

# NI 447x Specifications

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This document lists specifications for the NI 447x Dynamic Signal Acquisition (DSA) devices including the NI PXI/PCI-4472 (NI 4472), NI PCI-4474, and NI PXI/PCI-4472B (NI 4472B). These specifications are typical at 25 °C unless otherwise stated. The system must be allowed to warm up for 15 minutes to achieve the rated accuracy. All specifications are subject to change without notice. Visit [ni.com/manuals](http://ni.com/manuals) for the most current specifications and product documentation.



**Caution** The inputs of this sensitive test and measurement product are not protected for electromagnetic interference for functional reasons. As a result, this product may experience reduced measurement accuracy or other temporary performance degradation when cables are attached in an environment with electromagnetic interference present. Refer to the Declaration of Conformity (DoC) for this product for details of the standards applied to assess electromagnetic compatibility performance. To obtain the DoC, visit [ni.com/certification](http://ni.com/certification), search by model number or product line, and click the appropriate link in the Certification column.



**Note** Keep the filler panels on all unused slots in your chassis or computer to maintain forced air cooling.

## Analog Input

### Channel Characteristics

Number of channels		Sample rates ( $f_s$ ), samples-per-second (S/s).....	102.4 kS/s down to 1.0 kS/s in 190.7 $\mu$ S/s increments for $f_s > 51.2$ kS/s or 95.37 $\mu$ S/s increments for $f_s \leq 51.2$ kS/s
NI 4472/4472B .....	8, simultaneously sampled		
NI PCI-4474 .....	4, simultaneously sampled		
Input configuration .....	Pseudodifferential		
Input coupling .....	AC or DC, software-selectable	ADC modulator oversample rate	
A/D converter (ADC) resolution ....	24 bits	1.0 kS/s $\leq f_s \leq 51.2$ kS/s .....	128 $f_s$
ADC type .....	Delta-sigma	51.2 kS/s $< f_s \leq 102.4$ kS/s .....	64 $f_s$
		Sample Clock Timebase, low-frequency alias rejection disabled (default) <sup>1</sup>	
		1.0 kS/s $\leq f_s \leq 51.2$ kS/s .....	256 $f_s$
		51.2 kS/s $< f_s \leq 102.4$ kS/s .....	128 $f_s$

<sup>1</sup> Low-frequency alias rejection can be enabled at sample rates of 25.6 kS/s and lower for supported NI 447x devices. Refer to the *National Instruments Dynamic Signal Acquisition Help* for supported devices and more information.

Sample Clock Timebase, low-frequency alias rejection enabled

Sample Rate (kS/s)	Sample Clock Timebase
$1.0 \leq f_s \leq 1.6$	$8,192 f_s$
$1.6 < f_s \leq 3.2$	$4,096 f_s$
$3.2 < f_s \leq 6.4$	$2,048 f_s$
$6.4 < f_s \leq 12.8$	$1,024 f_s$
$12.8 < f_s \leq 25.6$	$512 f_s$
$25.6 < f_s \leq 51.2$	$256 f_s$
$51.2 < f_s \leq 102.4$	$128 f_s$

FIFO buffer size .....1,023 samples

Data transfers.....DMA

Overvoltage protection

Positive input ..... $\pm 42.4 V_{pk}$

Negative input (shield).....Not protected

External trigger .....Not protected

Frequency accuracy .....  $\pm 25$  ppm

Input signal range.....  $\pm 10 V_{pk}$

### Transfer Characteristics

DC-coupled offset (residual) .....  $\pm 3$  mV, max

Gain (amplitude accuracy).....  $\pm 0.1$  dB, max,  $f_{in} = 1$  kHz

### Amplifier Characteristics

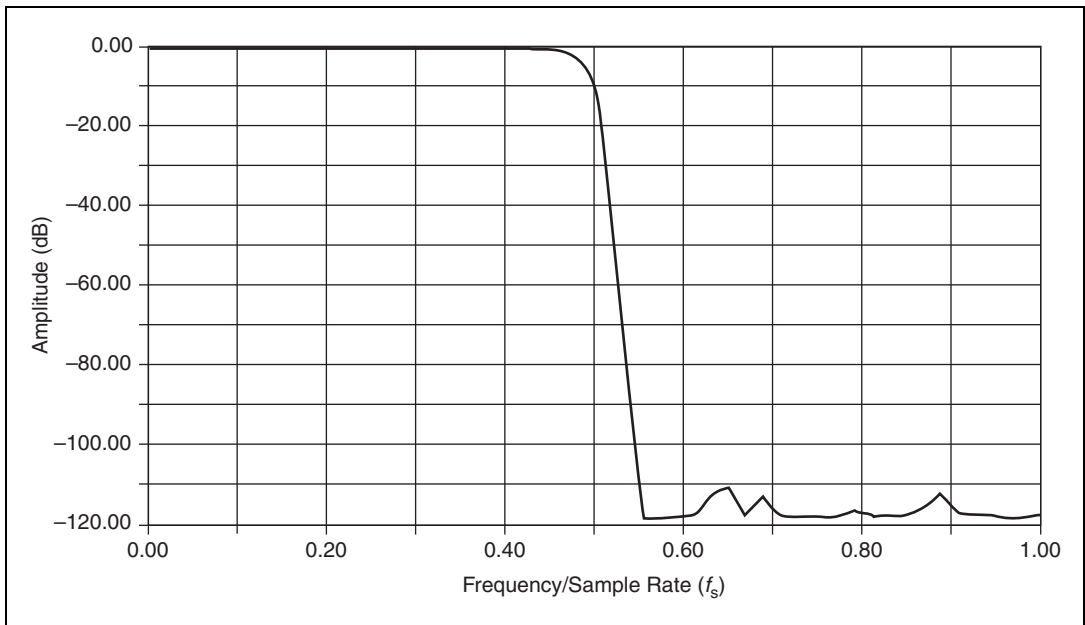
Input Impedance (Ground Referenced)	Pseudodifferential Configuration
Between positive input and chassis ground (NI 447x all revisions and NI PXI-4472B revision G and earlier)	$1 M\Omega \parallel 60$ pF
Between positive input and chassis ground (NI PXI-4472B revision H and later)	$10 M\Omega \parallel 60$ pF
Between negative input and chassis ground	$50 \Omega \parallel 0.02 \mu F$

Common-mode rejection ratio (CMRR)

Input frequency ( $f_{in}$ ) < 1 kHz..... 60 dB

### Dynamic Characteristics

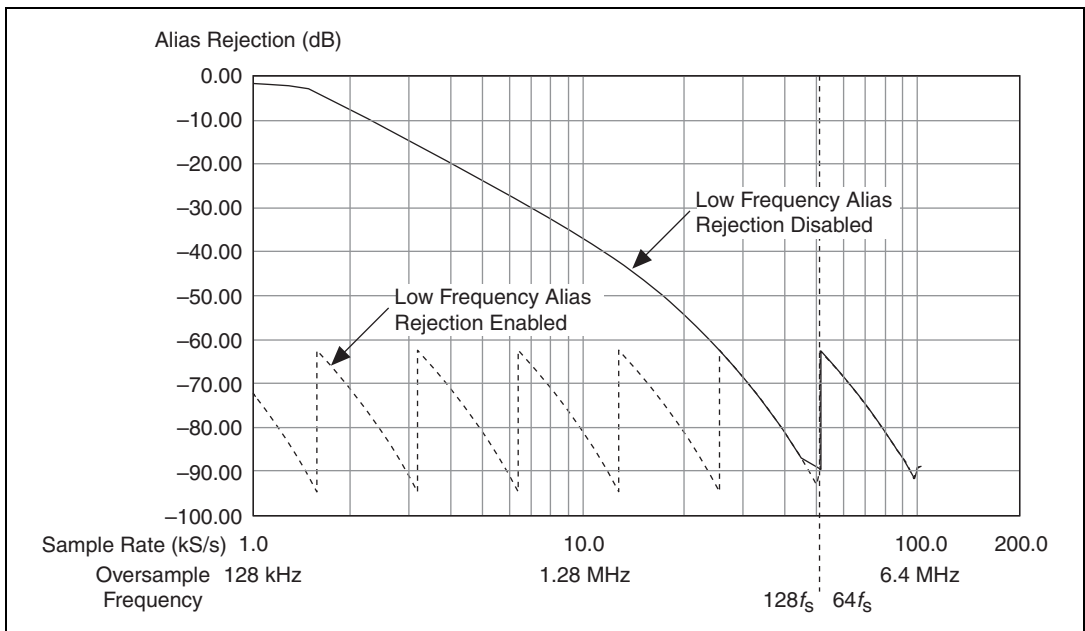
Specification	Low-Frequency Alias Rejection Disabled (Default)	Low-Frequency Alias Rejection Enabled
Alias-free bandwidth (BW) (passband)	DC to $0.4535 f_s$	DC to $0.4 f_s$
Alias rejection, minimum	110 dBc	104 dBc
Alias rejection by frequency	$0.5465 f_s < \text{input frequency} < 127.4535 f_s$ , where $1.0 \text{ kS/s} \leq f_s \leq 51.2 \text{ kS/s}$  $0.5465 f_s < \text{input frequency} < 63.4535 f_s$ , where $51.2 \text{ kS/s} < f_s \leq 102.4 \text{ kS/s}$	Input frequency $> 0.6 f_s$
-3 dB BW	$0.491 f_s$	$0.4863 f_s$



**Figure 1.** Digital Filter Input Frequency Response

Aliasing can occur for frequencies around multiples of 128 or 64  $f_s$  with low-frequency alias rejection disabled. In Figure 2, the solid line shows the amount of rejection for signals that appear in the  $f_s$ -wide windows around multiples of 128 or 64  $f_s$ .

The dashed line shows the improvement achieved with low-frequency alias rejection enabled. Refer to the *National Instruments Dynamic Signal Acquisition Help* for more information.



**Figure 2.** Analog Filter Alias Rejection at Oversample Rates

ADC Filter Delay

Low-Frequency Alias Rejection Disabled (Default)		Low-Frequency Alias Rejection Enabled	
Sample Rate (kS/s)	Filter Delay (Samples)	Sample Rate (kS/s)	Filter Delay (Samples)
$1.0 \leq f_s \leq 1.6$	38.7	$1.0 \leq f_s \leq 1.6$	32
$1.6 < f_s \leq 3.2$		$1.6 < f_s \leq 3.2$	32
$3.2 < f_s \leq 6.4$		$3.2 < f_s \leq 6.4$	32
$6.4 < f_s \leq 12.8$		$6.4 < f_s \leq 12.8$	33.675
$12.8 < f_s \leq 25.6$		$12.8 < f_s \leq 25.6$	35.35
$25.6 < f_s \leq 102.4$		$25.6 < f_s \leq 102.4$	38.7

AC –3 dB cut-off frequency

NI 447x .....3.4 Hz  
 NI 4472B.....0.5 Hz

Flatness, relative to 1 kHz, DC coupled, for sample rate

$1.0 \text{ kS/s} \leq f_s \leq 51.2 \text{ kS/s}$ .....  $\pm 0.03 \text{ dB}$ , max  
 $51.2 \text{ kS/s} < f_s \leq 102.4 \text{ kS/s}$ .....  $\pm 0.1 \text{ dB}$ , max

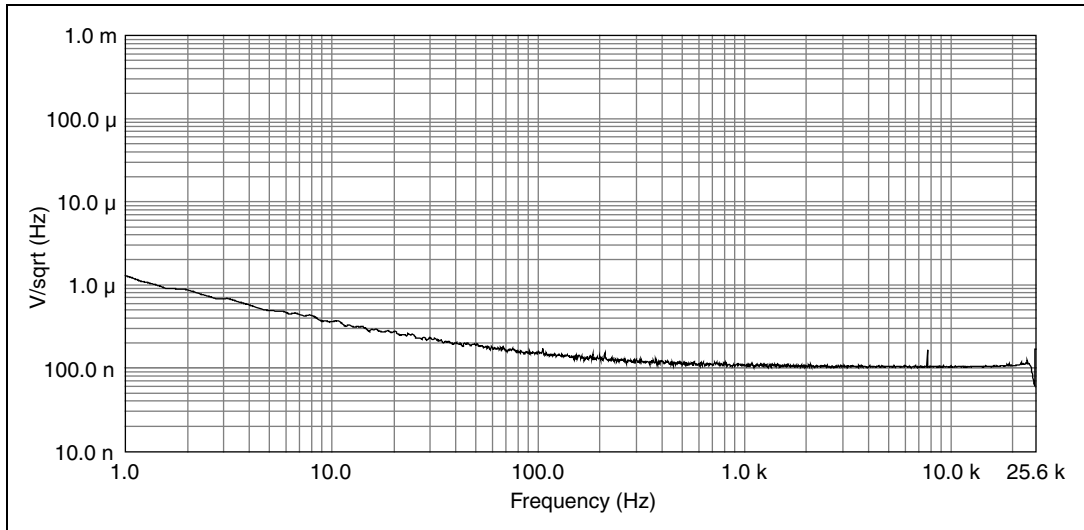
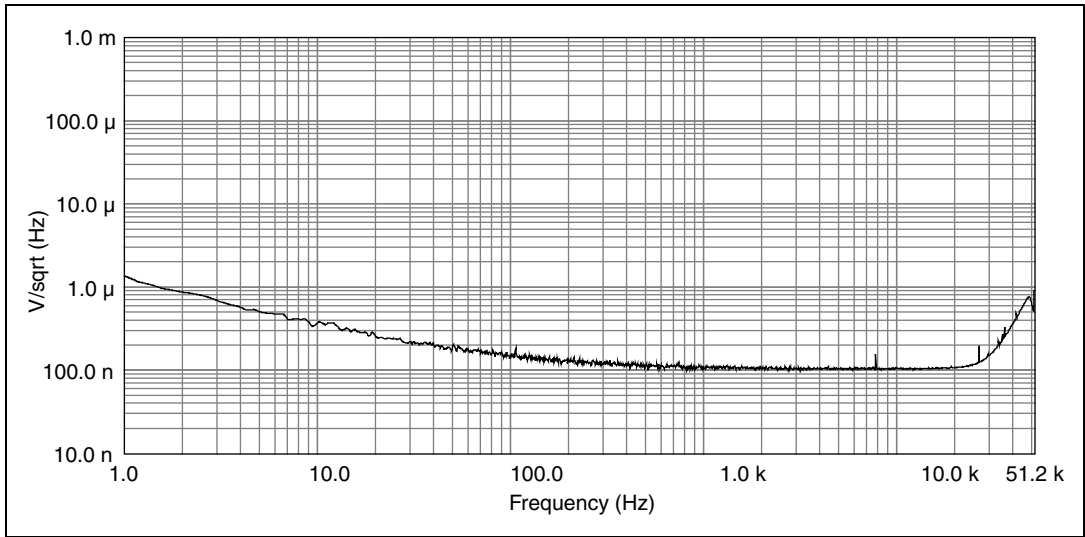


Figure 3. Input Noise Spectral Density at 128-Times Oversampling (50 Ω Connected at Input)

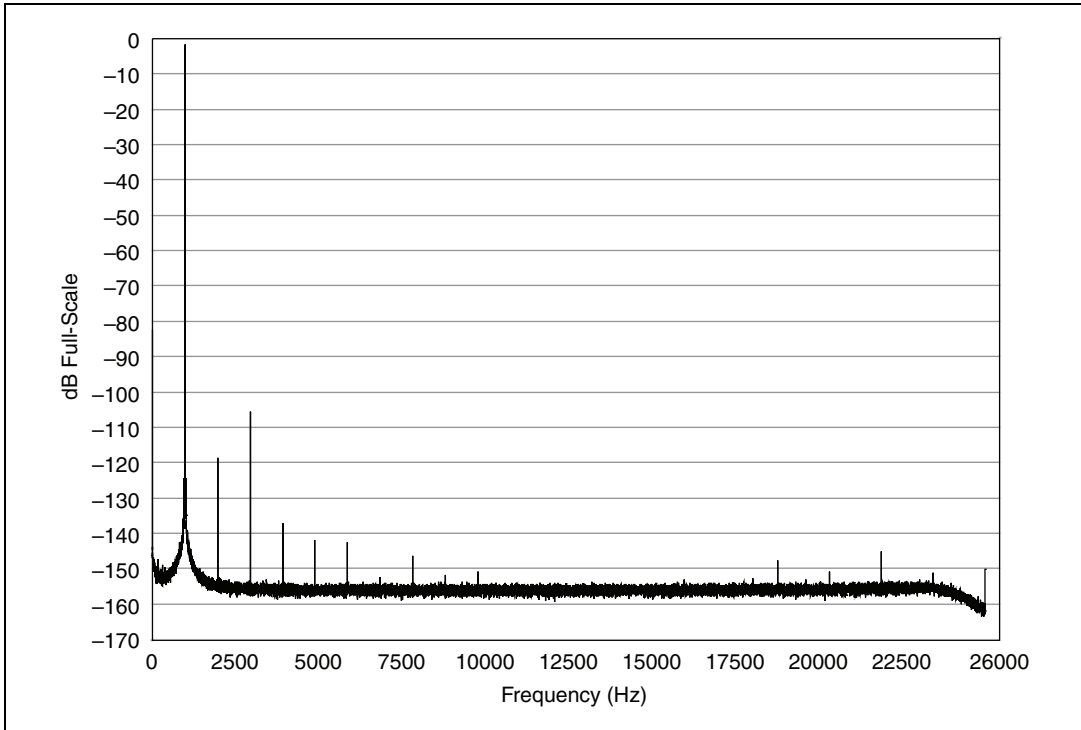


**Figure 4.** Input Noise Spectral Density at 64-Times Oversampling (50  $\Omega$  Connected at Input)

Idle channel noise, for sample rate

$f_s = 51.2$  kS/s,  
 bandwidth = 25.6 kHz ..... -94 dBV<sub>rms</sub>  
 $f_s = 102.4$  kS/s,  
 bandwidth = 51.2 kHz ..... -81 dBV<sub>rms</sub>

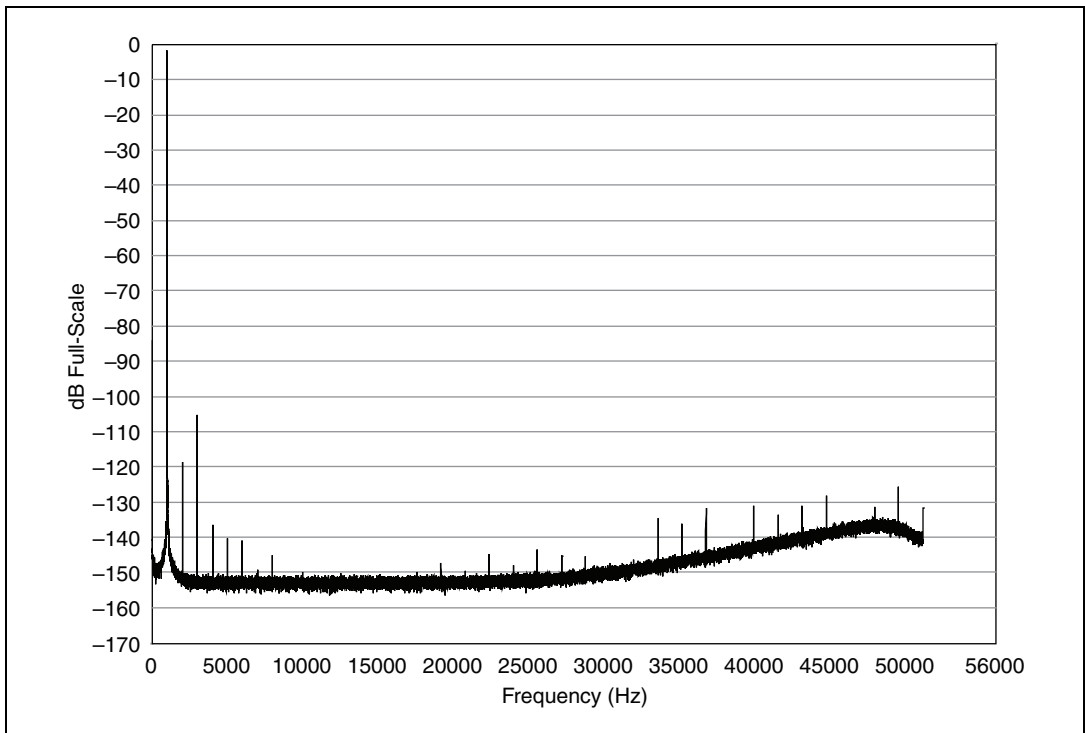
Spurious free dynamic range<sup>1,2</sup> .....104 dB



**Figure 5.** SFDR 51.2 kS/s (-1 dBFS, 1 kHz Sine Wave Input, FFT Size 131,072 Samples, Five Averages)

<sup>1</sup> Measurement includes all harmonics.

<sup>2</sup> 1 kHz input tone, input amplitude is -1 dBFS or 8.91 V<sub>pk</sub>.



**Figure 6.** SFDR 102.4 kS/s (-1 dBFS, 1 kHz Sine Wave Input, FFT Size 131,072 Samples, Five Averages)

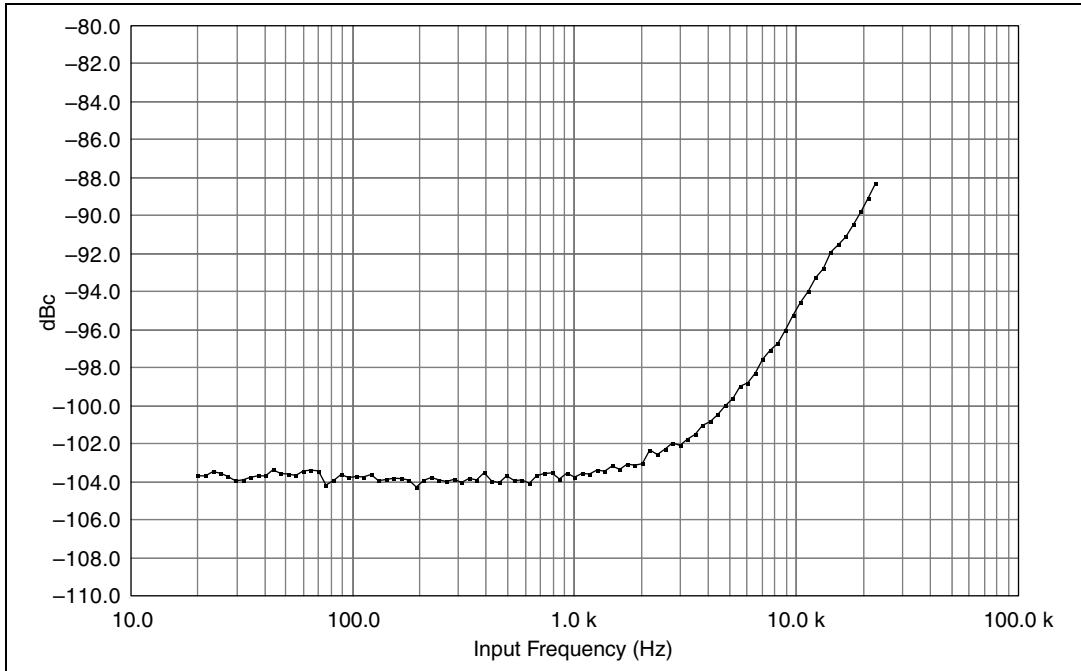
Dynamic range,<sup>1,2</sup> for sample rate

1.0 kS/s  $\leq f_s \leq$  51.2 kS/s..... 111 dB

51.2 kS/s  $< f_s \leq$  102.4 kS/s..... 99 dB

<sup>1</sup> Bandwidth equals  $0.4535 f_s$  starting from 20 Hz.

<sup>2</sup> 1 kHz input tone, input amplitude is -60 dBFS.



**Figure 7.** THD (Unbalanced Source, 102.4 kS/s),  
-1 dBFS Input Sine Wave, DC Coupled

THD+N<sup>2</sup> ..... -97 dBc  
 IMD ..... -100 dBc  
 (CCIF 14 kHz + 15 kHz)

Crosstalk (Channel Separation)*, †	Shorted Input	1 kΩ Load
Adjacent channels	<-90 dB	<-80 dB
Other channel combinations	<-100 dB	<-90 dB

\* Measured with full-scale (±10 V) input.  
 †  $f_{in} = 0$  to 51.2 kHz

Interchannel gain mismatch, for sample rate  
 1.0 kS/s ≤  $f_s$  ≤ 51.2 kS/s ..... ±0.06 dB, max  
 51.2 kS/s <  $f_s$  ≤ 102.4 kS/s ..... ±0.2 dB, max

Interchannel phase mismatch ..... <  $f_{in}$  (in kHz) × 0.018° +  
 0.082°

Phase linearity ..... < ±0.5°

**Onboard Calibration Reference**

DC level ..... 5.000 V ±2.5 mV  
 Temperature coefficient ..... ±5 ppm/°C max  
 Long-term stability ..... ±20 ppm/√1,000 h

**Integrated Electronic Piezoelectric (IEPE)**

Current ..... 0 or 4 mA, ±5%, each  
 channel independently  
 software selectable  
 Compliance ..... 24 V  
 Output impedance ..... >250 kΩ at 1 kHz  
 Current noise ..... <500 pA/√Hz

<sup>1</sup> 1 kHz input tone, input amplitude is -1 dBFS.  
<sup>2</sup> 1 kHz input tone, -1 dBFS, 50 kHz measurement bandwidth.



## Triggers

### Analog trigger

Purpose .....	Start trigger or reference
Source	
NI 4472/4472B .....	CH<0..7>
NI PCI-4474 .....	CH<0..3>
Level .....	Full scale, programmable
Slope .....	Positive (rising) or negative (falling), software-selectable
Resolution .....	24 bits
Hysteresis .....	Programmable

### Digital trigger

Purpose .....	Start or reference trigger
Compatibility .....	5 V TTL/CMOS
Polarity .....	Rising or falling edge
Minimum pulse width .....	100 ns

## General Specifications

### Bus Interface

PCI or PXI .....	3.3 V or 5 V signal environment
DMA channels .....	1, analog input

### Synchronization

#### PXI

PXI_STAR .....	Up to 14 devices per chassis
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#### PCI

RTSI .....	Up to 5 devices across ribbon cable
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### Power Requirements

#### +3.3 VDC

NI PCI-4472/4472B/4474 .....	0 mA
NI PXI-4472/4472B .....	400 mA, max

#### +5 VDC

NI PCI-4472/4472B .....	2,600 mA, max
NI PCI-4474 .....	2,000 mA, max
NI PXI-4472/4472B .....	2,000 mA, max

+12 VDC ..... 120 mA, max

-12 VDC ..... 120 mA, max

## Physical

### Dimensions (not including connectors)

NI PCI-4472/4472B/4474 .....	17.5 × 10.7 cm (6.9 × 4.2 in.)
NI PXI-4472/4472B .....	16.0 × 9.9 cm (6.3 × 3.9 in.) (1 3U CompactPCI slot)

### Weight

NI PCI-4472/4472B .....	198 g (7 oz)
NI PCI-4474 .....	184 g (6.5 oz)
NI PXI-4472/4472B .....	241 g (8.5 oz)

Analog I/O connectors .....SMB male

Digital trigger connector .....SMB male

## Environmental

### Operating Environment

#### Ambient temperature range

PXI-447x .....	0 to 55 °C (Tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.)
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PCI-447x .....	0 to 50 °C (Tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.)
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Relative humidity range ..... 10 to 90%,  
noncondensing  
(Tested in accordance  
with IEC-60068-2-56.)

Altitude ..... 2,000 m (at 25 °C ambient  
temperature)

Pollution Degree  
(indoor use only) ..... 2

### Storage Environment

Ambient temperature range ..... -20 to 70 °C  
(Tested in accordance  
with IEC-60068-2-1 and  
IEC-60068-2-2.)

Relative humidity range ..... 5 to 95%, noncondensing  
(Tested in accordance  
with IEC-60068-2-56.)

## Shock and Vibration (PXI Only)

Operational shock .....	30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC-60068-2-27. Test profile developed in accordance with MIL-PRF-28800F.)
Random vibration	
Operating .....	5 to 500 Hz, 0.3 g <sub>rms</sub>
Nonoperating .....	5 to 500 Hz, 2.4 g <sub>rms</sub> (Tested in accordance with IEC-60068-2-64. Nonoperating test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

## Calibration

Self-calibration .....	On software command, the device computes gain and offset corrections relative to high-precision internal reference
Interval .....	Recommended whenever ambient temperature differs from T <sub>cal</sub> by more than ±5 °C
External calibration interval .....	1 year
Warm-up time .....	15 minutes

## Maximum Working Voltage

Maximum working voltage refers to the signal voltage plus the common-mode voltage.

Channel-to-earth .....	42 V <sub>pk</sub> , Measurement Category I
Channel-to-channel .....	42 V <sub>pk</sub> , Measurement Category I



**Caution** Do *not* use the NI 447x for connections to signals or for measurements within Categories II, III, or IV.

## Safety

This product meets 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 the *Online Product Certification* section.

## Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- EN 61326 (IEC 61326): Class A emissions; Basic immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions



**Note** For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.



**Note** For EMC compliance, operate this device with shielded cables.



**Note** For EMC compliance, operate this product according to the documentation.

## CE Compliance

This product meets the essential requirements of applicable European Directives as follows:

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

## 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](http://ni.com/certification), search by model 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.

For additional environmental information, refer to the *NI and the Environment* Web page at [ni.com/environment](http://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](http://ni.com/environment/weee).

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