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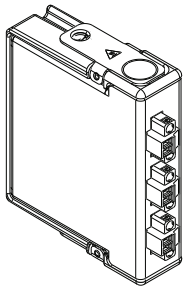
OPERATING INSTRUCTIONS AND SPECIFICATIONS

NI 9225

3-Channel, 300 V_{rms}, 24-Bit Simultaneous, Channel-to-Channel Isolated Analog Input Module

Français Deutsch 日本語 한국어 简体中文

ni.com/manuals



NATIONAL INSTRUMENTS

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This document describes how to use the National Instruments 9225 and includes specifications and pin assignments for the NI 9225.

Note The safety guidelines and specifications in this document are specific to the NI 9225. The other components in the system might not meet the same safety ratings and specifications. Refer to the documentation for each component in the system to determine the safety ratings and specifications for the entire system.

Related Information



NI CompactDAQ & NI CompactRIO Documentation
ni.com/info ➪ cseriesdoc



Chassis Compatibility
ni.com/info ➪ compatibility



Software Support
ni.com/info ➪ softwareversion



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Safety Guidelines

Operate the NI 9225 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.



Hazardous Voltage This icon denotes a warning advising you to take precautions to avoid electrical shock.



Caution Do not operate the NI 9242 in a manner not specified in this manual. 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 National Instruments for repair.

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_{pk} or 60 VDC to earth ground.

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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.

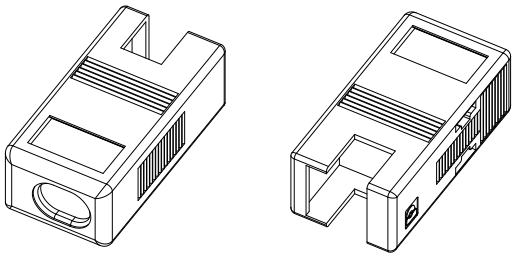
Caution Make sure that devices and circuits connected to the module are properly insulated from human contact.

Caution When module terminals are hazardous voltage LIVE (>42.4 V_{pk}/60 VDC), you must ensure that devices and circuits connected to the module are properly insulated from human contact. You must use the NI 9971 connector backshell kit to ensure that the terminals are *not* accessible.

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Figure 1 shows the NI 9971 connector backshell.

Figure 1. NI 9971 Connector Backshell



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Safety Guidelines for Hazardous Locations

The NI 9225 is suitable for use in Class I, Division 2, Groups A, B, C, D, T4 hazardous locations; Class I, Zone 2, AEx nA IIC T4, and Ex nA IIC T4 hazardous locations; and nonhazardous locations only. Follow these guidelines if you are installing the NI 9225 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 system in an enclosure rated to at least IP 54 as defined by IEC 60529 and EN 60529.

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Special Conditions for Marine Applications

Some modules are Lloyd's Register (LR) Type Approved for marine applications. To verify Lloyd's Register certification, visit `ni.com/certification` and search for the LR certificate, or look for the Lloyd's Register mark on the module.

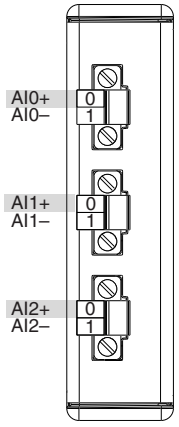
Caution To meet radio frequency emission requirements for marine applications, use shielded cables and install the system in a metal enclosure. Suppression ferrites must be installed on power supply inputs near power entries to modules and controllers. Power supply and module cables must be separated on opposite sides of the enclosure and must enter and exit through opposing enclosure walls.

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Connecting the NI 9225

The NI 9225 has three 2-terminal detachable screw-terminal connectors that provide connections for three simultaneously sampled, isolated analog input channels.

Figure 2. NI 9225 Terminal Assignments



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You can connect ground-referenced or floating signal sources to the NI 9225. Connect the positive signal of the signal source to the AI+ terminal, and connect the negative signal of the signal source to the AI- terminal. If you make a ground-referenced connection between the signal source and the NI 9225, make sure the voltage on the AI+ and AI- connections are in the channel-to-earth safety voltage range to ensure proper operation of the NI 9225. Refer to the *Specifications* section for more information about operating voltages and overvoltage protection.

Note You must use 2-wire ferrules to create a secure connection when connecting more than one wire to a single terminal on the NI 9225.

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Refer to Figures 3 and 4 for illustrations of how to connect grounded and floating signal sources to the NI 9225.

Figure 3. Connecting a Grounded Signal Source to the NI 9225

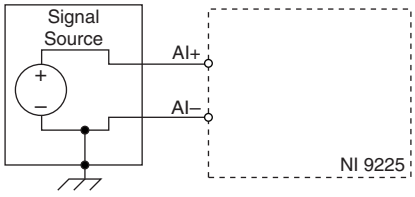
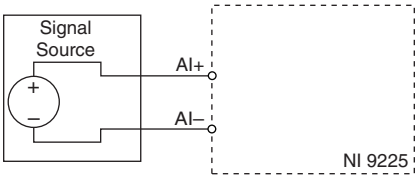


Figure 4. Connecting a Floating Signal Source to the NI 9225

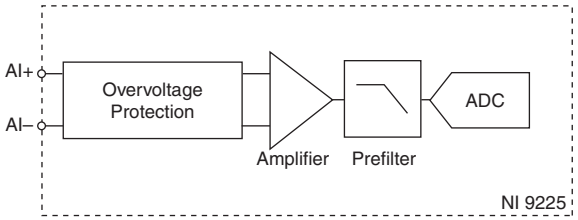


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The NI 9225 analog input channels are floating with respect to earth ground and each other. The incoming analog signal on each channel is conditioned, buffered, and then sampled by a 24-bit Delta-Sigma ADC.

Each channel provides an independent signal path and ADC, enabling you to sample all three channels simultaneously. Refer to Figure 5 for an illustration of the circuitry for one channel of the NI 9225.

Figure 5. Input Circuitry for One Channel of the NI 9225

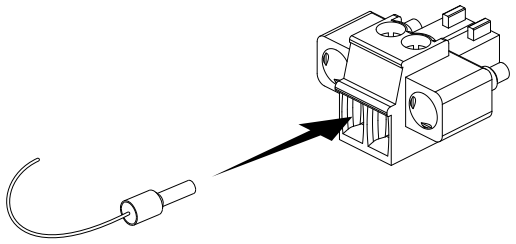


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Wiring for High-Vibration Applications

If an application is subject to high vibration, National Instruments recommends that you either use ferrules to terminate wires to the detachable screw-terminal connector or use the NI 9971 backshell kit to protect the connections. Refer to Figure 6 for an illustration of using ferrules. Refer to Figure 1 for an illustration of the NI 9971 connector backshell.

Figure 6. 2-Terminal Detachable Screw-Terminal Connector with Ferrule



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Understanding NI 9225 Filtering

The NI 9225 uses a combination of analog and digital filtering to provide an accurate representation of in-band signals while rejecting out-of-band signals. The filters discriminate between signals based on the frequency range, or bandwidth, of the signal. The three important bandwidths to consider are the passband, the stopband, and the alias-free bandwidth.

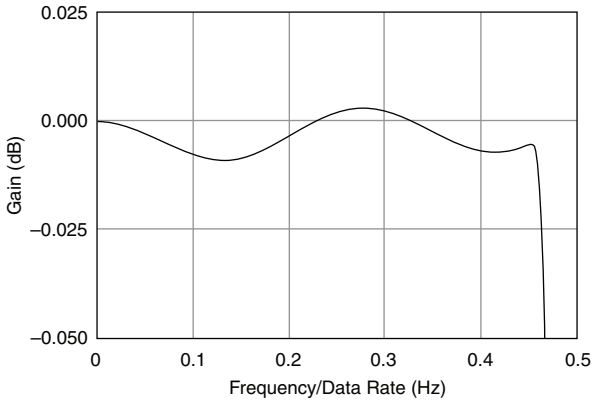
The NI 9225 represents signals within the passband, as quantified primarily by passband flatness and phase nonlinearity. All signals that appear in the alias-free bandwidth are either unaliased signals or signals that have been filtered by at least the amount of the stopband rejection.

Passband

The signals within the passband have frequency-dependent gain or attenuation. The small amount of variation in gain with respect to frequency is called the passband flatness. The digital filters of the NI 9225 adjust the frequency range of the passband to match the data rate. Therefore, the amount of gain or attenuation at a given frequency depends on the data rate. Figure 7 shows typical passband flatness for the NI 9225.

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Figure 7. Typical Passband Response of the NI 9225



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Stopband

The filter significantly attenuates all signals above the stopband frequency. The primary goal of the filter is to prevent aliasing. Therefore, the stopband frequency scales precisely with the data rate. The stopband rejection is the minimum amount of attenuation applied by the filter to all signals with frequencies within the stopband.

Alias-Free Bandwidth

Any signal that appears in the alias-free bandwidth of the NI 9225 is not an aliased artifact of signals at a higher frequency. The alias-free bandwidth is defined by the ability of the filter to reject frequencies above the stopband frequency and equals the data rate minus the stopband frequency.

Understanding NI 9225 Data Rates

The frequency of a master timebase (f_M) controls the data rate (f_s) of the NI 9225. The NI 9225 includes an internal master timebase with a frequency of 12.8 MHz, but the module also can accept an external master timebase or export its own master timebase. To synchronize the data rate of an NI 9225 with other modules that use master timebases to control sampling, all of the modules must

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share a single master timebase source. Refer to the software help for information about configuring the master timebase source for the NI 9225. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.

The following equation provides the available data rates of the NI 9225:

$$f_s = \frac{f_M \div 256}{n}$$

where n is any integer from 1 to 31.

However, the data rate must remain within the appropriate data rate range. Refer to the *Specifications* section for more information about the data rate range. When using the internal master timebase of 12.8 MHz, the result is data rates of 50 kS/s, 25 kS/s, 16.667 kS/s, and so on down to 1.613 kS/s, depending on the value of n. When using an external timebase with a frequency other than 12.8 MHz, the NI 9225 has a different set of data rates.

Note The cRIO-9151 R Series Expansion chassis does not support sharing timebases between modules.

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Sleep Mode

This module supports a low-power sleep mode. Support for sleep mode at the system level depends on the chassis that the module is plugged into. Refer to the chassis manual for information about support for sleep mode. If the chassis supports sleep mode, refer to the software help for information about enabling sleep mode. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.

Typically, when a system is in sleep mode, you cannot communicate with the modules. In sleep mode, the system consumes minimal power and may dissipate less heat than it does in normal mode. Refer to the *Specifications* section for more information about power consumption and thermal dissipation.

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Specifications

The following specifications are typical for the range -40 to 70 °C unless otherwise noted. All voltages are relative to the AI- signal on each channel unless otherwise noted.

Input Characteristics

Number of channels ..... 3 analog input channels

ADC resolution ..... 24 bits

Type of ADC ..... Delta-Sigma (with analog prefiltering)

Sampling mode ..... Simultaneous

Internal master timebase (f_M)

- Frequency ..... 12.8 MHz
- Accuracy ..... ±100 ppm max

Data rate range (f_s) using internal master timebase

- Minimum ..... 1.613 kS/s
- Maximum ..... 50 kS/s

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Data rate range (f_s) using external master timebase

Minimum ..... 390.625 S/s

Maximum ..... 51.36 kS/s

Data rates[1] (f_s) ..... $\frac{f_M \div 256}{n}$, n = 1, 2, ..., 31

Operating voltage ranges[2]

Minimum ..... 294 V_{rms}

Typical ..... 300 V_{rms}

Typical scaling coefficient ..... 50.66 µV/LSB

Overvoltage protection ..... ±450 VDC

Input coupling ..... DC

Input impedance (AI+ to AI-) ..... 1 MΩ

[1] The data rate must remain within the appropriate data rate range. Refer to the *Understanding NI 9225 Data Rates* section for more information.

[2] Refer to the *Safety Guidelines* section for more information about safe operating voltages.

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Accuracy

Measurement Conditions	Percent of Reading (Gain Error)	Percent of Range* (Offset Error)
Calibrated max (-40 to 70 °C)	±0.23%	±0.05%
Calibrated typ (25 °C, ±5 °C)	±0.05%	±0.008%
Calibrated max (25 °C, ±15 °C)	±0.084%	±0.016%
Uncalibrated max (-40 to 70 °C)	±1.6%	±0.66%
Uncalibrated typ (25 °C, ±5 °C)	±0.4%	±0.09%
* Range equals 425 V.		

Input noise ..... 2 mV_{rms}

Stability

Gain drift ..... ±10 ppm/°C

Offset drift ..... ±970 µV/°C

Post calibration gain match
(ch-to-ch, 20 kHz)..... ±0.25 dB max

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Crosstalk (60 Hz)..... –130 dB

Phase match

Ch-to-ch, max..... 0.035°/kHz

Module-to-module, max..... 0.035°/kHz + 360° · f_{in}/f_M

Phase linearity (f_s = 50 kS/s)..... 0.22° max

Input delay ..... $40\frac{5}{512}/f_s$ + 3.6 µs

Passband

Frequency..... 0.453 · f_s

Flatness (f_s = 50 kS/s) ..... ±100 mdB max

Stopband

Frequency..... 0.547 · f_s

Rejection..... -100 dB

Alias-free bandwidth ..... 0.453 · f_s

-3 dB bandwidth (f_s = 50 kS/s)..... 24.56 kHz

CMRR (f_{in} = 60 Hz)..... 104 dB

SFDR (1 kHz, -60 dBFS)..... 128 dBFS

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Total Harmonic Distortion (THD)
(1 kHz, -20 dB) ..... -95 dB

MTBF ..... 301,606 hours at 25 °C; Bellcore Issue 2, 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

- Active mode ..... 495 mW max
- Sleep mode ..... 25 µW max

Thermal dissipation (at 70 °C)

- Active mode ..... 760 mW max
- Sleep mode ..... 265 mW max

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Physical Characteristics

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

Screw-terminal wiring	16 to 28 AWG copper conductor wire with 7 mm (0.28 in.) of insulation stripped from the end
Torque for screw terminals	0.22 to 0.25 N · m (1.95 to 2.21 lb · in.)
Ferrules	0.25 mm^2 to 0.5 mm^2
Weight	141 g (5.0 oz)

Safety

Maximum Voltage

Connect only voltages that are within the following limits.

AI+ to AI-	300 V_{rms} max

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Isolation Voltages

Channel-to-channel

Continuous	600 V_{rms}, Measurement Category II
Withstand	2,300 V_{rms}, verified by a 5 s dielectric withstand test

Channel-to-earth ground

Continuous	300 V_{rms}, Measurement Category II
Withstand	2,300 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 9225 to signals or use for measurements within Measurement Categories III or IV.

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Safety Standards

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1

Note For UL and other safety certifications, refer to the product label or visit `ni.com/certification`, search for the module 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 nA IIC T4
Canada (C-UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nA IIC T4

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Environmental

National Instruments C Series modules are intended for indoor use only but may be used outdoors if installed in a suitable enclosure. 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 to 70 °C

Storage temperature
(IEC 60068-2-1, 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

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Shock and Vibration

To meet these specifications, you must panel mount the system and either affix ferrules to the ends of the terminal wires or use the NI 9971 backshell kit to protect the connections.

Operating vibration

Random (IEC 60068-2-64)..... 5 g_{rms}, 10 to 500 Hz

Sinusoidal (IEC 60068-2-6) ..... 5 g, 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

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

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

CE Compliance CE

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

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

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 module number or product line, and click the appropriate link in the Certification column.

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.

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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 products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers, National Instruments WEEE initiatives, and compliance with WEEE Directive 2002/96/EC on Waste and Electronic Equipment, visit `ni.com/environment/weee`.

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Calibration

You can obtain the calibration certificate and information about calibration services for the NI 9225 at ni.com/calibration.

Calibration interval ..... 1 year

Worldwide Support and Services

The National Instruments website is your complete resource for technical support. At ni.com/support you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

Visit ni.com/services for NI Factory Installation Services, repairs, extended warranty, and other services.

Visit ni.com/register to register your National Instruments product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

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product safety. You can obtain the DoC for your product by visiting ni.com/certification. If your product supports calibration, you can obtain the calibration certificate for your product at ni.com/calibration.

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