NI-9231 Getting Started

2025-03-13

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NI-9231 Pinout

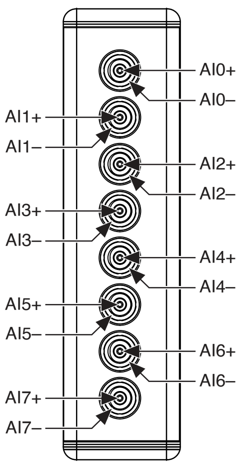
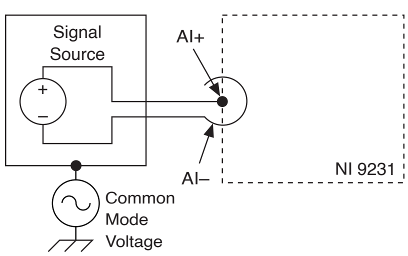


Table 1. Signal Descriptions

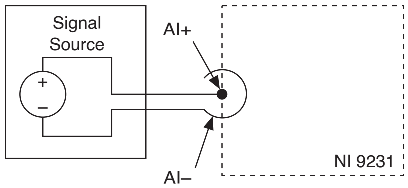
Signal	Description
AI+	Positive analog input signal connection
AI-	Negative analog input signal connection

Grounded Connections



Make sure the voltage on the AI+ and AI- connections are in the channel-to-earth safety voltage range to ensure proper operation.

Floating Connections



NI-9231 Connection Guidelines

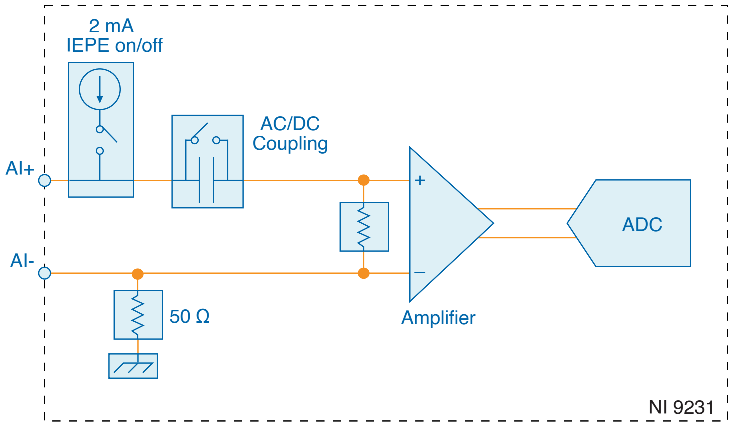
- Make sure that devices you connect to the NI-9231 are compatible with the module specifications.

> **Note** Electromagnetic interference can adversely affect the measurement accuracy of the NI-9231. The input ports of this device are not protected for electromagnetic interference. As a result, this device may experience reduced input or other temporary performance degradation when connected cables are routed in an environment with conducted radio frequency electromagnetic interference.

Integrated Electronic Piezoelectric (IEPE) Sensors

The NI-9231 provides an IEPE excitation current for each channel to measure the IEPE sensors. Typical IEPE sensors have a case that is electrically isolated from the IEPE electronics. As a result, connecting the sensor to the NI-9231 results in a floating connection even though the case of the sensor is grounded.

NI-9231 Block Diagram



- Input signals on each channel are buffered, conditioned, and then sampled by an ADC.
- Each AI channel provides an independent signal path to the ADC, enabling you to sample all channels simultaneously.
- AI channels are referenced to earth ground through a protected 50 Ω resistor.
- AC/DC coupling is software-selectable.
- IEPE excitation current is software-selectable.
- The module protects each channel from overvoltages.

Note The NI-9231 also has TEDS circuitry. For more information about TEDS, visit ni.com/info and enter the Info Code `rdteds`.

Filtering

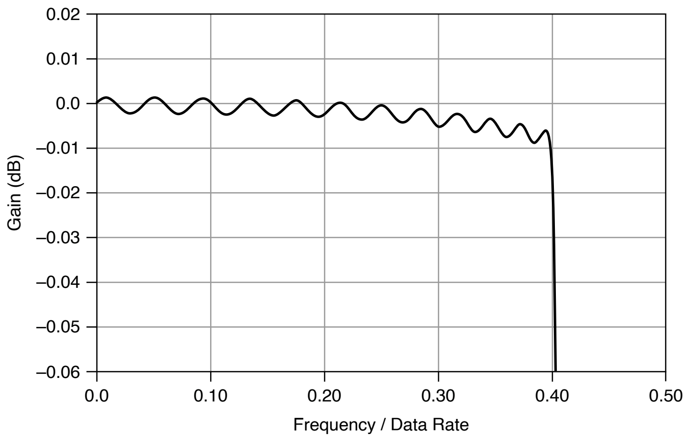
The NI-9231 uses a combination of analog and digital filtering to provide an accurate representation of in-band signals and reject out-of-band signals. The filters discriminate between signals based on the frequency range, or bandwidth, of the signal. The three important bandwidths to consider are the passband, the stopband, and the anti-imaging bandwidth.

The NI-9231 represents signals within the passband, as quantified primarily by passband ripple 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-9231 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 1. Typical Passband Flatness in DC Coupling for the NI-9231 at the Maximum Data Rate



Note The passband flatness improves at lower sample rates compared to the graph.

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 signals that appear in the alias-free bandwidth are not aliased artifacts 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. The alias-free bandwidth is equal to the data rate minus the stopband frequency.

Data Rates

The frequency of a master timebase (f_M) controls the data rate (f_S) of the NI-9231. The NI-9231 includes an internal master timebase with a frequency of 13.1072 MHz. Using the internal master timebase of 13.1072 MHz results in data rates of 51.2 kS/s, 34.133 kS/s, 25.6 kS/s, 17.067 kS/s, and so on down to 267 S/s, depending on the decimation rate and the value of the clock divider. However, the data rate must remain within the appropriate data rate range.

The following equation provides the available data rates of the NI-9231:

$$f_s = \frac{f_M}{4 \times a \times b}$$

where

- a is the decimation rate (32, 64, 128, 256, 512, 1024), and b is the clock divider (integer between 1 and 12).
- when the value of b is 1, the value of a can be 64, 128, 256, 512, or 1024.
- when the value of b is between 2 and 12, the value of a can be 32, 64, 128, 256, 512, or 1024.

> **Note**
>
> $\frac{f_M}{b}$
>
> must be greater than or equal to 1 MHz.

There are multiple combinations of clock dividers and decimation rates that yield the same data rate. The software always picks the highest decimation rate for the selected data rate for better noise performance. The following table lists available data rates with the internal master timebase.

Table 2. Available Data Rates with the Internal Master Timebase

f_S (kS/s)	Decimation Rate	Clock Divider
51.200	64	1
34.133	32	3
25.600	128	1

f_s (kS/s)	Decimation Rate	Clock Divider
20.480	32	5
17.067	64	3
14.629	32	7
12.800	256	1
11.378	32	9
10.240	64	5
9.309	32	11
8.533	128	3
7.314	64	7
6.400	512	1
5.689	64	9
5.120	128	5
4.655	64	11
4.267	256	3
3.657	128	7
3.200	1024	1
2.844	128	9
2.560	256	5
2.327	128	11
2.133	512	3
1.829	256	7
1.600	1024	2
1.422	256	9
1.280	512	5
1.164	256	11
1.067	1024	3
0.914	512	7

f_s (kS/s)	Decimation Rate	Clock Divider
0.800	1024	4
0.711	512	9
0.640	1024	5
0.582	512	11
0.533	1024	6
0.457	1024	7
0.400	1024	8
0.356	1024	9
0.320	1024	10
0.291	1024	11
0.267	1024	12

The NI-9231 also can accept an external master timebase or export its own master timebase. To synchronize the data rate of an NI-9231 with other modules that use master timebases to control sampling, all of the modules must share a single master timebase source. When using an external timebase with a frequency other than 13.1072 MHz, the NI-9231 has a different set of data rates. Refer to the software help for information about configuring the master timebase source for the NI-9231.

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

Note The cRIO-9151R Series Expansion chassis has different maximum data rates from the CompactRIO and CompactDAQ chassis. Refer to the ***Input Characteristics*** section for detailed information.

Conformal Coating

The NI-9231 is available with conformal coating for additional protection in corrosive and condensing environments, including environments with molds and dust.

In addition to the environmental specifications listed in the ***NI-9231 Safety, Environmental, and Regulatory Information***, the NI-9231 with conformal coating meets the following specification for the device temperature range. To meet this specification, you must follow the appropriate setup requirements for condensing environments. Refer to ***Conformal Coating and NI RIO Products*** for more information about conformal coating and the setup requirements for condensing environments.

Operating humidity (IEC 60068-2-30 Test Db)	80 to 100% RH, condensing

Related information:

- Conformal Coating and NI RIO Products

