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# 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 for the range -40 °C to 70 °C unless otherwise noted.

## 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	
<b>Internal master timebase (<math>f_M</math>)</b>		
Frequency	13.1072 MHz	
Accuracy	$\pm 100$ ppm maximum	
<b>CompactRIO &amp; CompactDAQ chassis data rate range (<math>f_s</math>)</b>		
<b>Using internal master timebase</b>		
Minimum	267 S/s	
Maximum	51.2 kS/s	
<b>Using external master timebase</b>		
Minimum	244.141 S/s	

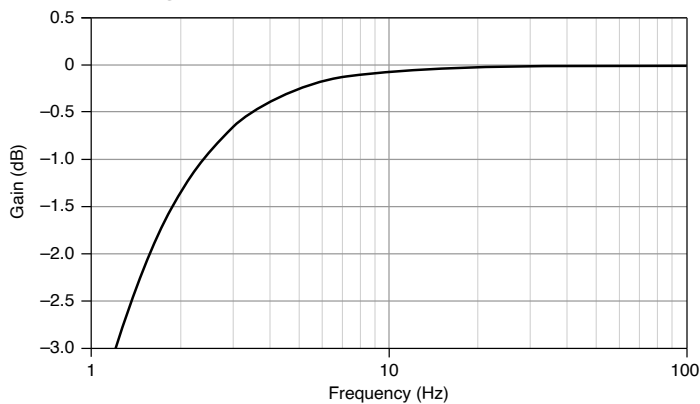
Maximum	51.367 kS/s	
<b>R Series Expansion chassis data rate range (<math>f_s</math>)</b>		
<b>Using internal master timebase</b>		
Minimum	267 S/s	
Maximum	25.6 kS/s	
<b>Using external master timebase</b>		
Minimum	244.141 S/s	
Maximum	25.684 kS/s	
Data rate		$f_s = \frac{f_M}{4 \times a \times b}$
Input delay		$34/f_s + 3.0 \mu\text{s}$
Overvoltage protection		$\pm 30 \text{ V}$ maximum on one channel at a time
<b>Input impedance</b>		
AI+ to chassis	918 k $\Omega$    135 pF	
AI- to chassis	50 $\Omega$	
<b>Input voltage range</b>		

Minimum	±5 V peak	
Typical	±5.1 V peak	
Scaling coefficient	610,715 pV/LSB	
<b>Maximum input voltage</b>		
AI+ to Ground	±5.16 V peak	
AI- to Ground	+0.7 V/-0.2 V	
<b>IEPE excitation current (software-selectable on/off)</b>		
Minimum	2 mA	
Typical	2.09 mA	
IEPE excitation noise	75 nArms at 51.2 kS/s	
IEPE compliance voltage <sup>1</sup>	19 V maximum	
<p>If you are using an IEPE sensor, use the following equation to make sure your configuration meets the IEPE compliance voltage range.</p> <p><math>(V_{\text{common-mode}} + V_{\text{bias}} \pm V_{\text{full-scale}})</math> must be 0 V to 19 V</p> <p>where</p> <ul style="list-style-type: none"> <li>• <math>V_{\text{common-mode}}</math> is the common-mode voltage applied to the NI-9231</li> <li>• <math>V_{\text{bias}}</math> is the bias voltage of the IEPE sensor</li> <li>• <math>V_{\text{full-scale}}</math> is the full-scale voltage of the IEPE sensor</li> </ul>		

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<b>IEPE Diagnostic Feature</b>	
Open Loop Detection	IEPE Current, <2 mA
Short Circuit Detection	AI+ to Ground, <1.2 V
<b>High pass filter cutoff frequency (AC)</b>	
-3 dB	1.2 Hz
-0.1 dB	7.9 Hz

**Figure 1. High Pass Filter Frequency Response**



**Table 1. Accuracy in DC Coupling**

Measurement Conditions	Percent of Reading (Gain Error)	Percent of Range <sup>2</sup> (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
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**Stability of Accuracy**

2. Range equals 5 V peak

Gain drift	3.7 ppm/°C; 22.4 ppm/°C, maximum	
Offset drift	8.6 $\mu\text{V}/^\circ\text{C}$ ; 34.8 $\mu\text{V}/^\circ\text{C}$ , maximum	
<b>Passband, -0.1 dB</b>		
Frequency	$0.4 * f_s$	
Flatness (peak-to-peak), DC to 20 kHz	0.035 dB, maximum	
<b>Phase linearity</b>		
DC coupling, DC to 20 kHz	0.06°, maximum	
<b>Channel-to-channel mismatch</b>		
Gain, DC to 20 kHz	0.123 dB, maximum	
Phase ( $f_{in}$ in kHz)	$f_{in} * 0.058^\circ$ , maximum	
<b>Stopband</b>		
Frequency	$0.499 * f_s$	
Rejection	105 dB	
Alias free bandwidth	$0.5 * f_s$	
<b>Alias rejection, at 2x oversample rate</b>		



$f_s = 51.2 \text{ kS/s}$	91 dB at 6.5536 MHz
$f_s = 267 \text{ S/s}$	35 dB at 546 kHz

**Table 2.** 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 3.** 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 4.** 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) <sup>3</sup>	
DIN 250 Hz + 8 kHz	-89 dB
CCIF 14 kHz + 15 kHz	-79 dB
Non-harmonic SFDR <sup>4</sup>	133 dBFS

## NI-9231 with 10-32 Coaxial Jack Safety Voltages

Connect only voltages that are within the following limits:

### 3. 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

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

Channel-to-earth ground	±30 V maximum, Measurement Category I
<b>Isolation</b>	
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
<b>Shock and Vibration</b>	
<b>Operating vibration</b>	
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

<b>Power consumption from chassis</b>	
Active mode	1.00 W maximum
Sleep mode	53 $\mu$ W maximum
<b>Thermal dissipation (at 70 °C)</b>	
Active mode	1.40 W maximum

Sleep mode	0.13 W maximum
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## Physical Characteristics

Dimensions	Visit <a href="https://ni.com/dimensions">ni.com/dimensions</a> and search by module number.
Weight	164 g (5.8 oz)