ended channels |
| ADC resolution | 16 bits |
| DNL | No missing codes guaranteed |

Table 4. Conversion Time (Maximum Sampling Rate)

| Chassis Type | Conversion Time |
|---|---|
| CompactRIO and 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 |

Table 5. Input Impedance (AI-to-COM)

| Device State | Input Impedance |
|---|---|
| Powered on | >10 GΩ in parallel with 100 pF |
| Powered off/overload | 4.7 kΩ minimum |

| | |
|---|---|
| Input bias current | ±100 pA |
| Analog bandwidth | 370 kHz |

Table 6. Crosstalk, at 100 kHz

| Proximity | Crosstalk |
|---|---|
| Adjacent channels | -65 dB |
| Non-adjacent channels | -70 dB |

Table 7. Overvoltage Protection

| Channel | Overvoltage Protection |
|---|---|
| AI channel, 0 to 31 | ±30 V, one channel only |
| AISENSE | ±30 V |

Table 8. Settling Time for Multi-channel Measurements, Accuracy, All Ranges

| Measurement Conditions | Settling Time |
|---|---|
| ±120 ppm of full-scale step, ±8 LSB | 4 µs convert interval |
| ±30 ppm of full-scale step, ±2 LSB | 8 µs convert interval |

Table 9. Analog Triggers

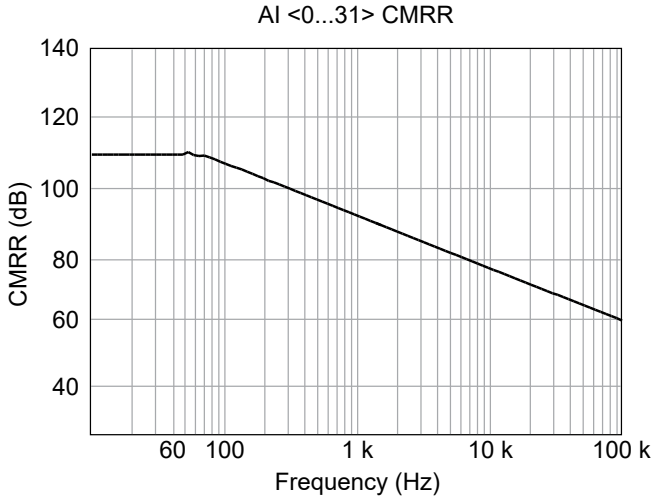
| | |
|---|---|
| Number of triggers | 1 |
| Resolution | 10 bits, 1 in 1,024 |
| Bandwidth, -3 dB | 370 kHz |
| Accuracy | ±1% of full scale |

Table 10. Scaling Coefficients

| Range | Scaling Coefficient |
|---|---|
| ±10 V | 328 µV/LSB |
| ±5 V | 164.2 µV/LSB |
| ±1 V | 32.8 µV/LSB |
| ±0.2 V | 6.57 µV/LSB |

| | |
|---|---|
| Common-mode rejection ratio (CMRR), DC to 60 Hz | 100 dB |

Figure 1. 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 11. Absolute Accuracy

| Range | Accuracy at Full Scale[1] | | Random Noise, [2]σ | Sensitivity[3] |
|---|---|---|---|---|
| | Within 2 Years of Calibration | Within 10 Years of Calibration | | |
| ±10 V | 6,230 µV | 7,280 µV | 237 µV RMS | 96.0 µV |
| ±5 V | 3,230 µV | 3,750 µV | 121 µV RMS | 46.4 µV |
| ±1 V | 692 µV | 800 µV | 29 µV RMS | 10.4 µV |
| ±0.2 V | 175 µV | 195 µV | 15 µV RMS | 4.0 µV |

**Note** NI recommends a calibration interval of 2 years and only provides calibration services referencing the 2-year specification limits. If you choose to calibrate less often, the 10-year column provides predicted performance over this extended interval. Choose an appropriate interval based on your application requirements. Longer calibration intervals are more likely to result in As-Found calibration failures when the device is sent back for calibration and compared against the 2-year specification limits.

Table 12. Residual Gain Error

| Range | Within 2 Years of Calibration | Within 10 Years of Calibration |
|---|---|---|
| ±10 V | 115 ppm of reading | 220 ppm of reading |
| ±5 V | 135 ppm of reading | 240 ppm of reading |
| ±1 V | 155 ppm of reading | 260 ppm of reading |
| ±0.2 V | 215 ppm of reading | 320 ppm of reading |

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.

| | |
|---|---|
| Gain tempco | 11 ppm/°C |
| Reference tempco | 5 ppm/°C |

Table 13. Residual Offset Error

| Range | Residual Offset Error |
|---|---|
| ±10 V | 20 ppm of range |
| ±5 V | 20 ppm of range |
| ±1 V | 25 ppm of range |
| ±0.2 V | 40 ppm of range |

Table 14. Offset Tempco

| Range | Offset Tempco |
|---|---|
| ±10 V | 44 ppm of range/°C |
| ±5 V | 47 ppm of range/°C |
| ±1 V | 66 ppm of range/°C |
| ±0.2 V | 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*** = (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[4] |
| Overvoltage protection | ±30 V |

4. The digital output channel is supported only in CompactRIO Systems with the FPGA Interface.

Table 15. Digital Logic Levels

| | Minimum | Maximum |
|---|---|---|
| Input high, $V_{IH}$ | 2.0 V | 3.3 V |
| Input low, $V_{IL}$ | 0 V | 0.34 V |
| Output high, $V_{OH}$, sourcing 75 µA | 2.1 V | 3.3 V |
| Output low, $V_{OH}$, sinking 250 µA | 0 V | 0.4 V |

Table 16. External Digital Triggers

| | |
|---|---|
| Source | PFI0 |
| Delay | 100 ns maximum |

# 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 (Black Connector) Isolation Voltages

| | |
|---|---|
| Channel-to-channel | None |
| **Channel-to-earth ground** | |
| Continuous | 250 V RMS, Measurement Category II |

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

| | |
|---|---|
| Withstand up to 2,000 m | 3,000 V RMS, verified by a 5 s dielectric withstand test |

## NI-9205 with Push-in Style Spring Terminal (Black/Orange Connector) 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 |

## 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 |
| Withstand up to 5,000 m | 500 V RMS |

# Measurement Category

## Measurement Category I

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

**Attention** Ne pas connecter le NI-9205 with DSUB à des signaux dans les catégories de mesure II, III ou IV et ne pas l'utiliser pour effectuer des mesures dans ces catégories.

**Warning** Do not connect the NI-9205 with DSUB to signals or use for measurements within Measurement Categories II, III, or IV, or for measurements on MAINs circuits or on circuits derived from Overvoltage Category II, III, or IV which may have transient overvoltages above what the product can withstand. The NI-9205 with DSUB must not be connected to circuits that have a maximum voltage above the continuous working voltage, relative to earth or to other channels, or this could damage and defeat the insulation. The NI-9205 with DSUB can only withstand transients up to the transient overvoltage rating without breakdown or damage to the insulation. An analysis of the working voltages, loop impedances, temporary overvoltages, and transient overvoltages in the system must be conducted prior to making measurements.

**Mise en garde** Ne pas connecter le NI-9205 with DSUB à des signaux dans les catégories de mesure II, III ou IV et ne pas l'utiliser pour des mesures dans ces catégories, ou des mesures sur secteur ou sur des circuits dérivés de surtensions de catégorie II, III ou IV pouvant présenter des surtensions transitoires supérieures à ce que le produit peut supporter. Le NI-9205 with DSUB ne doit pas être raccordé à des circuits ayant une tension maximale supérieure à la tension de fonctionnement continu, par rapport à la terre ou à d'autres voies, sous peine d'endommager et de compromettre l'isolation. Le NI-9205 with DSUB peut tomber en panne et son isolation risque d'être endommagée si les tensions transitoires dépassent la surtension transitoire nominale. Une analyse des tensions de fonctionnement, des impédances de

boucle, des surtensions temporaires et des surtensions transitoires dans le système doit être effectuée avant de procéder à des mesures.

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.

**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.

### Measurement Category II

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

**Attention** Ne pas connecter le NI-9205 with spring terminal à des signaux dans les catégories de mesure III ou IV et ne pas l'utiliser pour effectuer des mesures dans ces catégories.

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.

## Environmental Characteristics

| **Temperature** | |
|---|---|
| Operating | -40 °C to 70 °C |

| | |
|---|---|
| Storage | -40 °C to 85 °C |
| **Humidity** | |
| Operating | 10% RH to 90% RH, noncondensing |
| Storage | 5% RH to 95% RH, noncondensing |
| Ingress protection | IP40 |
| Pollution Degree | 2 |
| Maximum altitude | 5,000 m |
| **Shock and Vibration** | |
| **Operating vibration** | |
| Random | 5 g RMS, 10 Hz to 500 Hz |
| Sinusoidal | 5 g, 10 Hz to 500 Hz |
| Operating shock | 30 g, 11 ms half sine; 50 g, 3 ms half sine; 18 shocks at 6 orientations |

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

# 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

## Dimensions and Weight

| | |
|---|---|
| Dimensions | Visit ni.com/dimensions and search by module number. |

| **Weight** | |
|---|---|
| NI-9205 with push-in style spring terminal (black/orange connector) | 163 g (5.7 oz) |
| NI-9205 with spring terminal (black connector) | 158 g (5.8 oz) |
| NI-9205 with DSUB | 148 g (5.3 oz) |

## NI-9205 with Push-In Style Spring Terminal (Black/Orange Connector)

The push-in spring style NI-9205 with spring terminal does not require a tool for signal connection; push the wire into the terminal when using solid wire or stranded wire

with a ferrule, or by pressing the push button when using stranded wire without a ferrule.

| **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 screw terminal; two wires per screw 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 (1.8 lb · in.) |

## NI-9205 with Spring Terminal (Black Connector)

The NI-9205 with spring terminal (black connector) requires a flathead screwdriver with a 2.3 mm × 1.0 mm (0.09 in. × 0.04 in.) blade for signal connection; insert the screwdriver into a spring clamp activation slot to open the corresponding connector terminal, press a wire into the open connector terminal, and then remove the screwdriver from the activation slot to clamp the wire into place.

| **Spring-terminal wiring** |
|---|

| | |
|---|---|
| Gauge | 0.08 $mm^2$ to 1.0 $mm^2$ (28 AWG to 18 AWG) copper conductor wire |
| Wire strip length | 7 mm (0.28 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.) |

# Calibration

You can obtain the calibration certificate and information about calibration services for the NI-9205 at ni.com/calibration.

| | |
|---|---|
| Recommended calibration interval | 2 years |