NI PXI-446*X* Specifications

This document lists specifications for the NI PXI-4461 and NI PXI-4462 (NI PXI-446*X*) Dynamic Signal Acquisition (DSA) devices. These specifications are typical at 25 °C unless otherwise stated. The operating range is 0 °C to 55 °C. All specifications are subject to change without notice. Visit `ni.com/manuals` for the most current specifications and product documentation.

Analog Input

This section lists the NI PXI-446*X* analog input specifications.

Input Characteristics

Number of simultaneously sampled input channels

- NI PXI-4461 2
- NI PXI-4462 4

Input configuration ..... Differential or pseudodifferential (50 Ω between negative input and chassis ground), per input channel selectable

Input coupling ..... AC or DC, each channel independently software selectable

ADC resolution ..... 24 bits

ADC type ..... Delta-sigma

Sample rates (f_s) ..... 1 kS/s to 204.8 kS/s in 181.9 µS/s increments

Oversampling, for sample 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
- 102.4 kS/s ≤ f_s ≤ 204.8 kS/s ..... 32 f_s

NATIONAL INSTRUMENTS

Sample Clock Timebase Rate

Ratio between sample rate (f_s) and sample clock timebase rate (f_{tb})

Sample Rate (f_s)	Sample Clock Timebase Rate
1.0 kS/s ≤ f_s ≤ 1.6 kS/s	16,384 f_s
1.6 kS/s < f_s ≤ 3.2 kS/s	8,192 f_s
3.2 kS/s < f_s ≤ 6.4 kS/s	4,096 f_s
6.4 kS/s < f_s ≤ 12.8 kS/s	2,048 f_s
12.8 kS/s < f_s ≤ 25.6 kS/s	1,024 f_s
25.6 kS/s < f_s ≤ 51.2 kS/s	512 f_s
51.2 kS/s < f_s ≤ 102.4 kS/s	256 f_s
102.4 kS/s < f_s ≤ 204.8 kS/s	128 f_s

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

Data transfers.....Direct memory access (DMA)

Input Common Mode Range

Gain (dB)	Input	Differential[1]	Pseudodifferential[1]
≥0	+	±12 V_{pk}	±12 V_{pk}
	–	±12 V_{pk}	±10 V_{pk}
<0	+	±42.4 V_{pk}	±42.4 V_{pk}
	–	±42.4 V_{pk}	±10 V_{pk}

[1] Voltages with respect to ground

Input Overvoltage Protection

Differential configuration.....±42.4 V_{pk}

Pseudodifferential configuration, positive.....±42.4 V_{pk}

Pseudodifferential configuration, negative (shield).....±10.0 V_{pk}

Input Signal Range

Gain (dB)	Full Scale Range (V_{pk})[1]
30	±0.316
20	±1.00
10	±3.16
0	±10.0
–10	±31.6
–20	±42.4

[1] Each input channel gain is independently software selectable.

Transfer Characteristics

AI Offset (Residual DC)

Gain (dB)	DC Coupled Offset[1], Max, 24 Hr, T_{cal}[2] ±5 °C (±mV)	DC Coupled Offset[1], Max, 0 °C to 55 °C (±mV)
30	0.1	1
20	0.2	2
10	0.5	3
0	0.7	7
–10	5	30
–20	7	70

[1] Source impedance ≤50 Ω
[2] T_{cal} = ambient temperature at which last calibration was performed

AI Gain Amplitude Accuracy

1 kHz input tone

T_{cal} ±5 °C ..... ±0.03 dB max
0 °C to 55 °C ..... ±0.2 dB max

Amplifier Characteristics

Input Impedance

Input Impedance, Typical	Differential Configuration	Pseudodifferential Configuration
Between positive input and chassis ground	1 MΩ ‖ 217 pF	1 MΩ ‖ 217 pF
Between negative input and chassis ground	1 MΩ ‖ 229 pF	50 Ω

Common Mode Rejection Ratio (CMRR)

Gain (dB)	DC Coupled CMRR (dBc), Typical[1, 2]	AC Coupled CMRR (dBc), Typical[2, 3]
30	105	70
20	101	
10	90	
0	80	
–20, –10	60	65

[1] ≤1 kHz
[2] Differential configuration
[3] 50 or 60 Hz

Dynamic Characteristics[1]

Specification	Low Frequency Alias Rejection Enabled (Default)	Low Frequency Alias Rejection Disabled
Alias-free bandwidth (BW) (passband)	DC to 0.4 f_s	DC to 0.4535 f_s
Alias rejection, minimum	104 dBc	120 dBc
Alias rejection by frequency	Input frequency > 0.6 f_s	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 0.5465 f_s < input frequency < 31.4535 f_s, where 102.4 kS/s < f_s ≤ 204.8 kS/s
–3 dB BW	0.491 f_s	0.484 f_s

AC coupling BW

–3 dB cutoff frequency ..... 3.4 Hz typical

–0.1 dB cutoff frequency ..... 22.6 Hz typical

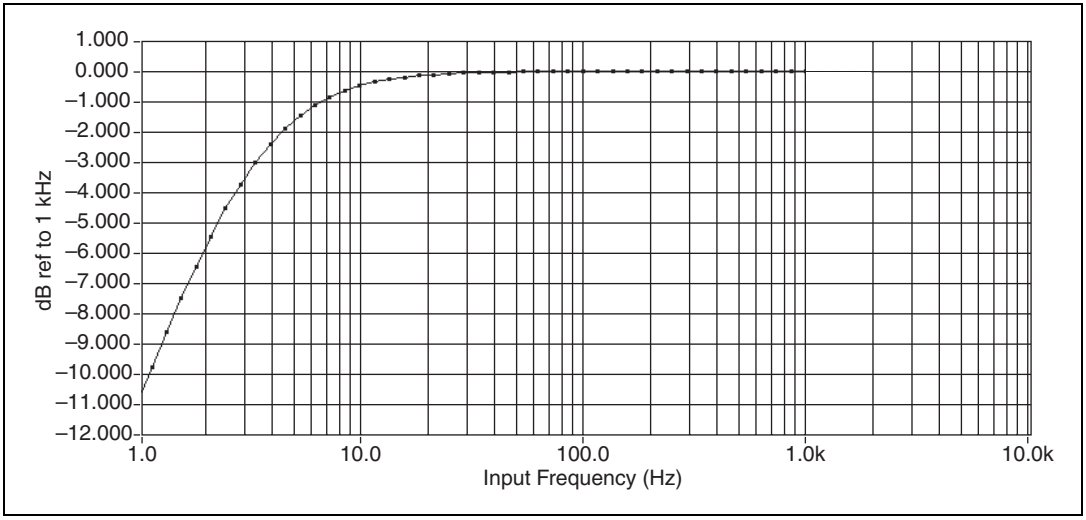

Figure 1. Magnitude Response of AC Coupling Circuit (1 Hz to 1 kHz)

[1] Test system equipped with a liquid crystal display (LCD) monitor for AI noise and distortion measurements to avoid possible magnetic interference caused by cathode ray tube (CRT)-based monitors.

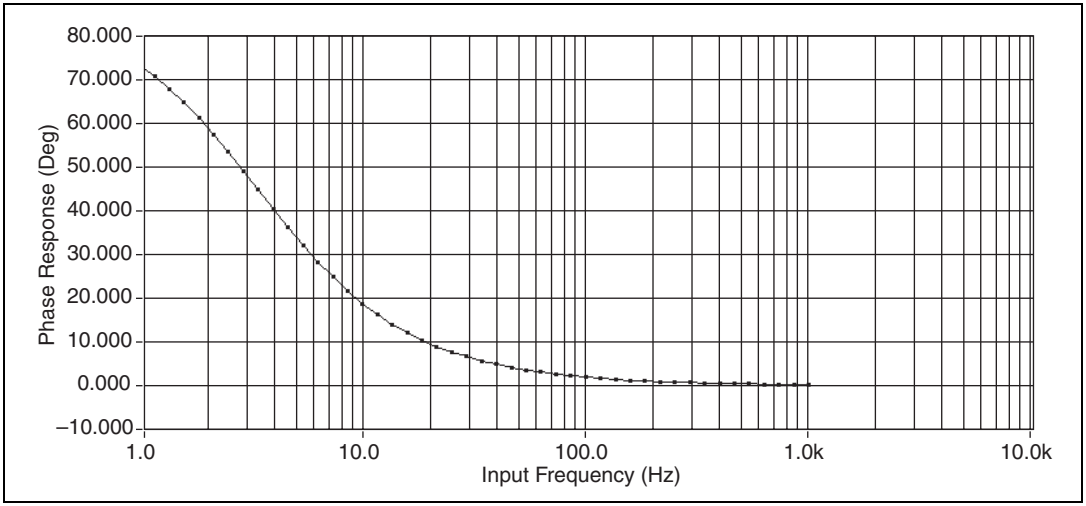

Figure 2. Phase Response of AC Coupling Circuit (1 Hz to 1 kHz)

ADC Filter Delay

Low Frequency Alias Rejection Enabled (Default)		Low Frequency Alias Rejection Disabled	
Sample Rate (kS/s)	**Filter Delay (Samples)**	**Sample Rate (kS/s)**	**Filter Delay (Samples)**
1.0 ≤ fs ≤ 1.6	94	1.0 ≤ fs ≤ 1.6	63
1.6 < fs ≤ 3.2	93	1.6 < fs ≤ 3.2	
3.2 < fs ≤ 6.4	91	3.2 < fs ≤ 6.4	
6.4 < fs ≤ 12.8	87	6.4 < fs ≤ 12.8	
12.8 < fs ≤ 25.6	79	12.8 < fs ≤ 25.6	
25.6 < fs ≤ 204.8	63	25.6 < fs ≤ 204.8	

AI Flatness

Gain (dB)	DC Coupled Flatness[1] (dB), Max (Typical)		
	20 Hz to 20 kHz	20 Hz to 45 kHz	20 Hz to 92.2 kHz
0, 10, 20, 30	±0.006 (±0.003)	±0.03 (±0.02)	±0.1 (±0.08)
–20, –10	±0.2 (±0.1)	±0.6 (±0.33)	±1 (±0.55)

[1] Relative to 1 kHz

AI Spectral Noise Density

AI spectral noise density ..... 8 nV/$\sqrt{\text{Hz}}$ typical at 30 dB gain, 1 kHz

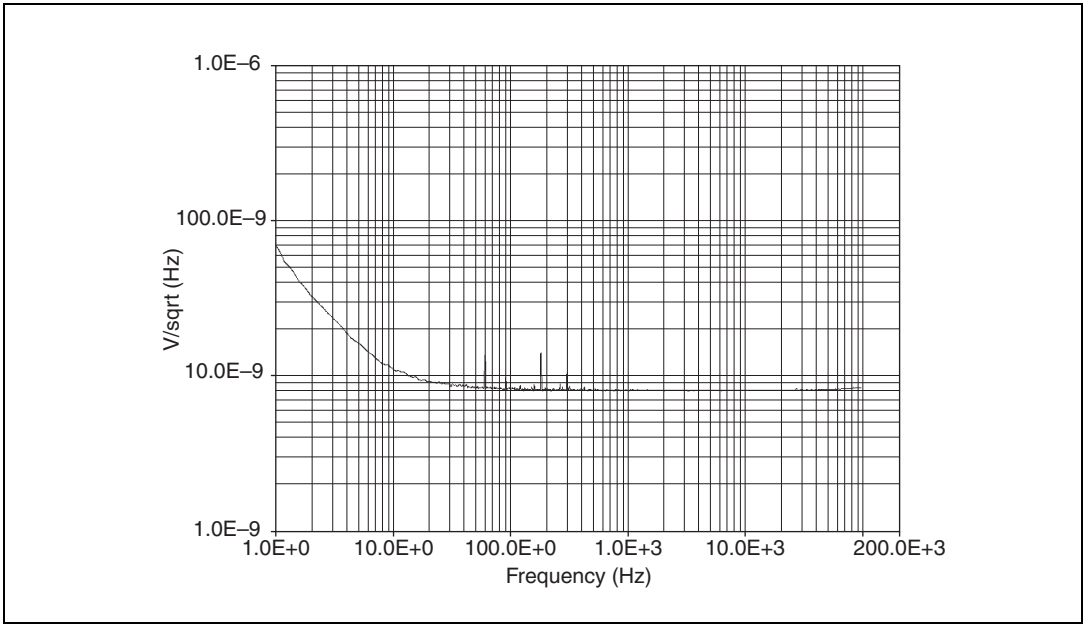

Figure 3. AI Spectral Noise Density (30 dB Gain)

AI Idle Channel Noise

Sample Rate (kS/s)	Idle Channel Noise, Typical[1, 2]	
	dBV_{rms}	μV_{rms}
1.0 kS/s ≤ f_s < 51.2 kS/s	–118 dBV_{rms}	1.3 μV_{rms}
51.2 kS/s ≤ f_s < 102.4 kS/s	–115 dBV_{rms}	1.8 μV_{rms}
102.4 kS/s ≤ f_s ≤ 204.8 kS/s	–111 dBV_{rms}	2.8 μV_{rms}

[1] Source impedance ≤50 Ω
[2] 30 dB gain

AI Spurious Free Dynamic Range (SFDR)

Gain Setting (dB)	SFDR (dBc), Typical[1, 2, 3]
30	106
0, 10, 20	108
–20, –10	110

[1] f_s = 204.8 kS/s
[2] 1 kHz input tone, input amplitude is the lesser of –1 dBFS or 8.91 V_{pk}.
[3] Measurement includes all harmonics.

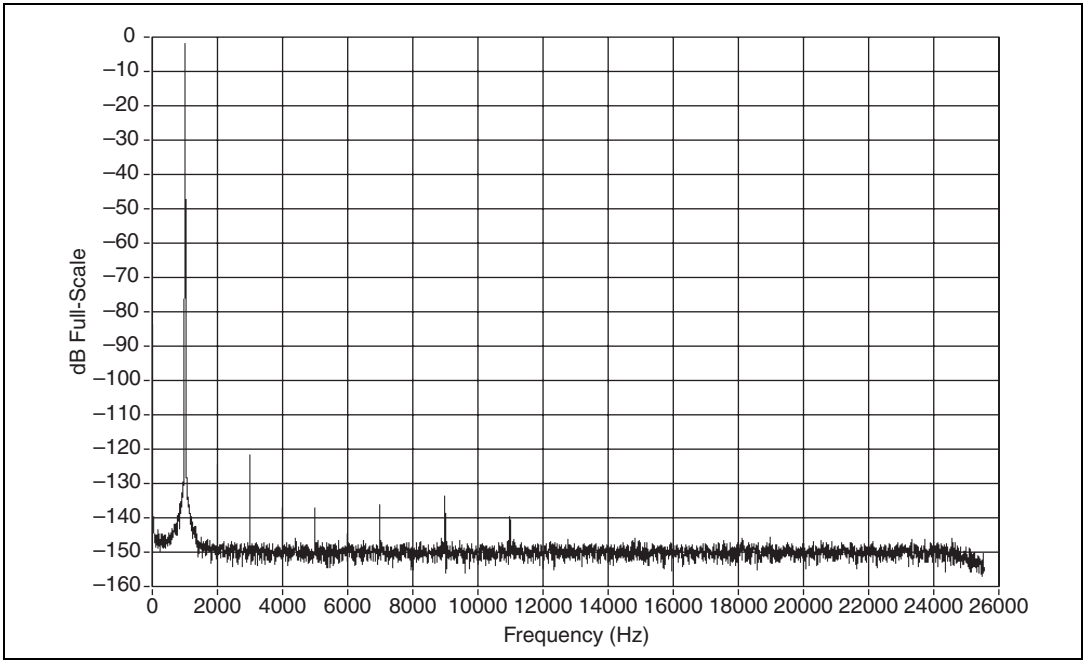

Figure 4. SFDR 51.2 kS/s (–1 dBFS, 0 dB Gain, 1 kHz Sine Wave Input)

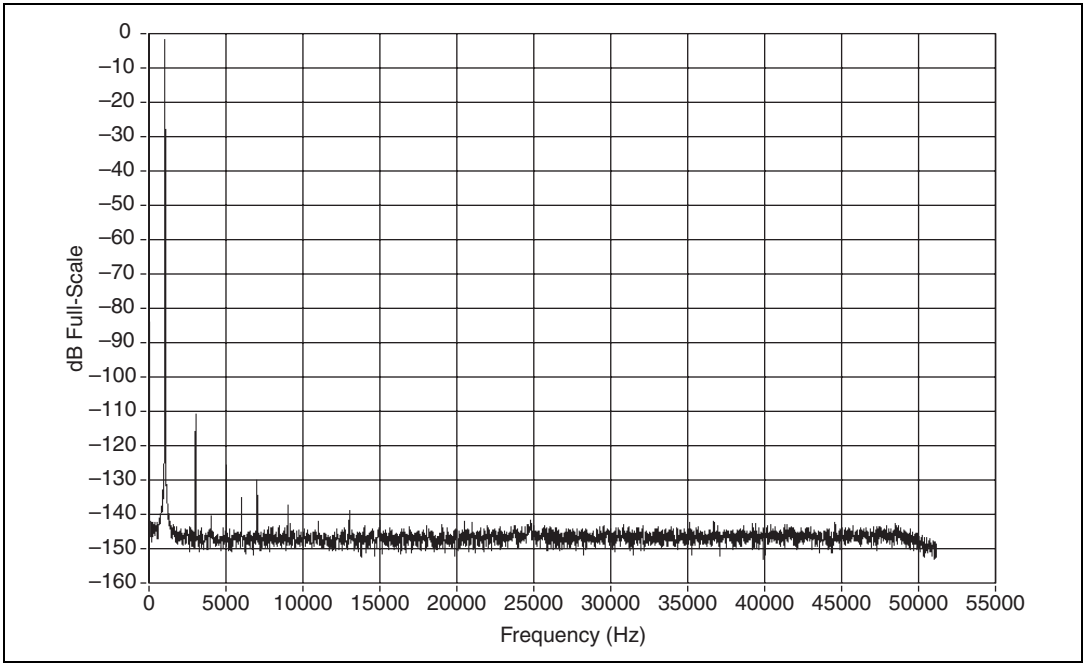

Figure 5. SFDR 102.4 kS/s (–1 dBFS, 0 dB Gain, 1 kHz Sine Wave Input)

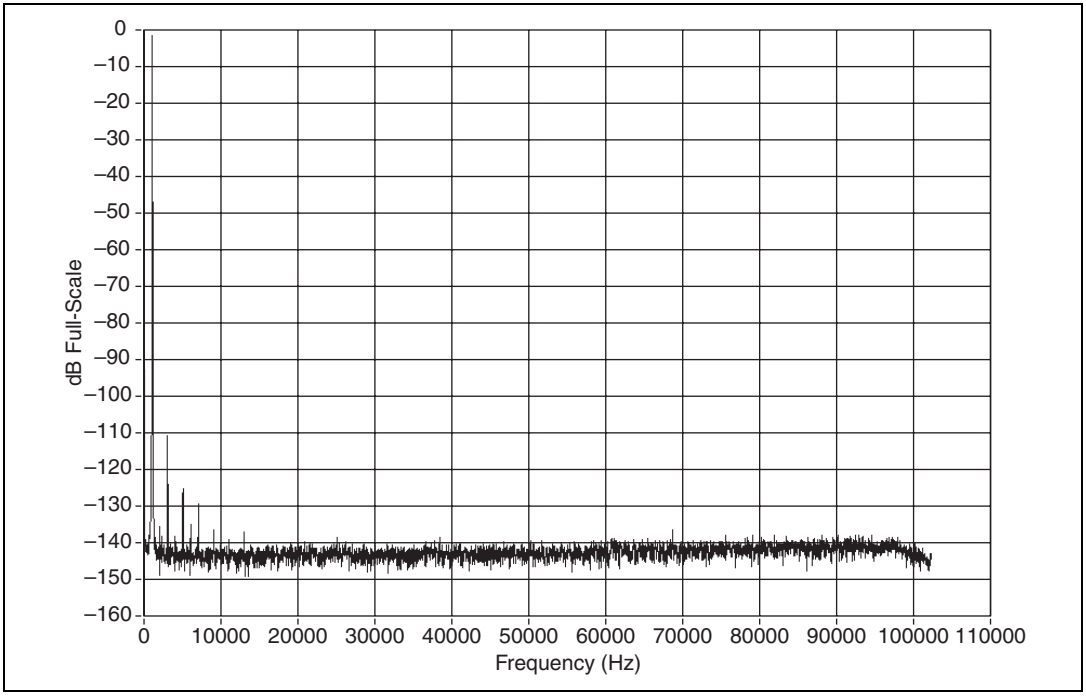

Figure 6. SFDR 204.8 kS/s (–1 dBFS, 0 dB Gain, 1 kHz Sine Wave Input)

AI Dynamic range

Gain Setting (dB)	Dynamic Range (dBFS)[1], Min (Typical)		
	1 kS/s ≤ f_s ≤ 51.2 kS/s	**51.2 kS/s < f_s ≤ 102.4 kS/s**	**102.4 kS/s < f_s ≤ 204.8 kS/s**
30	103 (105)	100 (102)	96 (98)
20	111 (113)	108 (110)	104 (106)
10	114 (117)	111 (114)	106 (110)
0	116 (118)	113 (114)	107 (110)
–10	107 (108)	104 (105)	101 (102)
–20	105 (107)	102 (104)	98 (101)

[1] 1 kHz input tone, –60 dBFS input amplitude

AI Total Harmonic Distortion (THD), Balanced Source

Gain (dB)	THD (dBc), Typical[1, 2]	
	20 Hz to 20 kHz	20 Hz to 92.2 kHz
30	–100	–97
20	–109	–106
0, 10	–107	–104
–10	–108	–107
–20	–107	–106

[1] f_s = 204.8 kS/s, 92.8 kHz BW, differential configuration
[2] Input amplitude is the lesser of –1 dBFS or 8.91 V_{pk}.

AI THD, Unbalanced Source

Gain (dB)	THD (dBc), Typical[1, 2]	
	20 Hz to 20 kHz	20 Hz to 92.2 kHz
30	–100	–93
20	–106	–94
10	–105	–92
0	–97	–87
–10	–90	–88
–20	–91	–89

[1] f_s = 204.8 kS/s, 92.8 kHz BW
[2] Input amplitude is the lesser of –1 dBFS or 8.91 V_{pk}.

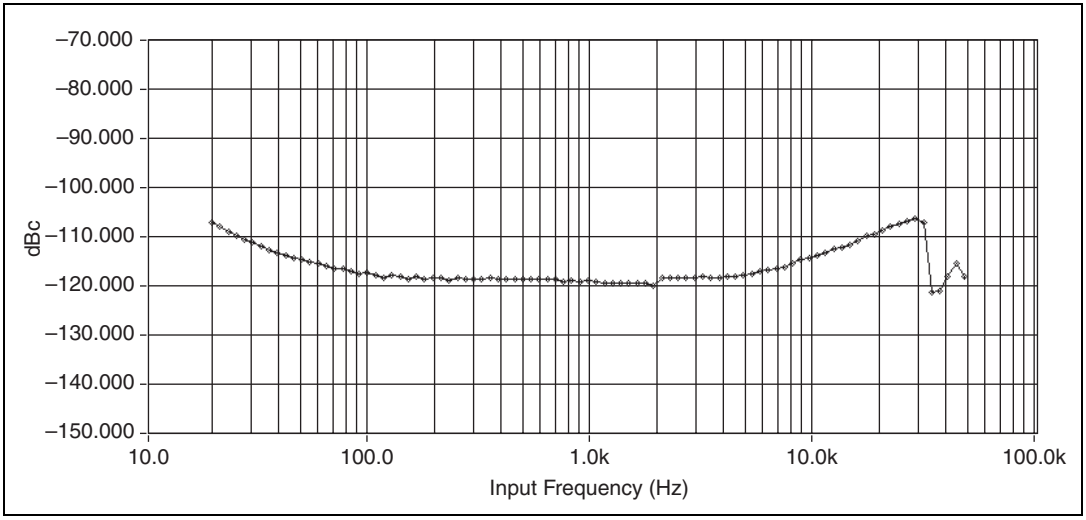

Figure 7. AI THD (Balanced Source with Differential Configuration, 204.8 kS/s, 0 dB Gain)

AI THD Plus Noise (THD+N), Balanced Source

Gain (dB)	THD+N (dBc), Typical[1]	
	51.2 kS/s 20 Hz to 20 kHz[2]	204.8 kS/s 20 Hz to 92.2 kHz[3]
30	–103	–94
20	–107	–95
10	–108	–96
0	–107	–96
–10	–96	–91
–20	–94	–88

[1] Input amplitude is the lesser of –1 dBFS or 8.91 V_{pk}, differential configuration.
[2] 23.2 kHz measurement BW
[3] 92.8 kHz measurement BW

AI THD+N, Unbalanced Source

Gain (dB)	THD+N (dBc), Typical[1]	
	51.2 kS/s 20 Hz to 20 kHz[2]	204.8 kS/s 20 Hz to 92.2 kHz[3]
30	–103	–91
20	–107	–93
10	–108	–91
0	–104	–87
–10	–94	–86
–20	–93	–86

[1] Input amplitude is the lesser of –1 dBFS or 8.91 V_{pk}.
[2] 23.2 kHz measurement BW
[3] 92.8 kHz measurement BW

AI Intermodulation Distortion (IMD)

Gain (dB)	IMD (dBc), Typical[1]
20, 30	–109
10	–107
0	–104
–20, –10	–111

[1] CCIF 14 kHz + 15 kHz, each tone amplitude is the lesser of –6 dBFS or 5 V_{pk}.

Crosstalk, Input Channel Separation

Gain (dB)	Crosstalk for Adjacent (Nonadjacent) Channels (dBc), Typical[1, 2]	
	1 kHz Signal	92.2 kHz
30	–130 (–140)	–110 (–124)
0, 10, 20	–138 (–145)	–110 (–124)
–20, –10	–96 (–124)	–62 (–108)

[1] Source impedance ≤50 Ω
[2] Input amplitude is the lesser of –1 dBFS or 8.91 V_{pk}.

AI Interchannel Gain Mismatch

Gain (dB)	DC Coupled Mismatch (dB), Typical[1]		AC Coupled Mismatch (dB), Typical[1]
	20 Hz to 20 kHz	20 Hz to 92.2 kHz	20 Hz
30	0.004	0.008	0.004
0, 10, 20	0.003	0.003	
–20, –10	0.04	0.25	0.006

[1] Identical channel configurations

AI Interchannel Phase Mismatch

Gain (dB)	DC Coupled Mismatch (deg), Typical[1]		AC Coupled Mismatch (deg), Typical[1]
	20 Hz to 20 kHz	20 Hz to 92.2 kHz	20 Hz
30	0.10	0.60	0.08
20	0.04	0.15	
0, 10	0.015	0.08	
–20, –10	0.7	1	

[1] Identical channel configurations

AI Phase Linearity

Gain (dB)	Linearity (deg), Typical	
	20 Hz to 20 kHz	20 Hz to 92.2 kHz
0, 10, 20, 30	±0.01	±0.03
–20, –10	±0.10	±1

Onboard Calibration Reference

DC level .....5.000 V ±2.5 mV

Temperature coefficient.....±5 ppm/°C max

Long-term stability .....±15 ppm/ $\sqrt{1{,}000\ \text{hr}}$

Integrated Electronic Piezoelectric (IEPE)

Current ..... 0, 4, or 10 mA ±5%, each channel independently software selectable

Compliance ..... 24 V min

Channel input impedance with IEPE enabled..... 1 MΩ ‖ 240 pF typical, pseudodifferential

Current noise ..... <300 pA/$\sqrt{\text{Hz}}$ typical

Analog Output (NI PXI-4461 Only)

This section lists the NI PXI-4461 analog output specifications.

Output Characteristics

Number of output channels ..... 2, simultaneously sampled

Output configuration ..... Differential or pseudodifferential (50 Ω to chassis ground on shield), each channel independently software selectable

DAC resolution ..... 24 bits

DAC type ..... Delta-sigma

Update rates (f_s)..... 1 kS/s to 204.8 kS/s in 181.9 μS/s increments

Oversampling, for update rate

- 1.0 kS/s ≤ f_s < 1.6 kS/s ..... 8,192 f_s
- 1.6 kS/s ≤ f_s < 3.2 kS/s ..... 4,096 f_s
- 3.2 kS/s ≤ f_s < 6.4 kS/s ..... 2,048 f_s
- 6.4 kS/s ≤ f_s < 12.8 kS/s ..... 1,024 f_s
- 12.8 kS/s ≤ f_s < 25.6 kS/s ..... 512 f_s
- 25.6 kS/s ≤ f_s < 51.2 kS/s ..... 256 f_s
- 51.2 kS/s ≤ f_s < 102.4 kS/s ..... 128 f_s
- 102.4 kS/s ≤ f_s ≤ 204.8 kS/s ..... 64 f_s

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

Data transfers ..... DMA

Output Signal Range

Attenuation (dB)	Full Scale Range (V_{pk})[1]
40	±0.1
20	±1.0
0	±10.0

[1] Each output channel range is independently software selectable.

Transfer Characteristics

AO Offset (Residual DC)

Attenuation (dB)	Maximum Offset, 24 Hr, T_{cal} ±5 °C (±mV)	Maximum Offset, 0 °C to 55 °C (±mV)
20, 40	1	2
0	1	10

Gain (Amplitude Accuracy)

Specifications valid at any attenuation setting with a 1 kHz output signal.

T_{cal} ±5 °C .....±0.04 dB max

0 °C to 55 °C .....±0.1 dB max

Voltage Output

Output coupling .....DC

Short circuit protection .....Indefinite protection between positive and negative

Minimum working load .....600 Ω

Output Impedance

Output Impedance, Typical	Differential Configuration	Pseudodifferential Configuration
Between positive output and chassis ground	2.4 kΩ	70 Ω
Between negative output and chassis ground	2.4 kΩ	50 Ω
Between positive and negative outputs	22 Ω	22 Ω

Dynamic Characteristics[1]

Image rejection..... 75 dB min < 768 kHz
66 dB min > 768 kHz

–3 dB BW..... 0.487 f_s

DAC filter delay (samples), for update rate

- 1.0 kS/s ≤ f_s < 1.6 kS/s 36.6
- 1.6 kS/s ≤ f_s < 3.2 kS/s 36.8
- 3.2 kS/s ≤ f_s < 6.4 kS/s 37.4
- 6.4 kS/s ≤ f_s < 12.8 kS/s 38.5
- 12.8 kS/s ≤ f_s < 25.6 kS/s 40.8
- 25.6 kS/s ≤ f_s < 51.2 kS/s 43.2
- 51.2 kS/s ≤ f_s < 102.4 kS/s 48.0
- 102.4 kS/s ≤ f_s ≤ 204.8 kS/s 32.0

AO Flatness

All attenuation settings relative to 1 kHz

- 20 Hz to 20 kHz ..... ±0.008 dB max
- 20 Hz to 92.1 kHz ..... ±0.1 dB max

[1] Test system equipped with an LCD monitor for AO noise and distortion measurements to avoid possible magnetic interference caused by CRT-based monitors.

AO Idle Channel Noise

Attenuation (dB)	Maximum Idle Channel Noise					
	102.5 kS/s (30 kHz BW)		204.8 kS/s (80 kHz BW)		204.8 kS/s (500 kHz BW)	
	dBV_{rms}	μV_{rms}	dBV_{rms}	μV_{rms}	dBV_{rms}	μV_{rms}
40	–106	5	–101	9	–87	45
20	–106	5	–101	9	–86	50
0	–96	16	–93	22	–73	224

AO Spurious Free Dynamic Range (SFDR)

Attenuation (dB)	SFDR (dBc), Typical[1, 2, 3]
40	87
20	94
0	98

[1] f_s = 204.8 kS/s
[2] 1 kHz output frequency, –1 dBFS output amplitude
[3] Measurement includes all harmonics.

AO Dynamic Range

Attenuation (dB)	Minimum Dynamic Range (dBFS)[1]		
	102.5 kS/s (30 kHz BW)	204.8 kS/s (80 kHz BW)	204.8 kS/s (500 kHz BW)
40	84	79	65
20	103	97	83
0	114	110	91

[1] 1 kHz output frequency

AO THD

Attenuation (dB)	THD (dBc), Typical[1]		
	102.5 kS/s 20 Hz to 20 kHz[2]	204.8 kS/s 20 Hz to 20 kHz[3]	204.8 kS/s 20 Hz to 92.1 kHz[3]
40	–99	–92	–92
20	–98	–95	–93
0	–97	–94	–86

[1] –1 dBFS output amplitude
[2] 30 kHz measurement BW
[3] 92.8 kHz measurement BW

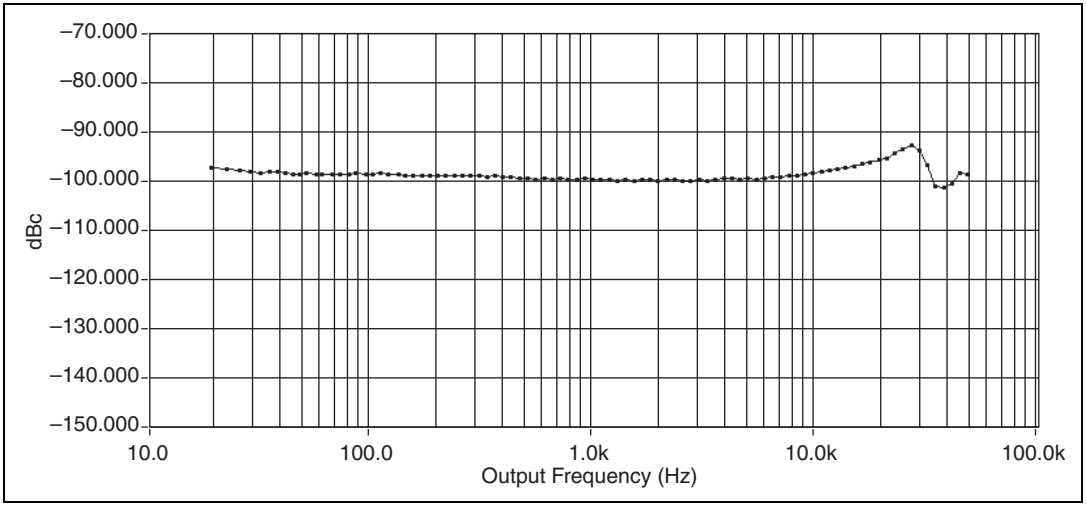

Figure 8. AO THD (204.8 kS/s, 0 dB Gain, 65,536 Samples)

AO THD+N

Attenuation (dB)	THD + N (dBc), Typical[1]		
	102.5 kS/s 20 Hz to 20 kHz[2]	204.8 kS/s 20 Hz to 80 kHz[3]	204.8 kS/s 20 Hz to 92.1 kHz[4]
40	–83	–77	–63
20	–98	–92	–79
0	–99	–89	–68

[1] –1 dBFS output amplitude
[2] 30 kHz measurement BW
[3] 80 kHz measurement BW
[4] 500 kHz measurement BW

AO Intermodulation Distortion (IMD)

Attenuation (dB)	IMD (dBc), Typical[1]
40	–99
20	–104
0	–104

[1] CCIF 14 kHz + 15 kHz, each tone amplitude is –6 dBFS.

Crosstalk, Output to Input Channel Separation

Gain (dB)	Crosstalk (dBc), Typical[1, 2]	
	1 kHz Signal	92.2 kHz
30	–151	–118
20	–150	–118
10	–144	–115
0	–137	–111
–20, –10	–87	–51

[1] Source impedance ≤50 Ω
[2] Output amplitude is the lesser of –1 dBFS or 8.91 V_{pk}.

Crosstalk, Output Channel Separation

No measurable crosstalk

AO Interchannel Gain Mismatch

All attenuation settings

20 Hz to 92.1 kHz ..... ±0.01 dB

AO Interchannel Phase Mismatch

All attenuation settings

20 Hz to 20 kHz ..... ±0.1° typical

20 Hz to 92.1 kHz ..... ±0.2° typical

AO Phase Linearity

Attenuation (dB)	Linearity (deg), Typical	
	20 Hz to 20 kHz	20 Hz to 92.1 kHz
0	±0.1	±1.7
20	±0.1	±1.6
40	±0.1	±1.8

Internal Frequency Timebase Characteristics

Accuracy ..... ±20 ppm, 0 °C to 55 °C

Aging..... 8 ppm in first year;
18 ppm after 10 years

Triggers

Analog Trigger

Purpose..... Start trigger

Source

NI PXI-4461 ..... AI0 or AI1

NI PXI-4462 ..... AI0, AI1, AI2, or AI3

Level ..... Full scale, programmable

Slope ..... Positive (rising) or negative (falling), software selectable

Resolution ..... 24 bits

Hysteresis..... Programmable

Digital Trigger

Purpose .....Start or reference trigger

Source .....PFI0, PXI_Trig<0..6>

Compatibility .....Transistor-transistor logic (TTL)

Polarity .....Rising or falling edge

Minimum pulse width.....10 ns

General Specifications

This section lists general specification information for the NI PXI-446*X*.

Bus Interface

Type .....PXI master/slave

Power Requirements

Voltage	NI PXI-4461, Typical	NI PXI-4462, Typical
+5 V	990 mA	990 mA
+3.3 V	1,430 mA	1,750 mA
+12 V	170 mA	130 mA
–12 V	110 mA	70 mA

Physical

Dimensions
(not including connectors) .....16 cm × 10 cm (6.3 in. × 3.9 in.)
3U CompactPCI slot

Analog I/O connectors.....BNC female

Digital trigger connector.....SMB male

Weight .....241 g (8.5 oz)

Installation Category.....I

Environmental

Operating Environment

Ambient temperature range ..... 0 °C to 55 °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 °C 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

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 Hz to 500 Hz, 0.3 g_{rms}

Nonoperating ..... 5 Hz 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

Safety

The NI PXI-446*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 PXI-446*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.

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