CompactRIO™ cRIO-9201/9221

8-Channel, 12-Bit Analog Input Modules

NATIONAL INSTRUMENTS™
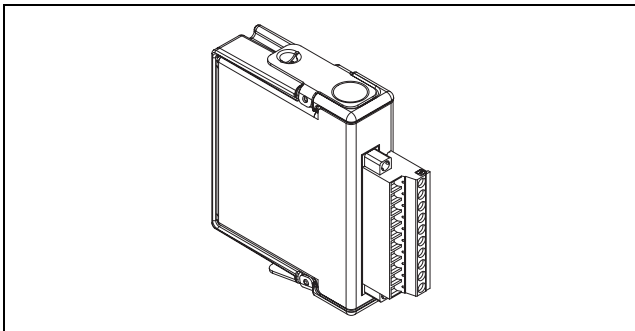
These operating instructions describe how to use the National Instruments cRIO-9201 and cRIO-9221. For information about installing, configuring, and programming the CompactRIO system, refer to the *CompactRIO Bookshelf* at **Start»All Programs»National Instruments»CompactRIO»Search the CompactRIO Bookshelf**.

Safety Guidelines

Operate the cRIO-9201/9221 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-9201/9221 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-9201/9221 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.

⚠️ **Caution** For Zone 2 applications, install a protection device between the input signal and the cRIO-9201/9221 input terminal. The device must prevent the input channel-to-COM voltage from exceeding 85 V if there is a transient overvoltage condition.

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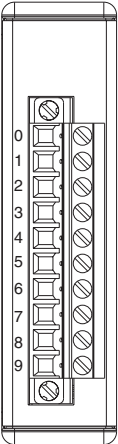
⚠️ **Caution**   When module terminals are live with hazardous voltages, make sure that the terminals are not accessible. You can use the cRIO-9932 connector kit or put the CompactRIO chassis in a suitably rated enclosure.

Wiring the cRIO-9201/9221

The cRIO-9201/9221 has a 10-terminal, detachable screw-terminal connector that provides connections for eight analog input channels. Each channel has a terminal, AI, to which you can connect a voltage signal. The cRIO-9201/9221 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	AI1
	2	AI2
	3	AI3
	4	AI4
	5	AI5
	6	AI6
	7	AI7
	8	No Connection
	9	Common (COM)

Connecting Single-Ended Voltage Signals to the cRIO-9201/9221

You can connect single-ended voltage signals to the cRIO-9201/9221. Connect the positive lead of the voltage signal to the AI terminal. Connect the ground signal to the COM terminal.
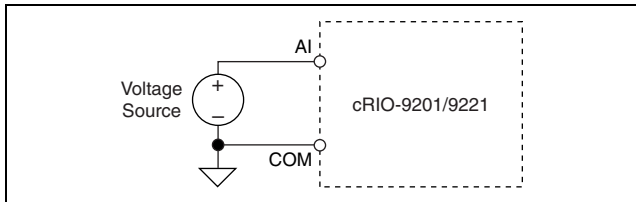

Figure 1. Connecting a Single-Ended Voltage Signal to the cRIO-9201/9221

Refer to the *CompactRIO Bookshelf* for information about reading from the cRIO-9201/9221.

cRIO-9201/9221 Circuitry

The cRIO-9201/9221 channels are isolated from other modules in the CompactRIO system. The module protects each channel from overvoltages. The input signals are scanned, buffered, conditioned, and are then sampled by a single 12-bit ADC. For more information about overvoltage protection, refer to the *Specifications* section.
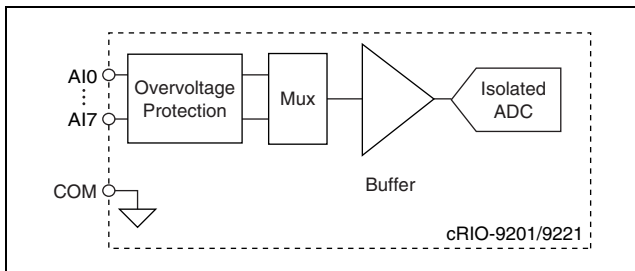
Figure 2. Input Circuitry for One Channel

The cRIO-9201/9221 returns uncalibrated, binary data that you can calibrate and scale in software. Refer to the *CompactRIO Bookshelf* for information about converting and calibrating cRIO-9201/9221 data.

Sleep Mode

You can enable sleep mode for the CompactRIO system in software. In sleep mode, the system consumes less power and may dissipate less heat. Typically, when a system is in sleep mode, you cannot communicate with the modules. 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.

NI-RIO Software

For information about determining which software you need for the modules you are using, go to ni.com/info and enter rdniriosoftware.

Specifications

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

Input Characteristics

Number of channels 8

ADC resolution .... 12 bits

Type of ADC .... Successive approximation register (SAR)

Operating voltage range

    cRIO-9201

        Typical .... ±10.53 V

        Minimum .... ±10.3 V

        Maximum .... ±10.8 V

    cRIO-9221

        Typical .... ±62.50 V

        Minimum .... ±61.4 V

        Maximum .... ±63.8 V

Overvoltage protection[1] .... 100 V Ch-to-COM max

Sample rate (aggregate)

    cRIO-9201 .... 500 kS/s max

    cRIO-9221 .... 800 kS/s max

Accuracy

Error	Percent of Reading	Percent of Range*
cRIO-9201		
Calibrated max (−40 to 70 ºC)	±0.25%	±0.25%
Calibrated typ (25 °C, ±5 °C)	±0.04%	±0.07%
Uncalibrated max (−40 to 70 ºC)	±0.67%	±1.25%
Uncalibrated typ (25 °C, ±5 °C)	±0.26%	±0.46%
* Range equals 10.53 V for the cRIO-9201, 62.50 V for the cRIO-9221		

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[1] Overvoltage protection is the amount of voltage that the product can tolerate on input signal lines without damage to the product.

Error	Percent of Reading	Percent of Range*
cRIO-9221		
Calibrated max (−40 to 70 ºC)	±0.25%	±0.25%
Calibrated typ (25 °C, ±5 °C)	±0.04%	±0.07%
Uncalibrated max (−40 to 70 ºC)	±0.67%	±1.06%
Uncalibrated typ (25 °C, ±5 °C)	±0.26%	±0.43%
* Range equals 10.53 V for the cRIO-9201, 62.50 V for the cRIO-9221		

Stability

    Offset drift

        cRIO-9201 ....±100 µV/°C

        cRIO-9221 ....±580 µV/°C

    Gain drift ....±34 ppm/°C

Input bandwidth (−3 dB)

    cRIO-9201..................................690 kHz min

    cRIO-9221..................................950 kHz min

Input impedance

    Resistance....................................1 MΩ

    Capacitance ....5 pF

Input noise (code-centered)

    RMS ....0.7 LSB_{rms}

    Peak-to-peak..............................5 LSB

No missing codes.............................12 bits

DNL..−0.9 to 1.5 LSB

INL...±1.5 LSB

Crosstalk ....−75 dB, 10 kHz

Settling time (to 1 LSB)

    cRIO-9201..................................2 μs

    cRIO-9221..................................1.25 μs

MTBF

cRIO-9201 .... 1,485,465 hours at 25 °C;
Bellcore Issue 6, Method 1,
Case 3, Limited Part Stress
Method

cRIO-9221 .... 1,485,465 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. Go to ni.com/certification and
search by model number or product line for more
information about MTBF and other product
certifications.

Power Requirements

Power consumption from chassis

    Active mode .... 550 mW max

    Sleep mode .... 1 mW max

Thermal dissipation (at 70 °C)

    Active mode .... 600 mW max

    Sleep mode .... 32 mW 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

cRIO-9201 Safety Voltages

Connect only voltages that are within these limits.

Channel-to-COM .... ±60 VDC max

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).

cRIO-9221 Safety Voltages

Connect only voltages that are within these limits.

Channel-to-COM ....±60 VDC max

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

Safety Standards

The cRIO-9201/9221 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 61010-1

- CAN/CSA-C22.2 No. 61010-1

> **Note** For UL and other safety certifications, refer to the product label, or visit ni.com/certification, 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, Ex 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
(IEC60068-2-1, IEC 60068-2-2) ...... −40 to 70 °C

Storage temperature
(IEC60068-2-1, IEC 60068-2-2) ...... −40 to 85 °C

Ingress protection .... IP 40

Operating humidity
(IEC 60068-2-56) .... 10 to 90% RH, noncondensing

Storage humidity
(IEC 60068-2-56) .... 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 ends 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/certification, 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-9201/9221 at ni.com/calibration.

Calibration interval .... 1 year

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, Canada (Calgary) 403 274 9391, Canada (Ottawa) 613 233 5949, Canada (Québec) 450 510 3055, Canada (Toronto) 905 785 0085, Canada (Vancouver) 604 685 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, 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 01 800 010 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, Spain 34 91 640 0085,
Sweden 46 0 8 587 895 00, Switzerland 41 56 200 51 51,
Taiwan 886 2 2528 7227, Thailand 662 992 7519,
United Kingdom 44 0 1635 523545

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