NI 447*X* Specifications

This document lists specifications for the NI 447*X* 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` for the most current specifications and product documentation.

Note Be sure to 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

NI 4472/4472B ..... 8, simultaneously sampled

NI PCI-4474..... 4, simultaneously sampled

Input configuration..... Pseudodifferential

Input coupling ..... AC or DC, software-selectable

A/D converter (ADC) resolution..... 24 bits

ADC type ..... Delta-sigma

Sample rates (f_s), samples-per-second (S/s) ..... 102.4 kS/s down to 1.0 kS/s in 190.7 µS/s increments for f_s > 51.2 kS/s or 95.37 µS/s increments for $f_s \leq$ 51.2 kS/s

ADC modulator oversample rate

1.0 kS/s ≤ f_s ≤ 51.2 kS/s ..... 128 f_s

51.2 kS/s < f_s ≤ 102.4 kS/s ..... 64 f_s

Sample Clock Timebase, low-frequency alias rejection disabled (default)[1]

1.0 kS/s ≤ f_s ≤ 51.2 kS/s.....256 f_s

51.2 kS/s < f_s ≤ 102.4 kS/s.....128 f_s

Sample Clock Timebase, low-frequency alias rejection enabled

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

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

Data transfers.....DMA

Overvoltage protection

Positive input.....±42.4 V_{pk}

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

External trigger.....Not protected

Frequency accuracy.....±25 ppm

Input signal range.....±10 V_{pk}

Transfer Characteristics

DC-coupled offset (residual).....±3 mV, max

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

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

Amplifier Characteristics

Input Impedance (Ground Referenced)	Pseudodifferential Configuration
Between positive input and chassis ground (NI 447*X* all revisions and NI PXI-4472B revision G and earlier)	1 MΩ ‖ 60 pF
Between positive input and chassis ground (NI PXI-4472B revision H and later)	10 MΩ ‖ 60 pF
Between negative input and chassis ground	50 Ω ‖ 0.02 µF

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 < input frequency < 127.4535 f_s, where 1.0 kS/s ≤ f_s ≤ 51.2 kS/s 0.5465 f_s < input frequency < 63.4535 f_s, where 51.2 kS/s < f_s ≤ 102.4 kS/s	Input frequency > 0.6 f_s
–3 dB BW	0.491 f_s	0.4863 f_s

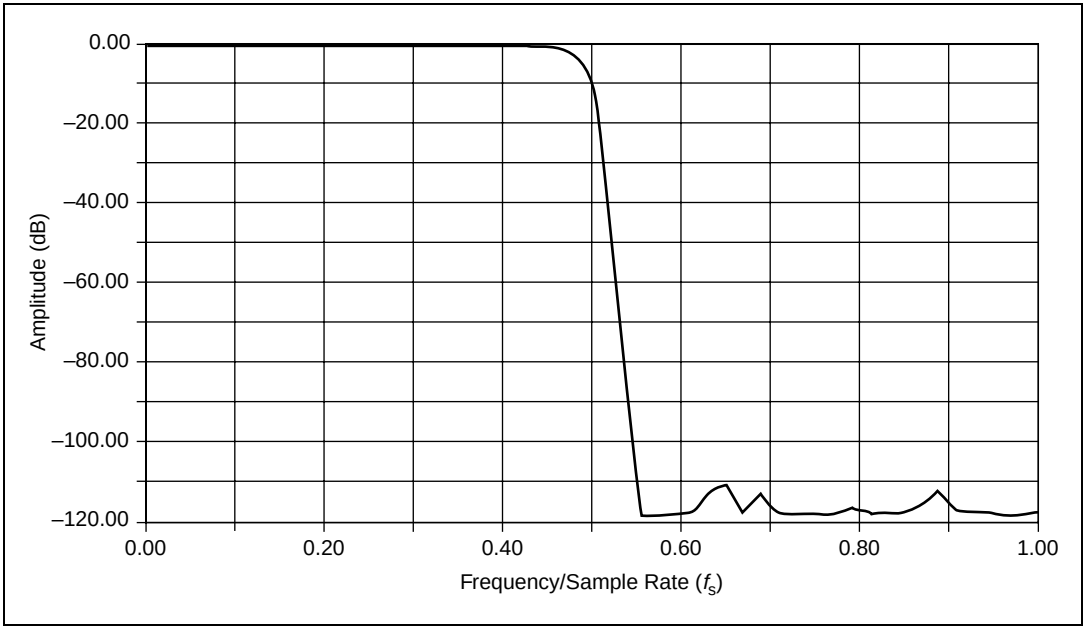

Figure 1. Digital Filter Input Frequency Response

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.

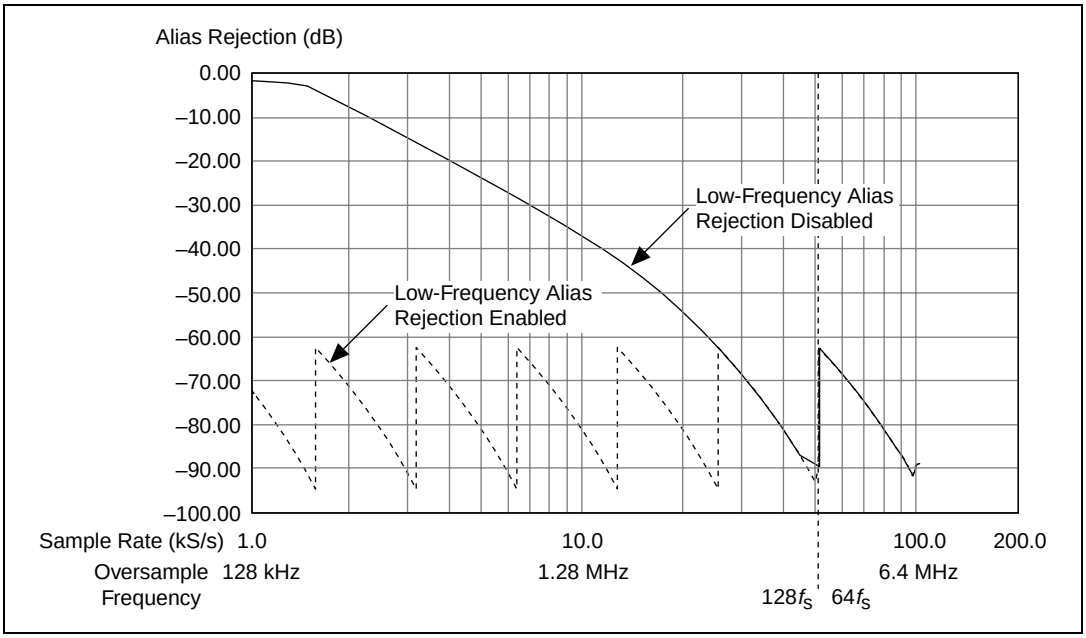

Figure 2. Analog Filter Alias Rejection at Oversample Rates

ADC Filter Delay

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

AC –3 dB cut-off frequency

NI 447*X* .....3.4 Hz

NI 4472B .....0.5 Hz

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

1.0 kS/s ≤ f_s ≤ 51.2 kS/s.....±0.03 dB, max

51.2 kS/s < f_s ≤ 102.4 kS/s.....±0.1 dB, max

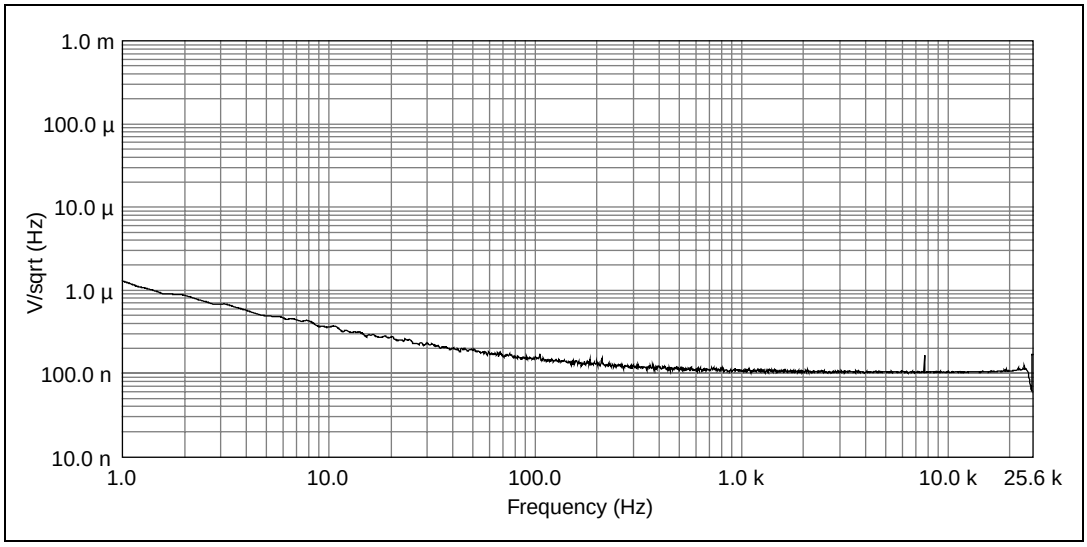

Figure 3. Input Noise Spectral Density at 128-Times Oversampling (50 Ω Connected at Input)

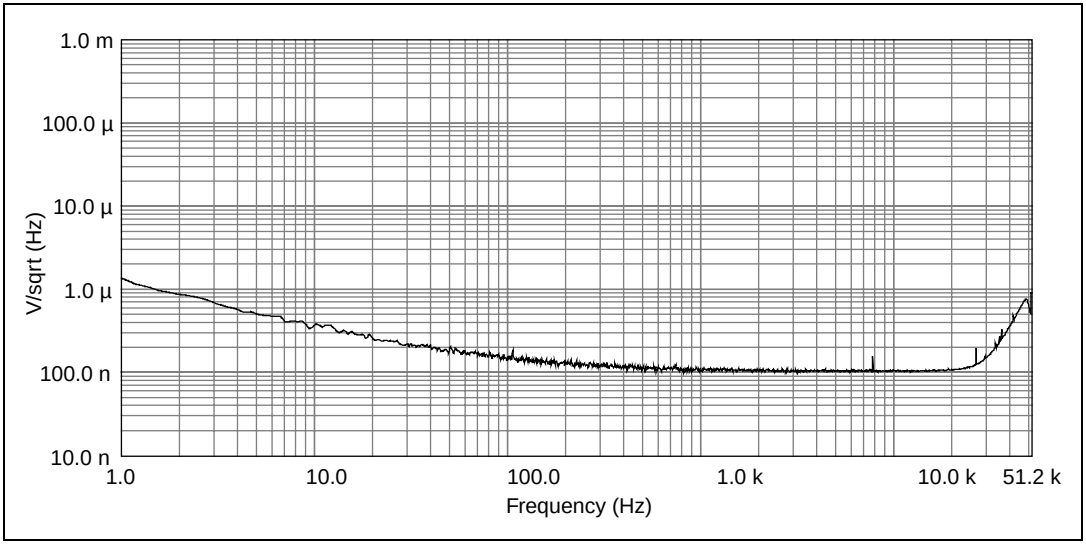

Figure 4. Input Noise Spectral Density at 64-Times Oversampling (50 Ω Connected at Input)

Idle channel noise, for sample rate
f_s = 51.2 kS/s,
bandwidth = 25.6 kHz..... –94 dBV_{rms}
f_s = 102.4 kS/s,
bandwidth = 51.2 kHz..... –81 dBV_{rms}

Spurious free dynamic range[1,2] ..... 104 dB

[1] Measurement includes all harmonics.

[2] 1 kHz input tone, input amplitude is –1 dBFS or 8.91 V_{pk}.

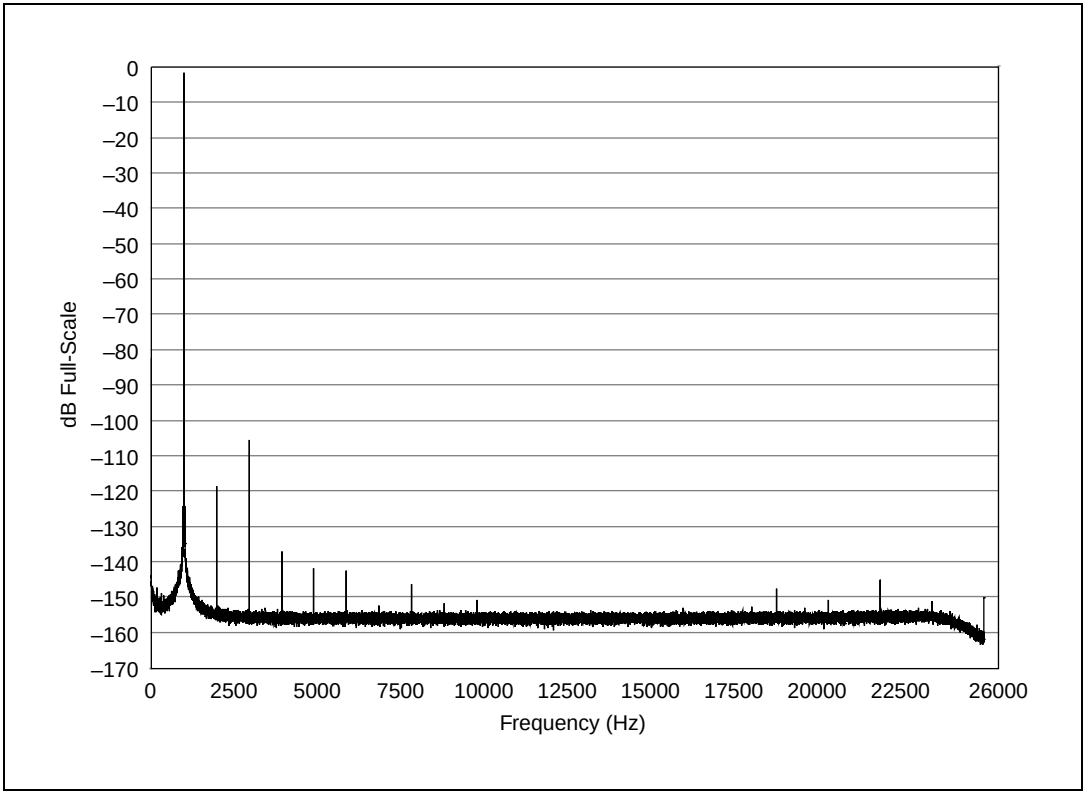

Figure 5. SFDR 51.2 kS/s (–1 dBFS, 1 kHz Sine Wave Input, FFT Size 131,072 Samples, Five Averages)

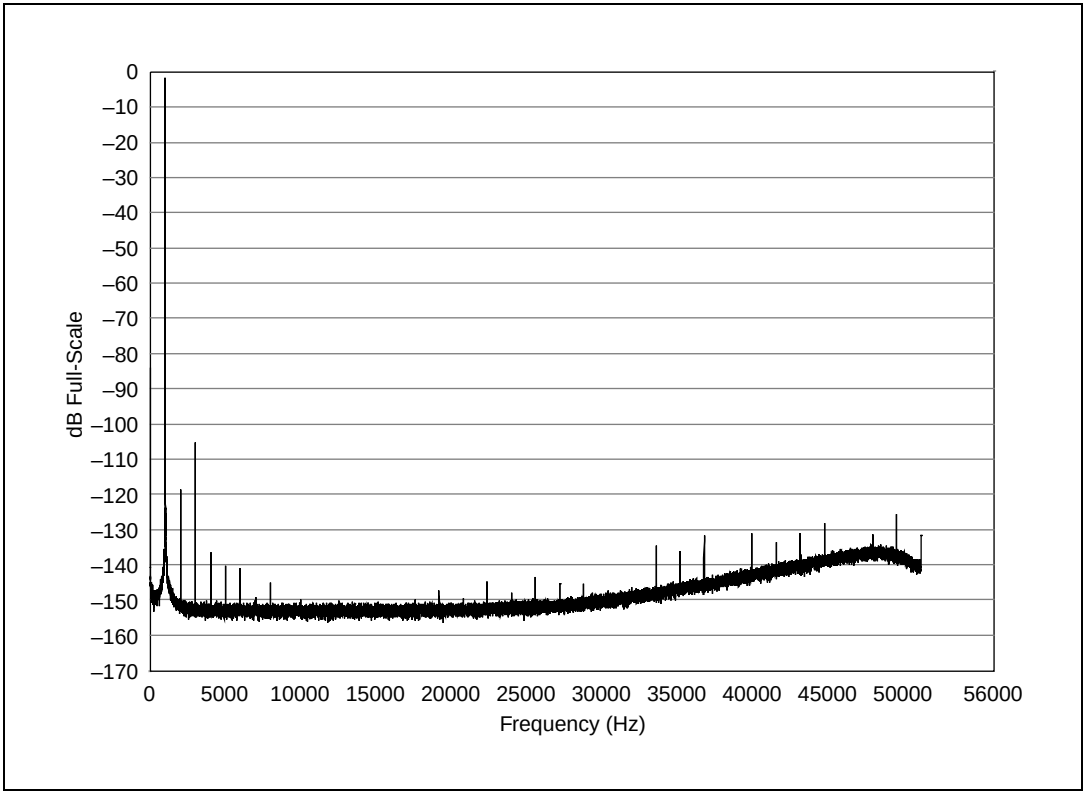

Figure 6. SFDR 102.4 kS/s (–1 dBFS, 1 kHz Sine Wave Input, FFT Size 131,072 Samples, Five Averages)

Dynamic range,[1,2] for sample rate

1.0 kS/s ≤ f_s ≤ 51.2 kS/s ..... 111 dB

51.2 kS/s < f_s ≤ 102.4 kS/s ..... 99 dB

Total harmonic distortion (THD)[3] ..... −102 dBc

[1] Bandwidth equals 0.4535 f_s starting from 20 Hz.

[2] 1 kHz input tone, input amplitude is –60 dBFS.

[3] 1 kHz input tone, input amplitude is –1 dBFS.

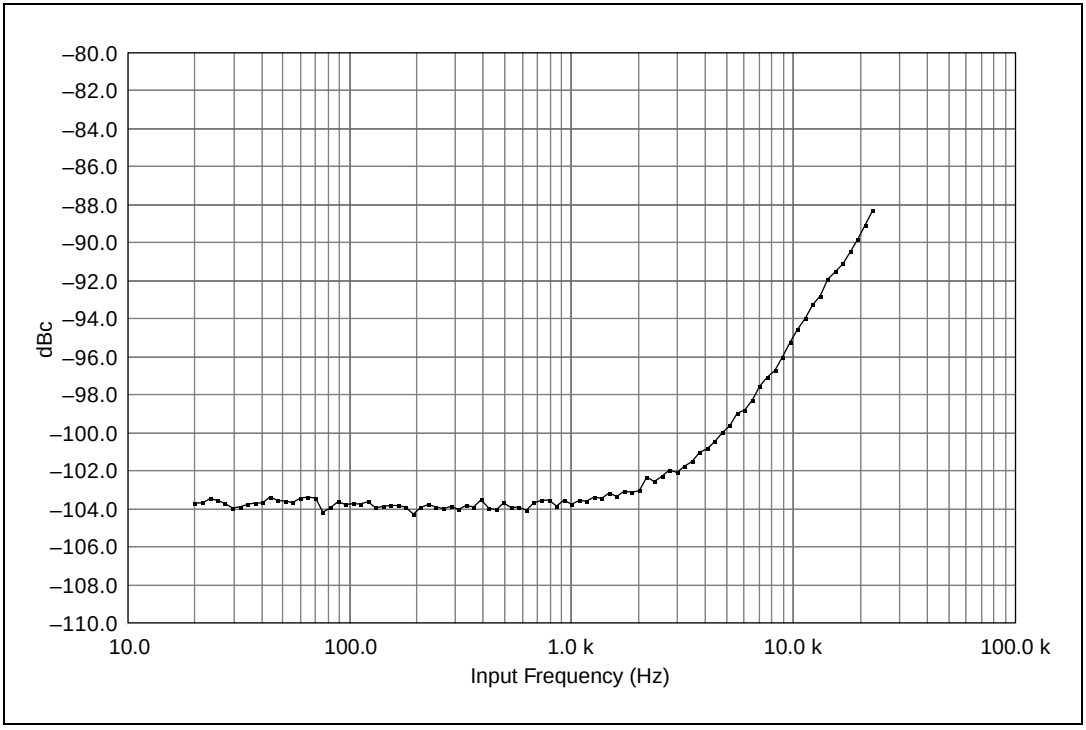

Figure 7. THD (Unbalanced Source, 102.4 kS/s), –1 dBFS Input Sine Wave, DC Coupled

THD+N[1].....–97 dBc

IMD .....–100 dBc
(CCIF 14 kHz + 15 kHz)

Crosstalk (Channel Separation)[2, 3]	**Shorted Input**	**1 kΩ Load**
Adjacent channels	<–90 dB	<–80 dB
Other channel combinations	<–100 dB	<–90 dB

[2] Measured with full-scale (±10 V) input.
[3] 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

[1] 1 kHz input tone, –1 dBFS, 50 kHz measurement bandwidth.

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/$\sqrt{1{,}000\ \text{h}}$

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/$\sqrt{\text{Hz}}$

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

PCI

RTSI .....Up to 5 devices across ribbon cable

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-447*X* ..... 0 to 55 °C (Tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.)

PCI-447*X* ..... 0 to 50 °C (Tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.)

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_{rms}

Nonoperating ..... 5 to 500 Hz, 2.4 g_{rms} (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_{cal} 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_{pk}, Measurement Category I

Channel-to-channel ..... 42 V_{pk}, Measurement Category I

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

Safety

The NI 447*X* is designed to meet 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
- CAN/CSA-C22.2 No. 61010-1

Note For UL and other safety certifications, refer to the product label, or visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

Emissions.....EN 55011 Class A at 10 m
FCC Part 15A above 1 GHz

Immunity .....EN 61326:1997 + A2:2001, Table 1

CE, C-Tick, and FCC Part 15 (Class A) Compliant

Note For EMC compliance, operate this device with shielded cabling.

CE Compliance

The NI 447*X* meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

Low-Voltage Directive (safety).....73/23/EEC

Electromagnetic Compatibility
Directive (EMC).....89/336/EEC

Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.