
NI-9231

Specifications

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NI-9231 Specifications

Definitions

Warranted specifications describe the performance of a model under stated operating conditions and are covered by the model warranty.

Characteristics describe values that are relevant to the use of the model under stated operating conditions but are not covered by the model warranty.

- *Typical* specifications describe the performance met by a majority of models.
- *Nominal* specifications describe an attribute that is based on design, conformance testing, or supplemental testing.

Specifications are *Typical* unless otherwise noted.

Related information:

- [Software Support for CompactRIO, CompactDAQ, Single-Board RIO, R Series, and EtherCAT](#)

Conditions

Specifications are valid under the following conditions unless otherwise noted.

- -40 °C to 70 °C

NI-9231 Pinout

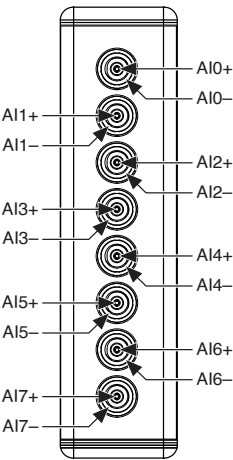


Table 1. Signal Descriptions

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

Input Characteristics

Number of channels	8 analog input channels
ADC resolution	24 bits
Type of ADC	Delta-Sigma with analog prefiltering
Sampling mode	Simultaneous
Input coupling	Software-selectable AC/DC
Type of TEDS supported	IEEE 1451.4 TEDS Class I

TEDS capacitive drive	5,000 pF
Internal master timebase (f_M)	
Frequency	13.1072 MHz
Accuracy	±100 ppm maximum
CompactRIO & CompactDAQ chassis data rate range (f_s)	
Using internal master timebase	
Minimum	267 S/s
Maximum	51.2 kS/s
Using external master timebase	
Minimum	244.141 S/s
Maximum	51.367 kS/s
R Series Expansion chassis data rate range (f_s)	
Using internal master timebase	
Minimum	267 S/s
Maximum	25.6 kS/s
Using external master timebase	

Minimum	244.141 S/s
Maximum	25.684 kS/s
Data rate	$f_s = \frac{f_M}{4 \times a \times b}$
Input delay	$34/f_s + 3.0 \mu\text{s}$
Overvoltage protection	$\pm 30 \text{ V}$ maximum on one channel at a time
Input impedance	
AI+ to chassis	$918 \text{ k}\Omega \parallel 135 \text{ pF}$
AI- to chassis	50Ω
Input voltage range	
Minimum	$\pm 5 \text{ V peak}$
Typical	$\pm 5.1 \text{ V peak}$
Scaling coefficient	610,715 pV/LSB
Maximum input voltage	
AI+ to Ground	$\pm 5.16 \text{ V peak}$

AI- to Ground	+0.7 V/-0.2 V
IEPE excitation current (software-selectable on/off)	
Minimum	2 mA
Typical	2.09 mA
IEPE excitation noise	75 nArms at 51.2 kS/s
IEPE compliance voltage	19 V maximum



Note

If you are using an IEPE sensor, use the following equation to make sure your configuration meets the IEPE compliance voltage range.

$(V_{\text{common-mode}} + V_{\text{bias}} \pm V_{\text{full-scale}})$ must be 0 V to 19 V

where

- $V_{\text{common-mode}}$ is the common-mode voltage applied to the NI-9231
- V_{bias} is the bias voltage of the IEPE sensor
- $V_{\text{full-scale}}$ is the full-scale voltage of the IEPE sensor

IEPE Diagnostic Feature	
Open Loop Detection	IEPE Current, <2 mA

Short Circuit Detection	AI+ to Ground, <1.2 V
High pass filter cutoff frequency (AC)	
-3 dB	1.2 Hz
-0.1 dB	7.9 Hz

Figure 1. High Pass Filter Frequency Response

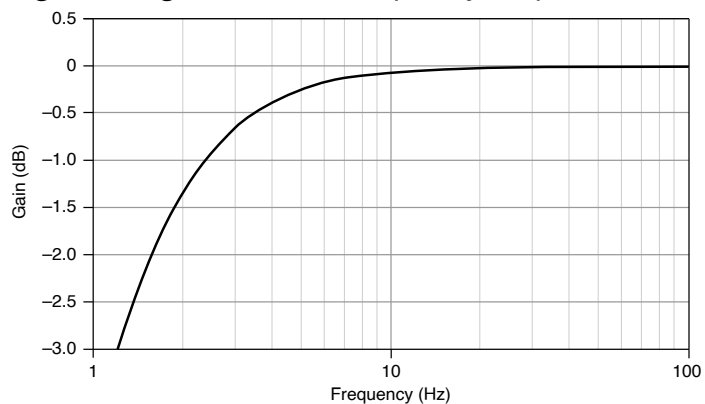


Table 2. Accuracy in DC Coupling

Measurement Conditions	Percent of Reading (Gain Error)	Percent of Range ¹ (Offset Error)
Maximum (-40 °C to 70 °C)	±0.220%	±0.075%
Typical (23 °C, ±5 °C)	±0.039%	±0.016%

Offset error (AC coupling)	±0.151%, maximum
Stability of Accuracy	
Gain drift	3.7 ppm/°C; 22.4 ppm/°C, maximum

1. Range equals 5 V peak

Offset drift	8.6 μV/°C; 34.8 μV/°C, maximum	
Passband, -0.1 dB		
Frequency	0.4 * f _S	
Flatness (peak-to-peak), DC to 20 kHz	0.035 dB, maximum	
Phase linearity		
DC coupling, DC to 20 kHz	0.06°, maximum	
Channel-to-channel mismatch		
Gain, DC to 20 kHz	0.123 dB, maximum	
Phase (f _{in} in kHz)	f _{in} * 0.058°, maximum	
Stopband		
Frequency	0.499 * f _S	
Rejection	105 dB	
Alias free bandwidth	0.5 * f _S	
Alias rejection, at 2x oversample rate		
f _S = 51.2 kS/s	91 dB at 6.5536 MHz	

$f_s = 267 \text{ S/s}$	35 dB at 546 kHz
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Table 3. Idle Channel Noise

Data Rate (S/s)	Decimation Rate	AC or DC Coupling ($\mu\text{V RMS}$)	Spectral Noise Density ($\text{nV}/\sqrt{\text{Hz}}$) at 1 kHz
51,200	64	15.5	104
34,133	32	19.4	159
25,600	128	10.9	104
12,800	256	7.8	103
6,400	512	5.6	103
3,200	1,024	4.1	103



Note The noise specifications assume the NI-9231 is using the internal master timebase frequency of 13.1072 MHz.

Table 4. Dynamic Range (At 1 kHz Input Frequency, -60 dBFS amplitude, $\text{BW}=0.5 * f_s$)

Data Rate (S/s)	Decimation Rate	AC or DC Coupled (dBFS)
51,200	64	107
34,133	32	105
25,600	128	110
12,800	256	113
6,400	512	116
3,200	1,024	119

Crosstalk (CH to CH)	
$f_{in} \leq 1 \text{ kHz}$	-116 dB

$f_{in} \leq 10 \text{ kHz}$	-99 dB
CMRR, $f_{in} \leq 1 \text{ kHz}$	45 dB minimum

Table 5. Total Harmonic Distortion (THD) at 51.2 kS/s

Input Amplitude	1 kHz	10 kHz
-1 dBFS	-103 dBc	-83 dBc
-10.97 dBFS	-107 dBc	-88 dBc

Intermodulation distortion (IMD) ²	
DIN 250 Hz + 8 kHz	-89 dB
CCIF 14 kHz + 15 kHz	-79 dB
Non-harmonic SFDR ³	133 dBFS

NI-9231 with 10-32 Coaxial Jack Safety Voltages

Connect only voltages that are within the following limits:

Channel-to-earth ground	$\pm 30 \text{ V}$ maximum, Measurement Category I
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2. Test standards:

- DIN 250 Hz + 8 kHz, amplitude ratio 4:1 with total amplitude at 0 dBFS
- CCIF 14 kHz + 15 kHz, amplitude ratio 1:1 with each tone amplitude at -6 dBFS

Up to fifth order harmonic

3. Tested with 1 kHz-60 dBFS input at 51.2 kS/s

Isolation	
Channel-to-channel	None
Channel-to-earth ground	None



Caution Do not connect the NI-9231 to signals or use for measurements within Measurement Categories II, III, or IV.



Attention Ne connectez pas le NI-9231 à des signaux et ne l'utilisez pas pour effectuer des mesures dans les catégories de mesure II, III ou IV.



Warning Do not connect the product to signals or use for measurements within Measurement Categories II, III, or IV, or for measurements on MAINS circuits or on circuits derived from Overvoltage Category II, III, or IV which may have transient overvoltages above what the product can withstand. The product must not be connected to circuits that have a maximum voltage above the continuous working voltage, relative to earth or to other channels, or this could damage and defeat the insulation. The product can only withstand transients up to the transient overvoltage rating without breakdown or damage to the insulation. An analysis of the working voltages, loop impedances, temporary overvoltages, and transient overvoltages in the system must be conducted prior to making measurements.



Mise en garde Ne pas connecter le produit à des signaux dans les catégories de mesure II, III ou IV et ne pas l'utiliser pour des mesures dans ces catégories, ou des mesures sur secteur ou sur des circuits dérivés de surtensions de catégorie II, III ou IV pouvant présenter des surtensions transitoires supérieures à ce que le produit peut supporter. Le produit ne doit pas être raccordé à des circuits ayant une tension maximale supérieure à la tension de fonctionnement continu, par rapport à la terre ou à d'autres voies, sous peine d'endommager et de compromettre l'isolation. Le produit peut tomber en panne et son isolation risque d'être endommagée si les tensions

transitoires dépassent la surtension transitoire nominale. Une analyse des tensions de fonctionnement, des impédances de boucle, des surtensions temporaires et des surtensions transitoires dans le système doit être effectuée avant de procéder à des mesures.

Measurement 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.



Note Measurement Categories CAT I and CAT O are equivalent. These test and measurement circuits are for other circuits not intended for direct connection to the MAINS building installations of Measurement Categories CAT II, CAT III, or CAT IV.

Environmental Characteristics

Temperature		
Operating		-40 °C to 70 °C
Storage		-40 °C to 85 °C
Humidity		
Operating	10% RH to 90% RH, noncondensing	
Storage	5% RH to 95% RH, noncondensing	
Ingress protection		IP40

Pollution Degree	2
Maximum altitude	5,000 m
Shock and Vibration	
Operating vibration	
Random	5 g RMS, 10 Hz to 500 Hz
Sinusoidal	5 g, 10 Hz to 500 Hz
Operating shock	30 g, 11 ms half sine; 50 g, 3 ms half sine; 18 shocks at 6 orientations

To meet these shock and vibration specifications, you must panel mount the system.

Power Requirements

Power consumption from chassis	
Active mode	1.00 W maximum
Sleep mode	53 μ W maximum
Thermal dissipation (at 70 °C)	
Active mode	1.40 W maximum
Sleep mode	0.13 W maximum

Physical Characteristics

Dimensions	Visit ni.com/dimensions and search by module number.
Weight	164 g (5.8 oz)

Calibration

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

Calibration Interval	2 years
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