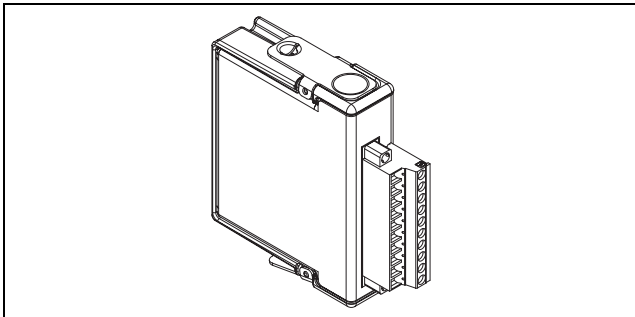


OPERATING INSTRUCTIONS

CompactRIO™ cRIO-9215

4-Channel, ± 10 VDC, 16-Bit Simultaneous Analog
Input Module



These operating instructions describe how to use the National Instruments cRIO-9215 module. For information about installing, configuring, and programming the CompactRIO system, refer to the *CompactRIO Bookshelf* at **Start»Program Files»National Instruments»CompactRIO»Search the CompactRIO Bookshelf**.

Safety Guidelines

Operate the cRIO-9215 only as described in these operating instructions.



Hot Surface This icon denotes that the component may be hot. Touching this component may result in bodily injury.

Safety Guidelines for Hazardous Locations

The cRIO-9215 is suitable for use in Class I, Division 2, Groups A, B, C, and D hazardous locations; Class 1, Zone 2, AEx nC IIC T4 and Ex nC IIC T4 hazardous locations; and nonhazardous locations only. Follow these guidelines if you are installing the cRIO-9215 in a potentially explosive environment. Not following these guidelines may result in serious injury or death.



Caution Do not disconnect I/O-side wires or connectors unless power has been switched off or the area is known to be nonhazardous.



Caution Do not remove modules unless power has been switched off or the area is known to be nonhazardous.




Caution Substitution of components may impair suitability for Class I, Division 2.



Caution For Zone 2 applications, install the CompactRIO system in an enclosure rated to at least IP 54 as defined by IEC 60529 and EN 60529.

Special Conditions for Safe Use in Europe

This equipment has been evaluated as EEx nC IIC T4 equipment under DEMKO Certificate No. 03 ATEX 0324020X. Each module is marked  II 3G and is suitable for use in Zone 2 hazardous locations.

Safety Guidelines for Hazardous Voltages

If *hazardous voltages* are connected to the module, take the following precautions. A hazardous voltage is a voltage greater than $42.4 V_{\text{peak}}$ or 60 VDC to earth ground.



Caution Ensure that hazardous voltage wiring is performed only by qualified personnel adhering to local electrical standards.



Caution Do not mix hazardous voltage circuits and human-accessible circuits on the same module.



Caution Make sure that devices and circuits connected to the module are properly insulated from human contact.

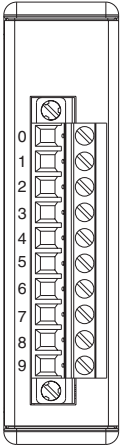


Caution When module terminals are live with hazardous voltages, make sure that the terminals are not accessible. You can use the cRIO-9932 connector kit or put the CompactRIO chassis in a suitably rated enclosure.

Wiring the cRIO-9215

The cRIO-9215 has a 10-terminal, detachable screw-terminal connector that provides connections for four analog input channels. Each channel has a terminal to which you can connect the positive lead of a voltage signal, AI+, and a terminal to which you can connect the negative lead of the voltage signal, AI-. The cRIO-9215 also has a common terminal, COM, that is internally connected to the isolated ground reference of the module. Refer to Table 1 for the terminal assignments for each channel.

Table 1. Terminal Assignments

| Module | Terminal | Signal |
|---|-----------------|---------------|
|  | 0 | AI0+ |
| | 1 | AI0- |
| | 2 | AI1+ |
| | 3 | AI1- |
| | 4 | AI2+ |
| | 5 | AI2- |
| | 6 | AI3+ |
| | 7 | AI3- |
| | 8 | No Connection |
| | 9 | Common (COM) |

Connecting Differential Voltage Signals to the cRIO-9215

You can connect differential voltage signals to the cRIO-9215. For grounded differential signals, connect the positive lead of the signal to the AI+ terminal and the negative lead to the AI- terminal. Connect the signal reference to the COM terminal.

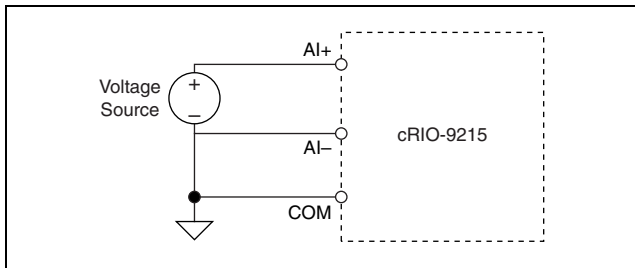


Figure 1. Connecting a Grounded Differential Voltage Signal to the cRIO-9215

For floating differential signals, the voltage source may go outside of the common-mode signal range of the cRIO-9215. If the voltage source is outside of the common-mode range, data read by the cRIO-9215 is not accurate. To keep the voltage source within the

common-mode range of the module, connect the negative lead of the signal to COM through a 1 M Ω resistor.

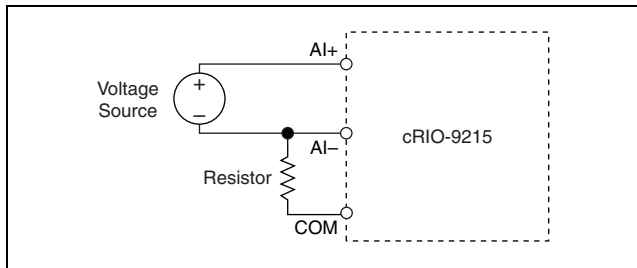


Figure 2. Connecting a Floating Differential Voltage Signal to the cRIO-9215

Refer to the *CompactRIO Bookshelf* for more information about reading from the cRIO-9215.

Connecting Single-Ended Voltage Signals to the cRIO-9215

You can connect single-ended voltage signals to the cRIO-9215. Connect the positive voltage signal to the AI+ terminal. Connect the ground signal to the AI- terminal. You must also connect the

ground signal to the COM terminal to keep the common-mode voltage in the specified range. For more information about the common-mode voltage range, refer to the *Specifications* section.

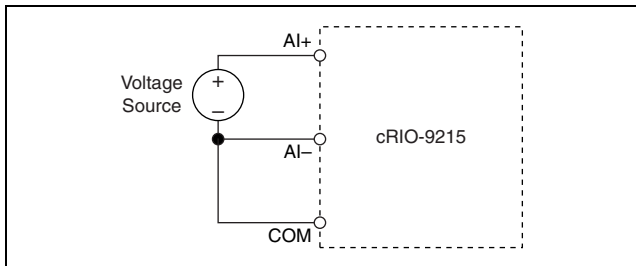


Figure 3. Connecting a Single-Ended Voltage Signal to the cRIO-9215

Refer to the *CompactRIO Bookshelf* for more information about reading from the cRIO-9215.

cRIO-9215 Circuitry

The cRIO-9215 channels share a common ground that is isolated from other modules in the CompactRIO system. The module protects each channel from overvoltages. For more information

about overvoltage protection, refer to the *Specifications* section. The signal is buffered and conditioned by the instrumentation amplifier. Then the signal is sampled by a 16-bit ADC. The channels have independent track and hold amplifiers that allow you to sample all four channels simultaneously.

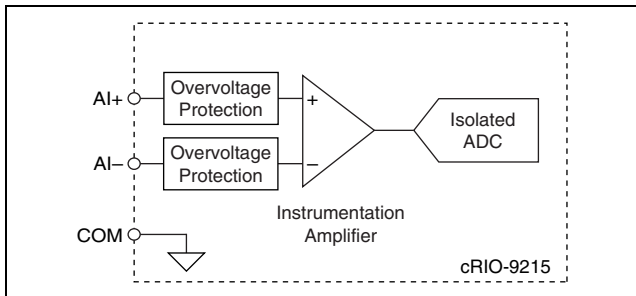


Figure 4. Input Circuitry for One Channel

The cRIO-9215 returns uncalibrated, binary data. You can convert the data in software. Refer to the *CompactRIO Bookshelf* for more information about converting and calibrating cRIO-9215 data.

Sleep Mode

You can enable sleep mode for the CompactRIO system in software. Typically, when a system is in sleep mode, you cannot communicate with the modules. In sleep mode, the system minimizes power consumption. The system thermal dissipation may decrease. Refer to the *Specifications* section for more information about power consumption and thermal dissipation. Refer to the *CompactRIO Bookshelf* for more information about enabling sleep mode in software.

Specifications

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

Input Characteristics

| | |
|--------------------------|---|
| Number of channels | 4 analog input channels |
| ADC resolution | 16 bits |
| Type of ADC | Successive approximation register (SAR) |

Operating voltage range (AI+-to-AI-)

Nominal ± 10.4 V

Minimum ± 10.2 V

Maximum ± 10.6 V

Maximum working voltage

(signal + common mode) Each channel must remain within ± 10.2 V of common

Overvoltage protection ± 30 V

Conversion time

One channel $4.34 \mu\text{s}$

Two channel $6 \mu\text{s}$

Three channel $8 \mu\text{s}$

Four channel $10 \mu\text{s}$

Accuracy

| Error | Percent of Reading | Percent of Range* |
|----------------------------------|--------------------|-------------------|
| Calibrated, max (-40 to 70 °C) | 0.2% | 0.067% |
| Calibrated, typ (25 °C, ±5 °C) | 0.02% | 0.0067% |
| Uncalibrated, max (-40 to 70 °C) | 1.05% | 0.82% |
| Uncalibrated, typ (25 °C, ±5 °C) | 0.6% | 0.38% |
| * Range equals 10.4 V | | |

Stability

Offset drift 60 $\mu\text{V}/^\circ\text{C}$

Gain drift 10 ppm/ $^\circ\text{C}$

CMRR (at 60 Hz)..... -73 dB min

Input bandwidth (-3 dB)..... 420 kHz min

Input impedance

Resistance..... 1 G Ω

Capacitance 25 pF

Input bias current 10 nA

Input noise

RMS 1.2 LSB_{rms}

Peak-to-peak 7 LSB

Crosstalk -80 dB

Settling time (to 2 LSBs)

10 V step..... 10 μ s

20 V step..... 15 μ s

No missing codes 15 bits guaranteed

DNL -1.9 to 2 LSB max

INL..... ± 6 LSB max

MTBF 1,167,174 hours at 25 °C;
Bellcore Issue 6, Method 1,
Case 3, Limited Part Stress
Method



Note Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

Power Requirements

Power consumption from chassis (full-scale input, 100 kS/s)

Active mode 560 mW max

Sleep mode 25 μ W max

Thermal dissipation (at 70 °C)

Active mode 560 mW max

Sleep mode 25 μ W max

Physical Characteristics

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

Screw-terminal wiring 12 to 24 AWG copper
conductor wire with 10 mm
(0.39 in.) of insulation
stripped from the end

Torque for screw terminals 0.5 to 0.6 N · m
(4.4 to 5.3 lb · in.)

Weight Approx. 150 g (5.3 oz.)

Safety

Safety Voltages

Connect only voltages that are within these limits.

Channel-to-COM ± 30 V max,
Installation Category I

Installation 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.

Isolation

Channel-to-channel No isolation between channels

Channel-to-earth ground

Withstand $2,300$ V_{rms}, 1 minute max

Continuous 250 V_{rms},
Installation Category II

Installation 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).

Safety Standards

The cRIO-9215 is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- EN 61010-1, IEC 61010-1
- UL 3111-1, UL 61010B-1
- CAN/CSA C22.2 No. 1010.1



Note For UL and other safety certifications, refer to the product label, or visit ni.com/hardref.nsf, search by model number or product line, and click the appropriate link in the Certification column.

Hazardous Locations

| | |
|---------------------|---|
| U.S. (UL) | Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nC IIC T4 |
| Canada (C-UL) | Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nC IIC T4 |
| Europe (DEMKO)..... | EEx nC IIC T4 |

Environmental

CompactRIO modules are intended for indoor use only. For outdoor use, mount the CompactRIO system in a suitably rated enclosure. Refer to the installation instructions for the chassis you are using for more information about meeting these specifications.

| | |
|-----------------------------|--------------------------------|
| Operating temperature | -40 to 70 °C |
| Storage temperature | -40 to 85 °C |
| Ingress protection..... | IP 40 |
| Operating humidity | 10 to 90% RH, noncondensing |

| | |
|------------------------------------|----------------------------|
| Storage humidity | 5 to 95% RH, noncondensing |
| Maximum altitude | 2,000 m |
| Pollution Degree (IEC 60664) | 2 |

Shock and Vibration

To meet these specifications, you must panel mount the CompactRIO system and affix ferrules to the end of the terminal wires.

| | |
|---|-----------------------------------|
| Operating vibration, random (IEC 60068-2-64) | 5 g _{rms} , 10 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 |
|--|--|

| | |
|--|-------------------|
| Operating vibration, sinusoidal (IEC 60068-2-6) | 5 g, 10 to 500 Hz |
|--|-------------------|

Electromagnetic Compatibility

| | |
|----------------|--|
| Emissions..... | EN 55011 Class A at 10 m FCC Part 15A above 1 GHz |
| Immunity..... | Industrial levels per EN 61326-1:1997 + A2:2001, Table A.1 |
| EMC/EMI | CE, C-Tick, and FCC Part 15 (Class A) Compliant |



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

FCC Compliance

Go to ni.com/info and enter `rdcriofcc` for information on using this product in compliance with FCC regulations.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

Low-Voltage Directive (safety)..... 73/23/EEC

Electromagnetic Compatibility

Directive (EMC) 89/336/EEC



Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit ni.com/hardref.nsf, search by model number or product line, and click the appropriate link in the Certification column.

Calibration

You can obtain the calibration certificate for the cRIO-9215 at ni.com/calibration.

National Instruments Contact Information

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at ni.com/support and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 1800 300 800, Austria 43 0 662 45 79 90 0,
Belgium 32 0 2 757 00 20, Brazil 55 11 3262 3599,
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Canada (Québec) 450 510 3055, Canada (Toronto) 905 785 0085,
Canada (Vancouver) 514 685 7530, China 86 21 6555 7838,
Czech Republic 420 224 235 774, Denmark 45 45 76 26 00,
Finland 385 0 9 725 725 11, France 33 0 1 48 14 24 24,
Germany 49 0 89 741 31 30, Greece 30 2 10 42 96 427,
India 91 80 51190000, Israel 972 0 3 6393737,
Italy 39 02 413091, Japan 81 3 5472 2970,
Korea 82 02 3451 3400, Malaysia 603 9131 0918,
Mexico 001 800 010 0793, Netherlands 31 0 348 433 466,
New Zealand 0800 553 322, Norway 47 0 66 90 76 60,

Poland 48 22 3390150, Portugal 351 210 311 210,
Russia 7 095 783 68 51, Singapore 65 6226 5886,
Slovenia 386 3 425 4200, South Africa 27 0 11 805 8197,
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Thailand 662 992 7519, United Kingdom 44 0 1635 523545

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