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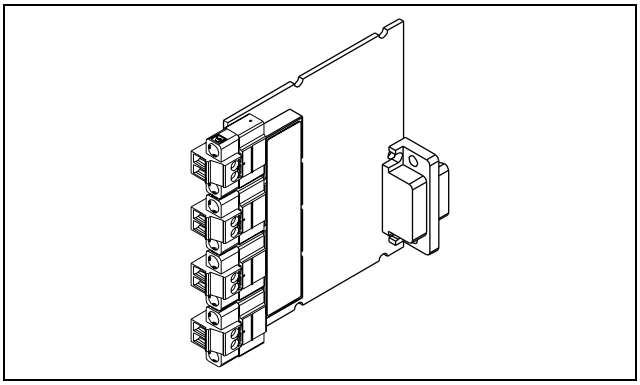
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Find the *National Instruments sbRIO-9229* at our website: *Click HERE*

OPERATING INSTRUCTIONS AND SPECIFICATIONS

NI 9229E/9239E

4-Channel, ±60/±10 V, 24-Bit Simultaneous, Channel-to-Channel Isolated Analog Input Modules



NATIONAL INSTRUMENTS

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This document describes how to use the National Instruments 9229E and National Instruments 9239E and includes dimensions, terminal assignments, and specifications. In this document, the NI 9229E and NI 9239E are referred to inclusively as the NI 9229E/9239E. Visit `ni.com/info` and enter `rdsoftwareversion` to determine which software you need for the modules you are using. For information about installing, configuring, and programming the system, refer to the system documentation. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.

Caution National Instruments makes no electromagnetic compatibility (EMC) or CE marking compliance claims for the NI 9229E/9239E. The end-product supplier is responsible for conformity to any and all compliance requirements.

Caution The NI 9229E/9239E must be installed inside a suitable enclosure prior to use. Hazardous voltages may be present.

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NI 9229E/9239E Dimensions

The following figure shows the dimensions of the NI 9229E/9239E.

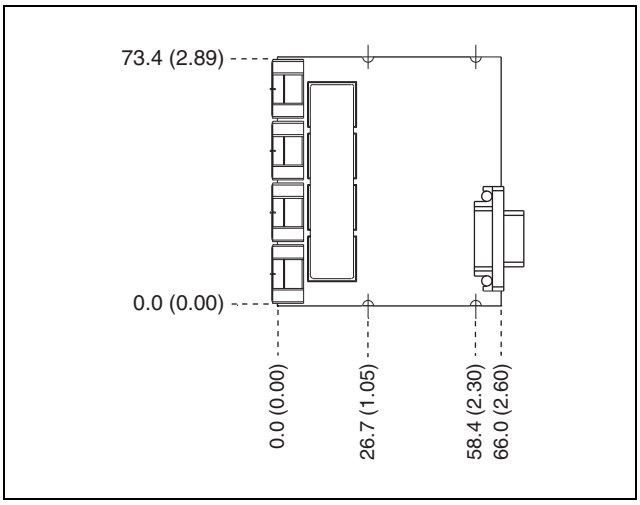


Figure 1. NI 9229E/9239E Dimensions in Millimeters (Inches)

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Connecting the NI 9229E/9239E

The NI 9229E/9239E provides connections for four simultaneously sampled, isolated analog input channels.

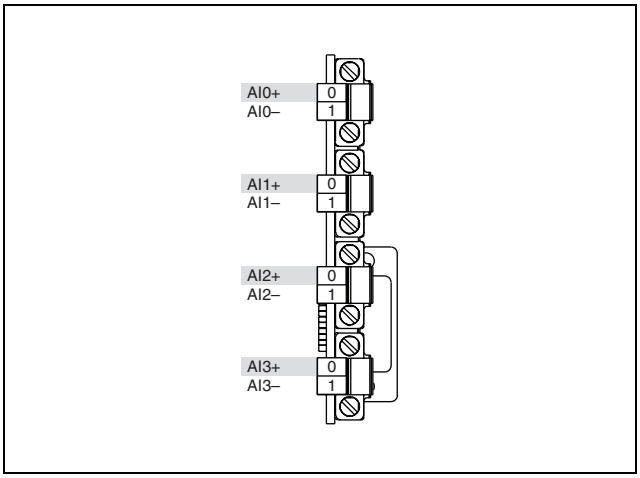


Figure 2. NI 9229E/9239E Terminal Assignments

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The NI 9229E/9239E has four 2-terminal detachable screw-terminal connectors.

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 9229E/9239E.

You can connect ground-referenced or floating signal sources to the NI 9229E/9239E. 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 9229E/9239E, 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 9229E/9239E. Refer to the *Specifications* section for more information about operating voltages and overvoltage protection. Refer to Figures 3 and 4 for illustrations of how to connect grounded and floating signal sources to the NI 9229E/9239E.

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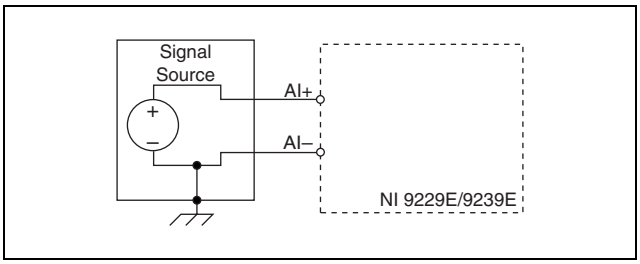


Figure 3. Connecting a Grounded Signal Source to the NI 9229E/9239E

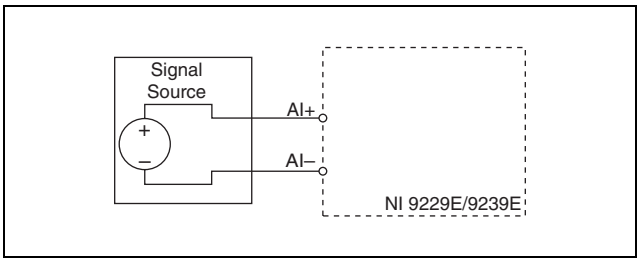


Figure 4. Connecting a Floating Signal Source to the NI 9229E/9239E

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The NI 9229E/9239E 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 four channels simultaneously. Refer to Figure 5 for an illustration of the circuitry for one channel.

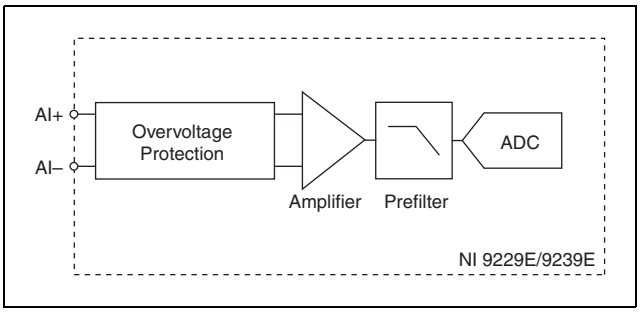


Figure 5. Input Circuitry for One Channel of the NI 9229E/9239E

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Understanding NI 9229E/9239E Filtering

The NI 9229E/9239E 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 9229E/9239E 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 9229E/9239E 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 6 shows typical passband flatness for the NI 9229E/9239E.

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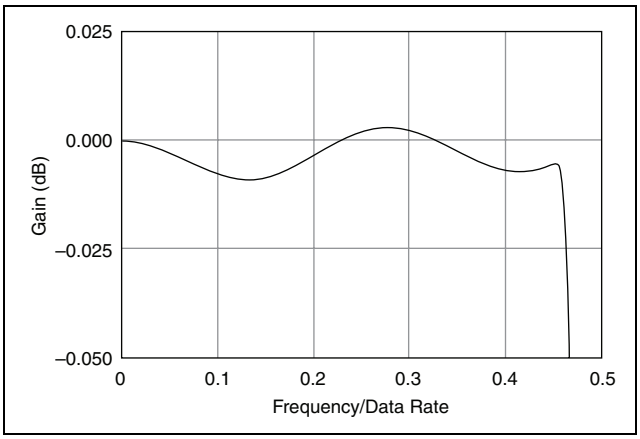


Figure 6. Typical Passband Flatness for the NI 9229E/9239E

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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 9229E/9239E 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 9229E/9239E Data Rates

The frequency of a master timebase (f_M) controls the data rate (f_s) of the NI 9229E/9239E. The NI 9229E/9239E 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 9229E/9239E with other modules that use master timebases

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to control sampling, all of the modules must share a single master timebase source. Refer to the software help for information about configuring the master timebase source for the NI 9229E/9239E. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.

The following equation provides the available data rates of the NI 9229E/9239E:

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

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, 16.67 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 9229E/9239E has a different set of data rates.

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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 85 °C internal to any enclosures unless otherwise noted. All voltages are relative to the AI– signal on each channel unless otherwise noted. The specifications are the same for the NI 9229E and the NI 9239E unless otherwise noted.

Input Characteristics

Number of channels ..... 4 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 ..... 51.2 kS/s

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

Input voltage ranges (AI+ to AI–)

Module	Nominal (V)	Typical (V)	Minimum (V)
NI 9229E	±60	±62.64	±61.5
NI 9239E	±10	±10.52	±10.3

Overvoltage protection ..... ±100 V

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 9229E/9239E Data Rates* section for more information.

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Accuracy, NI 9229E

Measurement Conditions	Percent of Reading (Gain Error)	Percent of Range* (Offset Error)
Calibrated max (–40 to 70 °C)	±0.13%	±0.05%
Calibrated typ (25 °C, ±5 °C)	±0.03%	±0.008%
Uncalibrated max (–40 to 70 °C)	±1.2%	±0.55%
Uncalibrated typ (25 °C, ±5 °C)	±0.3%	±0.11%
* Range equals 62.64 V		

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Accuracy, NI 9239E

Measurement Conditions	Percent of Reading (Gain Error)	Percent of Range* (Offset Error)
Calibrated max (–40 to 70 °C)	±0.13%	±0.06%
Calibrated typ (25 °C, ±5 °C)	±0.03%	±0.008%
Uncalibrated max (–40 to 70 °C)	±1.4%	±0.70%
Uncalibrated typ (25 °C, ±5 °C)	±0.3%	±0.11%
* Range equals 10.52 V		

Input noise

NI 9229E ..... 320 μV_{rms}

NI 9239E ..... 70 μV_{rms}

Stability

Gain drift ..... ±5 ppm/°C

Offset drift

NI 9229E..... ±150 µV/°C

NI 9239E..... ±26 µV/°C

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Post calibration gain match
(ch-to-ch, 20 kHz)..... 0.22 dB max

Crosstalk (1 kHz)..... –130 dB

Phase mismatch (ch-to-ch)

NI 9229E..... 0.045°/kHz max

NI 9239E..... 0.075°/kHz max

Phase mismatch (module-to-module, max)

NI 9229E..... $0.045°/kHz + 360° \cdot f_{in}/f_M$

NI 9239E..... $0.075°/kHz + 360° \cdot f_{in}/f_M$

Phase nonlinearity (f_s = 50 kS/s)..... 0.11° max

Input delay

NI 9229E..... $38.4/f_s + 2.6\ \mu s$

NI 9239E..... $38.4/f_s + 3\ \mu s$

Passband

Frequency..... $0.453 \cdot f_s$

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

Stopband

Frequency..... $0.547 \cdot f_s$

Rejection..... 100 dB

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

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

CMRR (f_{in} = 60 Hz)

- NI 9229E ..... 116 dB
- NI 9239E ..... 126 dB

SFDR (1 kHz, –60 dBFS) ..... 128 dBFS

Total Harmonic Distortion (THD)

- 1 kHz, –1 dBFS ..... –99 dB
- 1 kHz, –20 dBFS ..... –105 dB

MTBF ..... 662,484 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.

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Power Requirements

Power consumption from chassis

Active mode ..... 740 mW max

Sleep mode ..... 25 µW max

Thermal dissipation (at 70 °C)

Active mode ..... 760 mW max

Sleep mode ..... 16 mW max

Physical Characteristics

Use a dry, low-velocity stream of air to clean the module. If needed, use a soft-bristle brush for cleaning around components.

Note For two-dimensional drawings and three-dimensional models of the C Series module and connectors, visit `ni.com/dimensions` and search by module number.

Screw-terminal wiring ..... 16 to 28 AWG copper conductor wire with 7 mm (0.28 in.) of insulation stripped from the end

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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 ..... 50 g (1.8 oz)

Safety

Isolation Voltages

Connect only voltages that are within the following limits.

Channel-to-channel

- Continuous ..... 250 V_{rms}, Measurement Category II, (Basic insulation)
- Withstand ..... 1,390 V_{rms}, verified by a 5 s dielectric withstand test

Channel-to-earth ground

- Continuous ..... 250 V_{rms}, Measurement Category II, (Double insulation)
- Withstand ..... 2,300 V_{rms}, verified by a 5 s dielectric withstand test

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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 9229E/9239E to signals or use for measurements within Measurement Categories III or IV.

Safety Standards

This product meets the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use when installed in a suitable enclosure:

- 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 the *Online Product Certification* section.

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

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 85 °C

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

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

Storage humidity
(IEC 60068-2-56)..... 5 to 95% RH, noncondensing

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Maximum altitude..... 2,000 m

Pollution Degree (IEC 60664) 2

Environmental Management

National Instruments 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 *NI and the Environment* 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 life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit `ni.com/environment/weee`.

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Calibration

You can obtain the calibration certificate and information about calibration services for the NI 9229E/9239E at `ni.com/calibration`.

Calibration interval ..... 1 year

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Where to Go for Support

The National Instruments Web site 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.

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