SPECIFICATIONS

PXIe-4480

1.25 MS/s, 3.4 Hz AC/DC-Coupled, 6-Input PXI Sound and Vibration Module

Definitions

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

The following characteristic specifications 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.

Conditions

Specifications are valid for the range -40 °C to 70 °C unless otherwise noted.

Input Characteristics

Number of simultaneously sampled input channels	6
Measurement types	Voltage or Charge, each channel independently software-selectable
Input configuration	
Voltage	Differential or pseudodifferential (50 Ω between negative input and chassis ground), each channel independently software-selectable
Charge	Single-ended (negative input grounded)

Input coupling	
Voltage	AC or DC, each channel independently software-selectable
Charge	AC
A/D converter (ADC) resolution	24 bits
ADC type	Delta-Sigma
Sample rates (f_s)	
Range	100 Sample/s to 1.25 MSample/s
Resolution[1]	≤1.458 mSample/s
ADC modulator sample rate	20 MSample/s
FIFO buffer size	1,023 samples per task + 8,221 samples per channel in task
Data transfers	Direct Memory Access (DMA), Programmed I/O

Common-Mode Range (Voltage)

Input	Configuration	
	Differential (V_{pk})*	**Pseudodifferential (V_{pk})***
Positive input (+)	±10	±10
Negative input (-)	±10	±10

* Voltages with respect to chassis ground.

Signal Range (Voltage)

Range (V) *	Full-Scale Input, Min	
	V_{pk}	**V_{rms} †**
10	±10.0‡	7.07‡
5	±5.0	3.53
1	±1.0	0.707

[1] Dependent on the sample rate. Refer to the *PXIe-4480/4481 User Manual* for more information.

Range (V) *	Full-Scale Input, Min	
	V_{pk}	V_{rms} †
0.5	±0.5	0.353

* Each input channel range is independently software-selectable.

† Sine input.

‡ Typical.

Signal Range (Charge)

Range (pC) *	Full-Scale Input, Min	
	Q_{pk} (pC)	Q_{rms} (pC)†
20,000	±20,000‡	14,140‡
10,000	±10,000	7,070
2,000	±2,000	1,414
1,000	±1,000	707

* Each input channel range is independently software-selectable.

† Sine input.

‡ Typical.

Overvoltage Protection (Voltage)

Input	Configuration	
	Differential (V_{pk})*	Pseudodifferential (V_{pk})*
Positive input (+)	±30	±30
Negative input (-)	±30	±10

* Voltages with respect to chassis ground.

Overvoltage Protection (Charge)

Input	Voltage (V_{pk})*
Positive input (+)	±15
Negative input (-)	None
* Voltages with respect to chassis ground.	

Overvoltage Protection (Unpowered)

Input	Voltage (V_{pk})*
Positive input (+)	±15
Negative input (-)	±15
* Voltages with respect to chassis ground.	

Transfer Characteristics

Offset (Residual DC)

Range (V)	DC-Coupled Offset (±mV)*, Max (Typical)	AC-Coupled Offset (±mV)†, Typical, 25 °C	DC-Coupled Offset (±mV)†, Max, 55 °C
10	5.0 (2.0)	1.1	7.0
5	2.2 (1.0)	0.6	5.0
1	0.8 (0.5)	0.3	4.2
0.5	0.65 (0.4)	0.3	4.2
* Source impedance ≤ 50 Ω.			
† Applied DC bias ≤ 15 V.			

Gain Amplitude Accuracy

Voltage	
1 kHz input tone	±0.05 dB max, ±0.02 dB typical

Charge

1 kHz input tone	±0.01 dB max, ±0.06 dB typical

Amplifier Characteristics

Input Impedance (Voltage)

Input Impedance	Configuration	
	Differential	Pseudodifferential
Between positive input and chassis ground	1.62 MΩ || 200 pF	1.62 MΩ || 200 pF
Between negative input and chassis ground	1.62 MΩ || 200 pF	50 Ω

Common-Mode Rejection Ratio (CMRR)

Range (V)	DC-Coupled CMRR (dBc)*, †	AC-Coupled CMRR (dBc)*, ‡
10	60	60
5	70	70
1	85	80
0.5	90	80

* $f_{in} \leq 1$ kHz.

† Differential configuration.

‡ f_{in} = 50 Hz or 60 Hz.

Dynamic Characteristics

Bandwidth and Alias Rejection

Alias-free bandwidth (BW) (passband)	DC to 0.403 f_s
Alias rejection	120 dBc min, 0.597 $f_s < f_{in} <$ 19.25375 MHz

Filter Delay

Digital filter delay	Adjustable[2]

[2] Digital filter delay is compensated to 0 ns by default and adjustable in software.

Analog filter delay	
10 V range	31 ns
5 V range	47 ns
1 V range	150 ns
0.5 V range	215 ns

AC Coupling (Voltage)

-3 dB cutoff frequency	0.49 Hz
-0.1 dB cutoff frequency	3.2 Hz

Figure 1. AC-Coupled Voltage Measurement Magnitude Response vs. Frequency

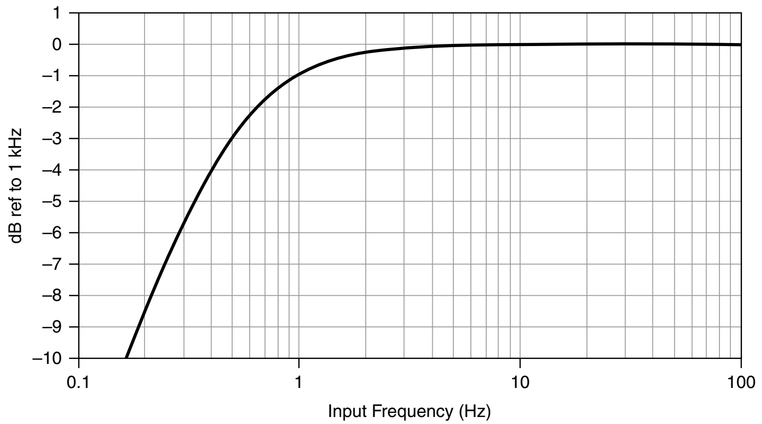
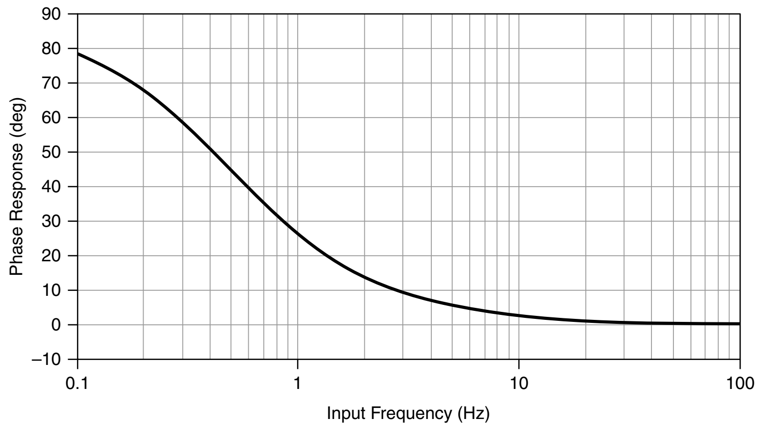


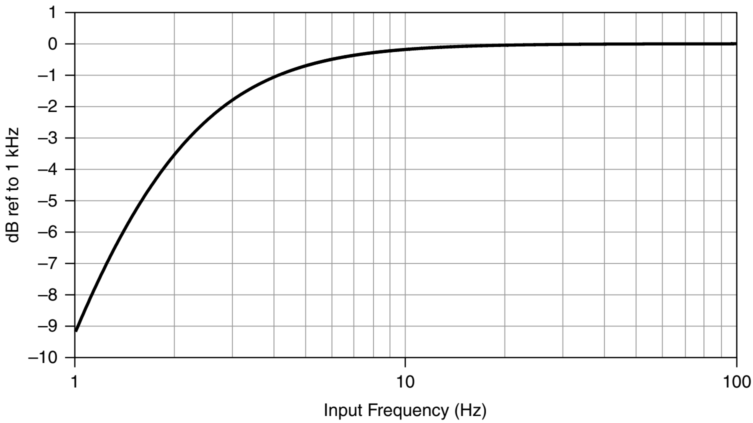
Figure 2. AC-Coupled Voltage Measurement Phase Response vs. Frequency



AC Coupling (Charge)

-3 dB cutoff frequency	2.2 Hz
-0.1 dB cutoff frequency	13.5 Hz

Figure 3. Charge Measurement Magnitude Response vs. Frequency



Gain Flatness (Voltage)

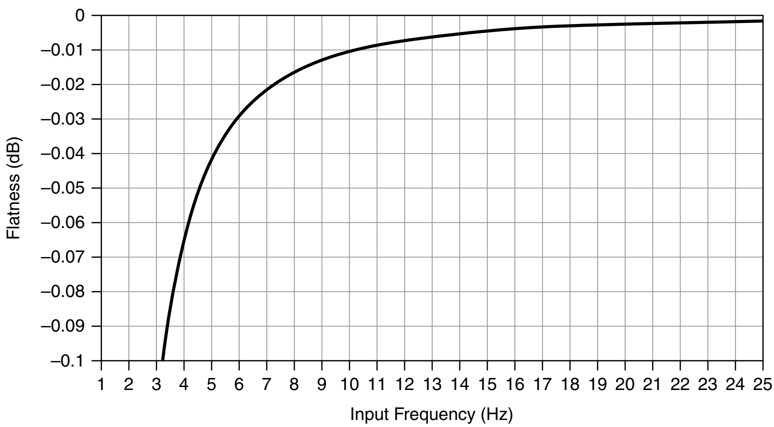
Range (V)	f_s = 1.25 MSamples/s				
	DC-Coupled Flatness (dB)*, Max (Typical)				
	f_{in} = 20 Hz to 20 kHz	f_{in} > 20 kHz to 50 kHz	f_{in} > 50 kHz to 100 kHz	f_{in} > 100 kHz to 200 kHz	f_{in} > 200 kHz to 500 kHz
10	±0.007 (±0.001)	±0.013 (±0.003)	±0.03 (±0.003)	±0.11 (±0.005)	(±0.025)
5	±0.007 (±0.001)	±0.013 (±0.003)	±0.03 (±0.0035)	±0.11 (±0.0055)	(±0.04)
1	±0.007 (±0.001)	±0.016 (±0.004)	±0.057 (±0.022)	±0.22 (±0.1)	(±0.6)
0.5	±0.008 (±0.002)	±0.025 (±0.012)	±0.094 (±0.055)	±0.36 (±0.23)	(±1.25)

* Relative to 1 kHz.

Range (V)	f_s = 1.25 MSamples/s					
	DC-Coupled Flatness (dB)*, Max (Typical)					
	f_{in} ≤ 25 Hz	f_{in} > 25 Hz to 20 kHz	f_{in} > 20 kHz to 50 kHz	f_{in} > 50 kHz to 100 kHz	f_{in} > 100 kHz to 200 kHz	f_{in} > 200 kHz to 500 kHz
10	Refer to the following figure.	±0.007 (±0.001)	±0.013 (±0.003)	±0.03 (±0.003)	±0.11 (±0.005)	(±0.025)
5	Refer to the following figure.	±0.007 (±0.001)	±0.013 (±0.003)	±0.03 (±0.0035)	±0.11 (±0.0055)	(±0.04)
1	Refer to the following figure.	±0.007 (±0.001)	±0.016 (±0.004)	±0.057 (±0.022)	±0.22 (±0.1)	(±0.6)
0.5	Refer to the following figure.	±0.008 (±0.002)	±0.025 (±0.012)	±0.094 (±0.055)	±0.36 (±0.23)	(±1.25)

* Relative to 1 kHz.

Figure 4. Voltage Measurement AC-Coupled Gain Flatness



Gain Flatness (Charge)

Range (pC)	f_s = 1.25 MSample/s					
	Flatness (dBc)*, †					
	f_{in}≤ 60 Hz	f_{in} > 60 Hz to 20 kHz	f_{in} > 20 kHz to 50 kHz	f_{in} > 50 kHz to 100 kHz	f_{in} > 100 kHz to 200 kHz	f_{in} > 200 kHz to 500 kHz
20,000	Refer to the following figure.	±0.001	±0.003	±0.003	±0.005	±0.025
10,000	Refer to the following figure.	±0.001	±0.003	±0.0035	±0.0055	±0.04
2,000	Refer to the following figure.	±0.001	±0.004	±0.022	±0.1	±0.6
1,000	Refer to the following figure.	±0.002	±0.012	±0.055	±0.23	±1.25

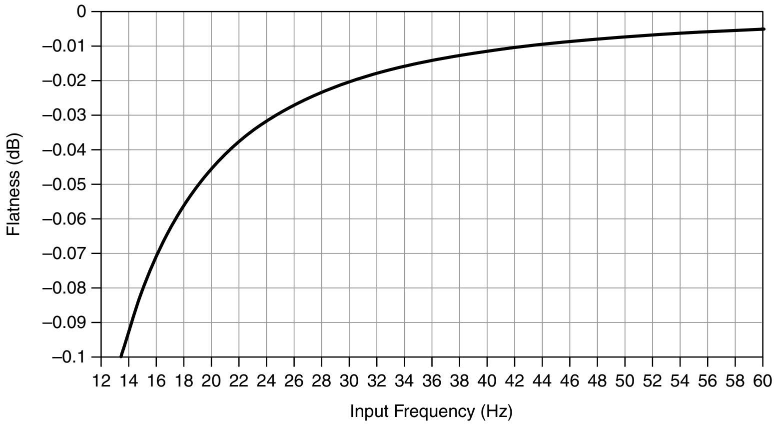
* Relative to 1 kHz.

† Charge filter OFF.

Charge Measurement FIlter

OFF	None
ON	2nd order, 30 kHZ low-pass filter

Figure 5. Charge Measurement Gain Flatness



Interchannel Gain Mismatch (Voltage)

Range (V)	AC/DC-Coupled Mismatch (dB)*, Max, (Typical)			AC-Coupled Mismatch (dB)*, Max (Typical)	
	f_{in} = 20 Hz to 20 kHz	f_{in} > 20 kHz to 50 kHz	f_{in} > 50 kHz to 100 kHz	f_{in} = 5 Hz	f_{in} = 10 Hz
10	0.011 (0.005)	0.011 (0.005)	0.011 (0.005)	0.019 (0.009)	0.015 (0.007)
5	0.013 (0.006)	0.013 (0.006)	0.013 (0.006)		
1	0.015 (0.007)	0.015 (0.007)	0.019 (0.009)		
0.5	0.015 (0.007)	0.017 (0.008)	0.034 (0.017)		

* Identical channel configurations.

Interchannel Phase Mismatch (Voltage)

Range (V)	AC/DC-Coupled Mismatch*, Max, (Typical)			AC-Coupled Mismatch*, Max (Typical)	
	f_{in} = 20 Hz to 20 kHz	f_{in} > 20 kHz to 50 kHz	f_{in} > 50 kHz to 100 kHz	f_{in} = 5 Hz	f_{in} = 10 Hz
10	0.02° (0.01°)	0.05° (0.025°)	0.1° (0.05°)	0.34° (0.17°)	0.17° (0.09°)
5	0.04° (0.02°)	0.10° (0.05°)	0.2° (0.1°)		
1	0.24° (0.12°)	0.60° (0.30°)	1.2° (0.6°)		
0.5	0.38° (0.19°)	0.96° (0.48°)	1.9° (0.95°)		

* Identical channel configurations.

Note Listed gain and phase mismatch specifications are valid for measurements made on channels on the same module. For measurements made on channels on different modules, the listed gain and phase mismatch specifications still apply, but are subject to the following conditions:

- For gain matching, all modules must be properly warmed up. Refer to the Environmental section for the specified warm-up time.
- For phase matching, all modules must be synchronized to a common timebase. To the listed specifications, add the following error: 360° × f_{in} × `clock skew`. Refer to the Timing and Synchronization section for the maximum intermodule clock skew.

Idle Channel Noise (Voltage)

Range (V)	Idle Channel Noise (μVrms)*		
	f_s = 51.2 kSample/s	f_s = 204.8 kSample/s	f_s = 1.25 MSample/s
10	16	32	87
5	6.5	13	35
1	1.8	3.6	9.1
0.5	1.5	3.0	7.1

* Source impedance ≤ 50 Ω.

Dynamic Range (Voltage)

Range (V)	Dynamic Range (dBFS)*, †		
	f_s = 51.2 kSample/s	f_s = 204.8 kSample/s	f_s = 1.25 MSample/s
10	113	107	98
5	115	109	100
1	112	106	98
0.5	107	101	94

* 1 kHz tone, -60 dBFS input amplitude.

† Source impedance ≤ 50 Ω.

Idle Channel Noise (Charge)

Range (pC)	Idle Channel Noise (fC_{rms})*		
	f_s = 51.2 kSample/s	f_s = 204.8 kSample/s	f_s = 1.25 MSample/s
20,000	32	64	174
10,000	16	30	75
2,000	13	18	25
1,000	13	18	25

* Charge filter OFF.

Representative Measurement FFTs (1 kHz)

Test conditions for all FFTs: Unaveraged computation of 1.6 million samples, differential input configuration.

Figure 6. -3 dBFS, 1 kHz Tone Acquired at 1.25 MSample/s, 10 V Range (Full Bandwidth)

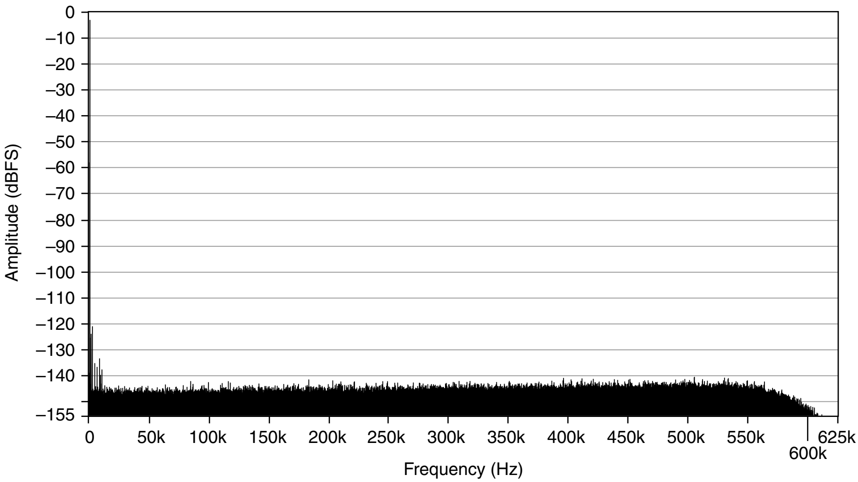


Figure 7. -3 dBFS, 1 kHz Tone Acquired at 1.25 MSample/s, 10 V Range (20 kHz Bandwidth)

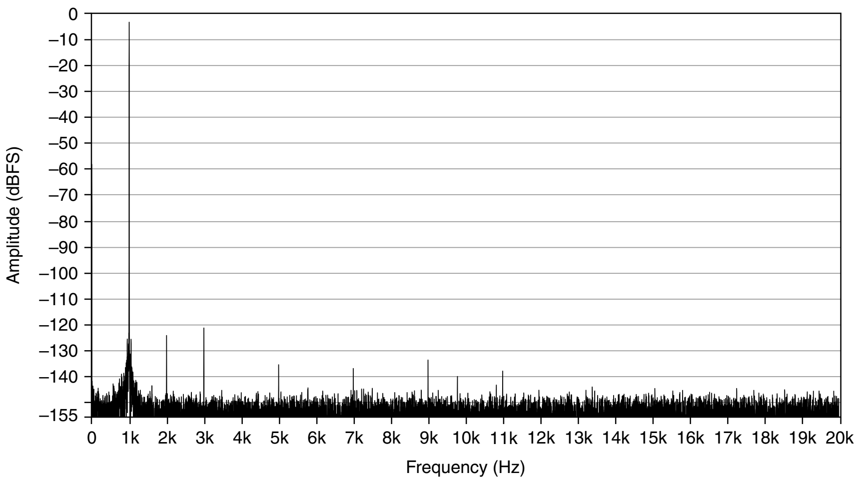


Figure 8. -3 dBFS, 1 kHz Tone Acquired at 1.25 MSample/s, 5 V Range (Full Bandwidth)

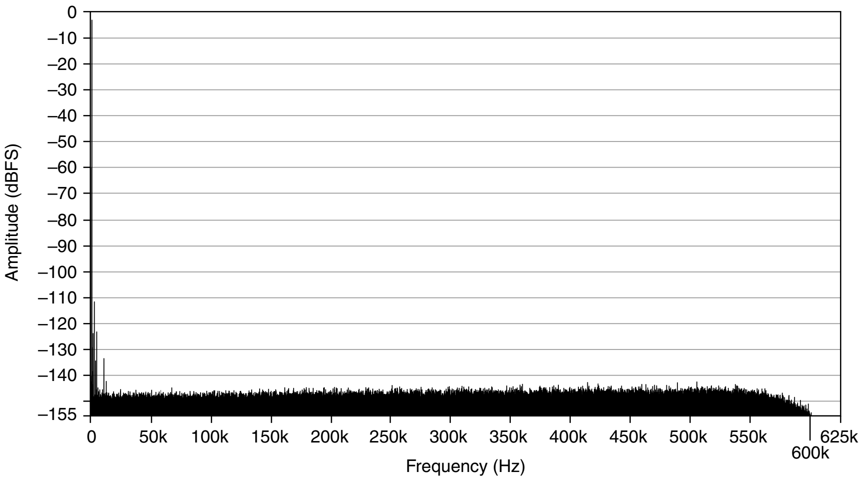


Figure 9. -3 dBFS, 1 kHz Tone Acquired at 1.25 MSample/s, 5 V Range (20 kHz Bandwidth)

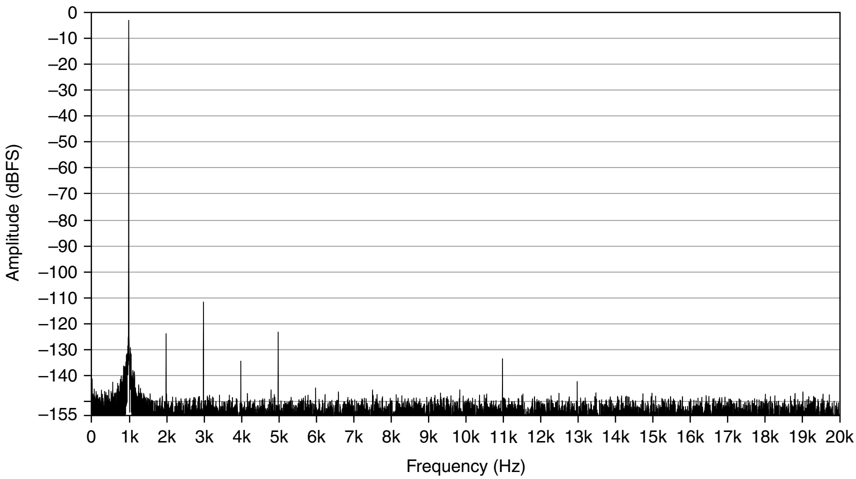


Figure 10. -3 dBFS, 1 kHz Tone Acquired at 1.25 MSample/s, 1 V Range (Full Bandwidth)

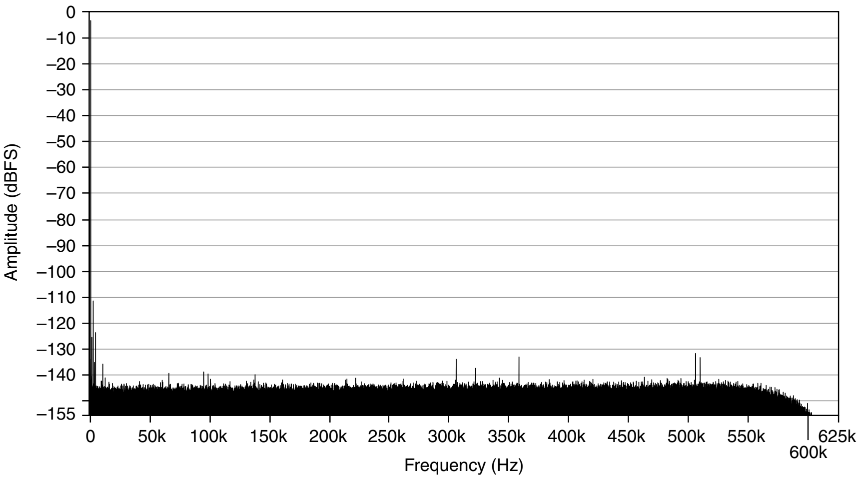


Figure 11. -3 dBFS, 1 kHz Tone Acquired at 1.25 MSample/s, 1 V Range (20 kHz Bandwidth)

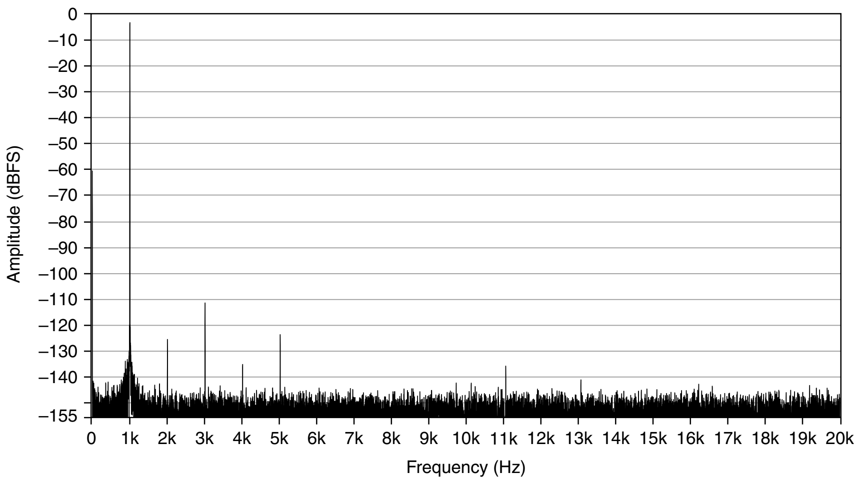


Figure 12. -3 dBFS, 1 kHz Tone Acquired at 1.25 MSample/s, 0.5 V Range (Full Bandwidth)

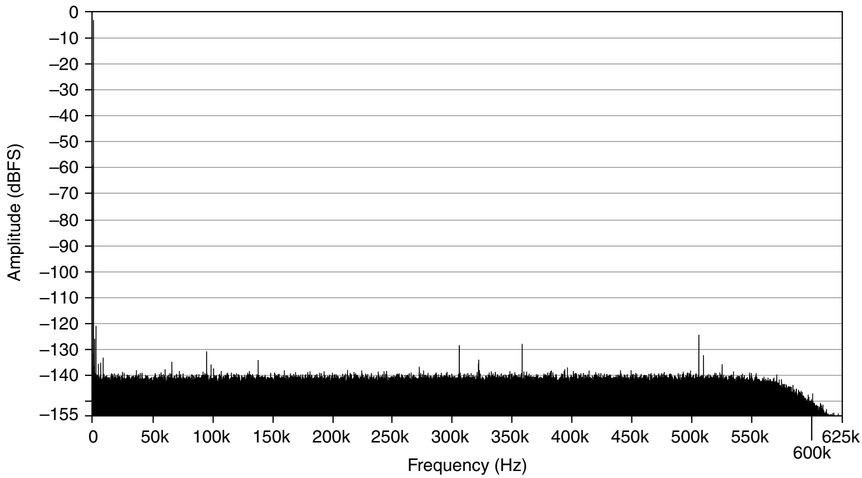
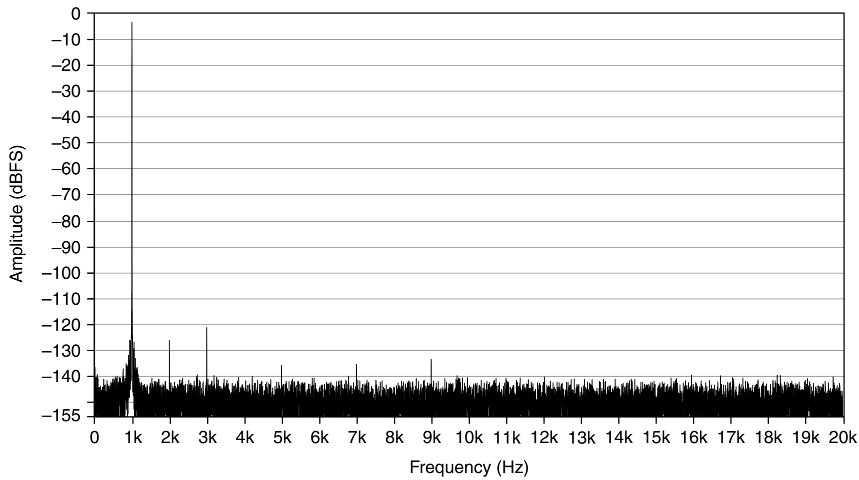


Figure 13. -3 dBFS, 1 kHz Tone Acquired at 1.25 MSample/s, 0.5 V Range (20 kHz Bandwidth)



Representative Measurement FFTs (10 kHz)

Test conditions for all FFTs: Unaveraged computation of 1.6 million samples, differential input configuration.

Figure 14. -3 dBFS, 10 kHz Tone Acquired at 1.25 MSample/s, 10 V Range (Full Bandwidth)

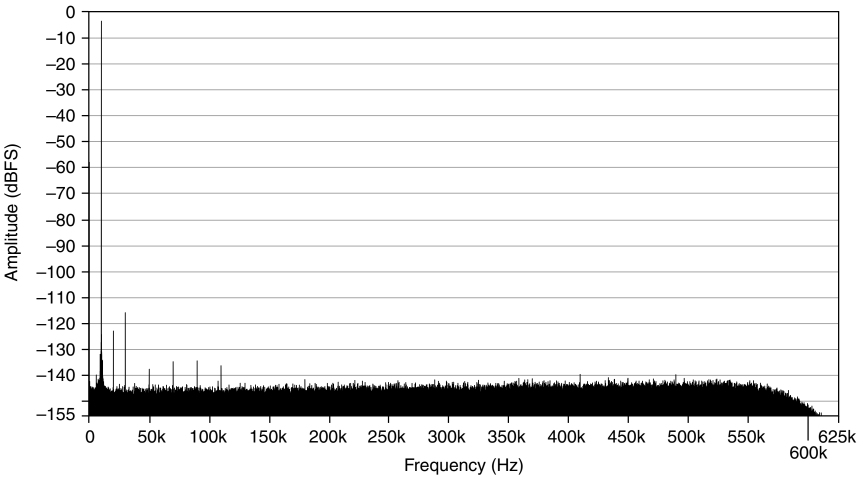


Figure 15. -3 dBFS, 10 kHz Tone Acquired at 1.25 MSample/s, 10 V Range (150 kHz Bandwidth)

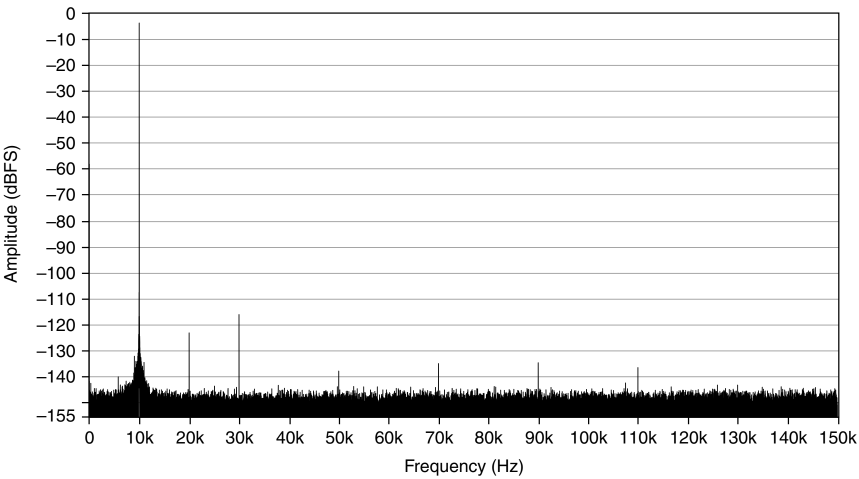


Figure 16. -3 dBFS, 10 kHz Tone Acquired at 1.25 MSample/s, 5 V Range (Full Bandwidth)

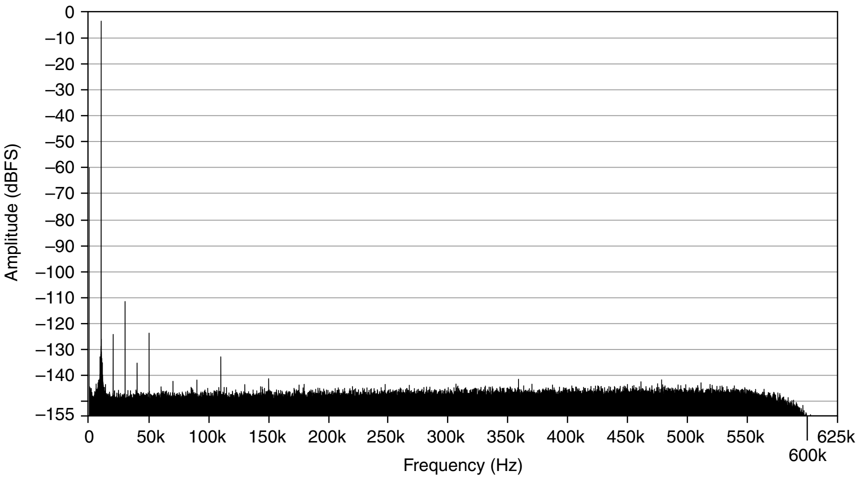


Figure 17. -3 dBFS, 10 kHz Tone Acquired at 1.25 MSample/s, 5 V Range (150 kHz Bandwidth)

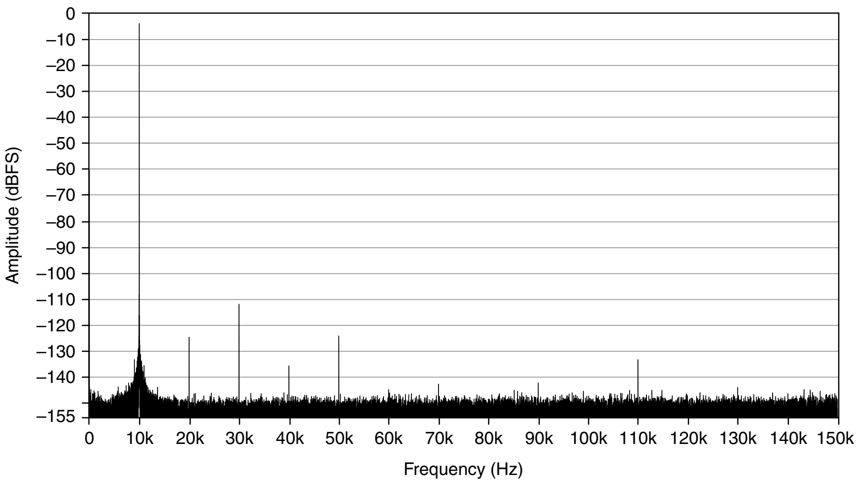


Figure 18. -3 dBFS, 10 kHz Tone Acquired at 1.25 MSample/s, 1 V Range (Full Bandwidth)

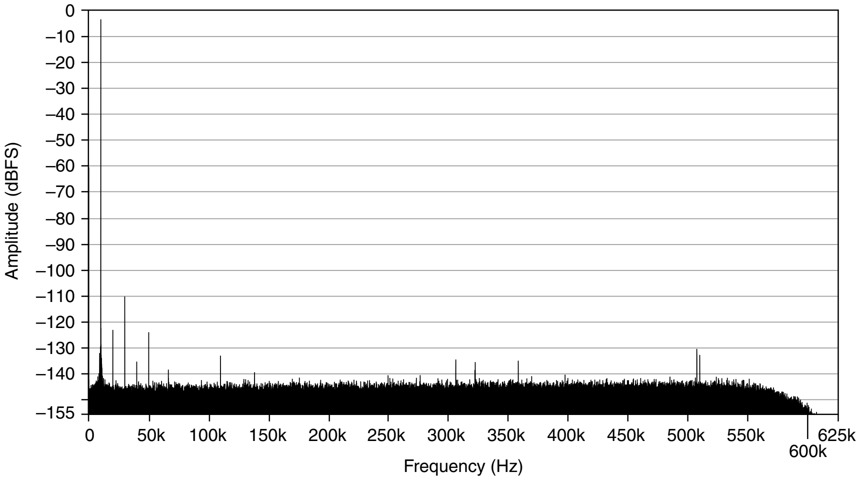


Figure 19. -3 dBFS, 10 kHz Tone Acquired at 1.25 MSample/s, 1 V Range (150 kHz Bandwidth)

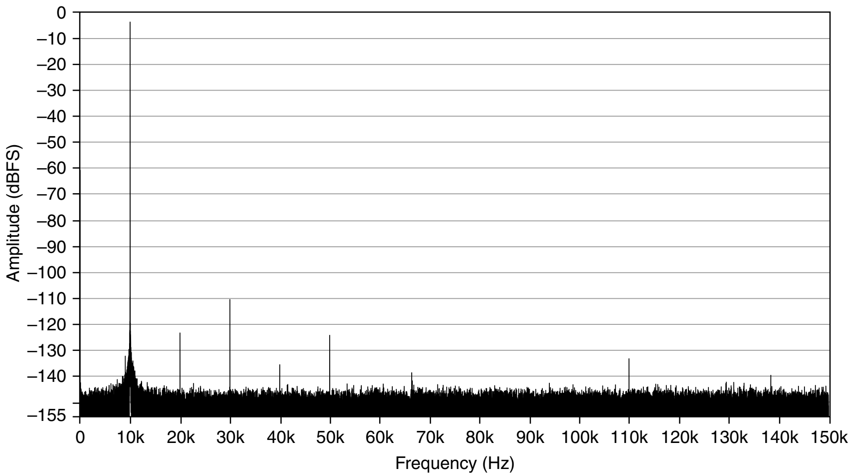


Figure 20. -3 dBFS, 10 kHz Tone Acquired at 1.25 MSample/s, 0.5 V Range (Full Bandwidth)

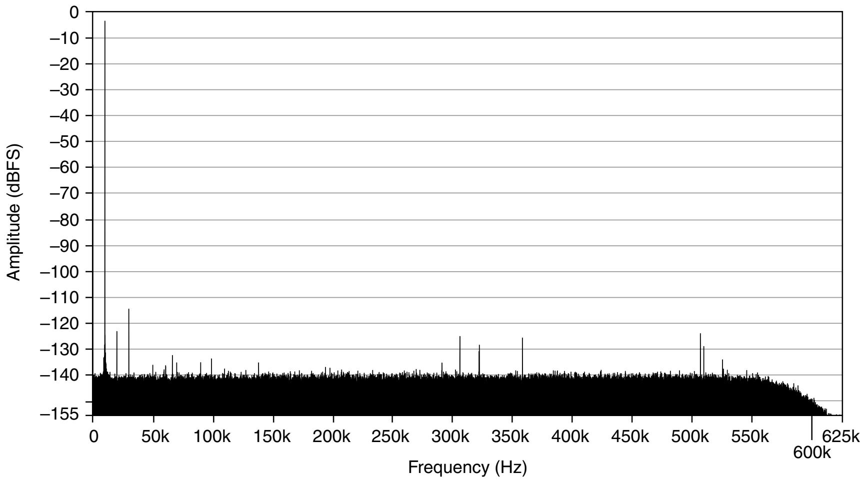
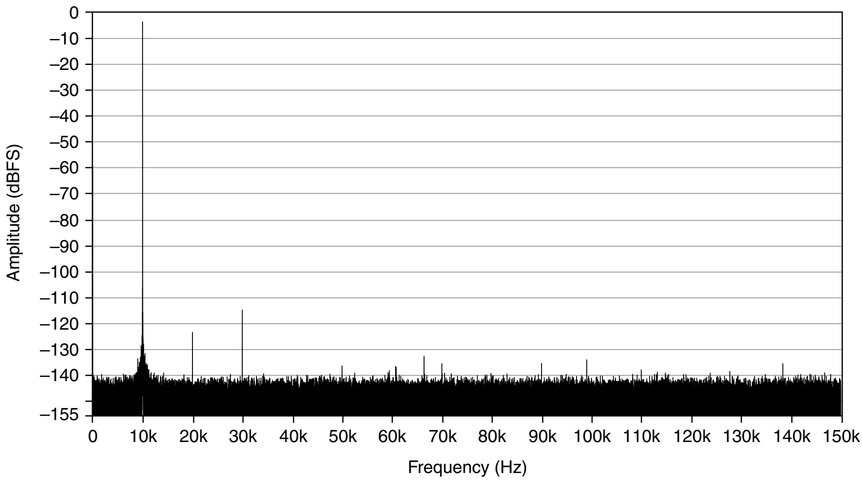


Figure 21. -3 dBFS, 10 kHz Tone Acquired at 1.25 MSample/s, 0.5 V Range (150 kHz Bandwidth)



Spurious Free Dynamic Range (Voltage)

Range (V)	SFDR (dBC)*, †, ‡		
	f_s = 51.2 kSample/s	f_s = 204.8 kSample/s	f_s = 1.25 MSample/s
10	100	100	100
5	100	100	100
1	100	100	94
0.5	100	100	88

* 1 kHz input tone, input amplitude is -3 dBFS.

† Differential configuration.

‡ Evaluation BW = 10 Hz to 0.4 f_s

Total Harmonic Distortion (THD), Balanced Source

Range (V)	THD (dBC)*, †				
	f_s = 51.2 kSample/s		f_s = 204.8 kSample/s		
	f_{in} = 1 kHz	f_{in} = 20 Hz to 20 kHz	f_{in} = 1 kHz	f_{in} = 20 Hz to 20 kHz	f_{in} > 20 kHz to 80 kHz
10, 5, 1, 0.5	-100	-100	-100	-98	-96

* Input amplitude is -3 dBFS.

† Differential configuration.

Range (V)	THD (dBC)*, †				
	f_s = 1.25 MSample/s				
	f_{in} = 1 kHz	f_{in} = 10 kHz	f_{in} = 20 Hz to 20 kHz	f_{in} > 20 kHz to 50 kHz	f_{in} > 50 kHz to 100 kHz
10, 5, 1, 0.5	-100	-99	-98	-95	-90

* Input amplitude is -3 dBFS.

† Differential configuration.

Total Harmonic Distortion (THD), Unbalanced Source

Range (V)	THD (dBC)*, †				
	f_s = 51.2 kSample/s		f_s = 204.8 kSample/s		
	f_{in} = 1 kHz	f_{in} = 20 Hz to 20 kHz	f_{in} = 1 kHz	f_{in} = 20 Hz to 20 kHz	f_{in} > 20 kHz to 80 kHz
10	-100	-97	-100	-90	-85
5, 1, 0.5	-100	-100	-100	-97	-96

* Input amplitude is -3 dBFS.

† Pseudodifferential configuration.

Range (V)	THD (dBC)*, †				
	f_s = 1.25 MSample/s				
	f_{in} = 1 kHz	f_{in} = 10 kHz	f_{in} = 20 Hz to 20 kHz	f_{in} > 20 kHz to 50 kHz	f_{in} > 50 kHz to 100 kHz
10	-100	-95	-90	-81	-74
5, 1, 0.5	-100	-98	-97	-92	-81

* Input amplitude is -3 dBFS.

† Pseudodifferential configuration.

Crosstalk, Input Channel Separation

Range (V)	Crosstalk (dBC)*, †	
	f_{in} = 1 kHz	f_{in} = 100 kHz
10, 5, 1, 0.5	-140	-100

* Input amplitude is -1 dBFS.

† Source impedance is ≤ 50 Ω

Voltage Reference

DC level	4,096 V
Temperature coefficient	5 ppm/°C max
Time stability	20 ppm/1,000 hr

IEPE Excitation

Current settings	
OFF	0 mA
4 mA	4 mA min, 4.15 mA typical, 4.3 mA max
10 mA	9.7 mA min, 10 mA typical, 10.3 mA max
20 mA	19.4 mA min, 20 mA typical, 20.6 mA max

Each channel independently software-selectable.

Voltage compliance	22 V

Note Use the following equation to make sure that your configuration meets the IEPE voltage compliance range: $CommonMode + Bias \pm FullScale + (Excitation \text{ x } 50\ \Omega)$ must be 0 V to 22 V, where

CommonMode is the common-mode voltage seen by the input channel,
Bias is the DC bias voltage of the sensor,
FullScale is the full-scale voltage of the sensor, and
Excitation is the selected excitation setting.

Sensor open detection[3] (software-readable)	
4 mA	23 V
10 mA	22.5 V
20 mA	22 V
Sensor short detection[3] (software-readable)	
4 mA	1.3 V
10 mA	1 V
20 mA	0.5 V
Channel input impedance with IEPE enabled	1.62 MΩ || 250 pF, pseudodifferential

[3] Voltage between positive input (+) and negative input (-).

Transducer Electronic Data Sheet

Supports Transducer Electronic Data Sheet (TEDS) according to the IEEE 1451 Standard	Class I, all module inputs

Note For more information about TEDS, go to *ni.com/info* and enter the Info Code `rdteds`.

Maximum load capacitance	10,000 pF

Voltage Excitation

Voltage settings	
OFF	0 V
10 V (fixed)	10 V
25 V (fixed)	25 V
Adjustment range	9.5 V to 11.98 V
Adjustment resolution	10 mV

Each channel independently software-selectable.

Load regulation[4]	0.01%/mA
Output current (per channel)	25 mA min
Current limit detection (software-readable)	27.5 mA

Frequency Timebase Characteristics

Accuracy	
Using internal VCXO timebase	±50 ppm max
Using external timebase	Equal to accuracy of external timebase

[4] Excludes the effect of external cable resistance.

Timing and Synchronization

Number of timing engines[5]	3
Reference clock source	Onboard clock, backplane PXIe_CLK100
Intermodule ADC clock skew[6]	
T_{tb} ±5 °C	11 ns max (Listed accuracy is valid for 30 days following a timebase change. T_{tb} = ambient temperature at which the timebase source was last changed.)
Over full operating temperature range	20 ns max

Triggers

Analog trigger	
Purpose	Reference trigger only
Source	Any channel
Level	Full scale, programmable
Mode	Rising-edge or falling-edge with hysteresis, entering or leaving window
Resolution	24 bits
Digital trigger	
Purpose	Start or reference trigger
Source	PFI0, PXI_Trig<0..7>, PXI_Star, PXIe_DStar<A..B>
Polarity	Rising or falling edge, software-selectable
Minimum pulse width	100 ns for PXI_Trig<0..7>, 20 ns for others

[5] Channels can be arbitrarily grouped and assigned to timing engines. Timing engines can be independently synchronized, started, and stopped. Each timing engine can be utilized in frequency domain mode or time domain mode, but not both types simultaneously. All timing engines must use the same reference clock source. Refer to the *PXIe-4480/4481 User Manual* for more details on the assignment of timing engines.

[6] Valid between PXIe-4480/4481 modules installed in the same chassis. Between PXIe-4480/4481 modules in different chassis, add the potential skew in the PXI_CLK10 clock distribution. Refer to the appropriate chassis documentation for its clock skew specifications.

Output Timing Signals

Sources	Start Trigger Out, Reference Trigger Out, Sync Pulse Out
Destinations	PFI0, PXI_Trig<0..7>, PXIe_DStarC
Polarity	Software-selectable except for Sync Pulse Out (always active low)

PFI0 (Front Panel Digital Trigger)

Input	
Logic compatibility	3.3 V or 5 V
Input range	0 V to 5.5 V
V_{IL}	0.95 V max
V_{IH}	2.4 V min
Input impedance	10 kΩ
Overvoltage protection	±10 V_{pk}
Output	
Output range	0 V to 3.45 V
V_{OL}	0.33 V max at 5 mA
V_{OH}	2.8 V min at 5 mA
Output impedance	50 Ω
Output current	±5 mA max

Time Domain Mode

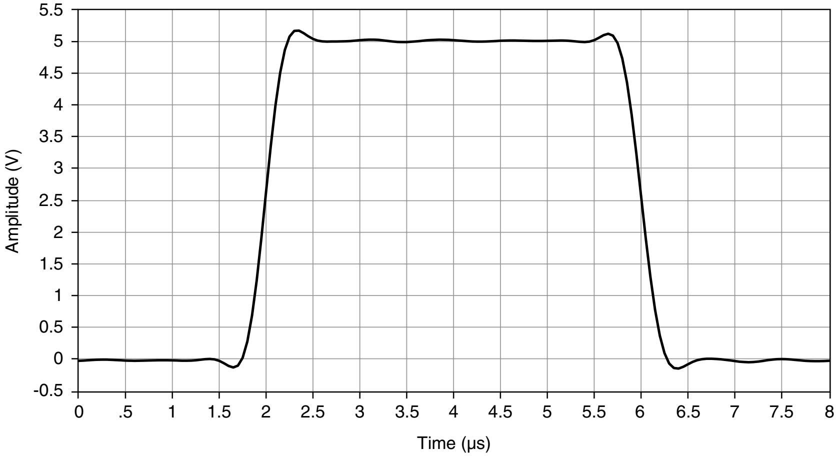
Base sample rate	20 MSample/s
Sample rate decimation[7]	Base sample rate divided by integers 1 to 15
Default FIR filter[8]	
Type	Equiripple low pass
Number of taps	35

[7] Time domain mode always operates and filters at the base sample rate of 20 MSample/s. Users may request a slower sample rate that the module will create by dropping samples to decimate down to the requested rate.

[8] Digital filter is user-programmable. Refer to the *PXIe-4480/4481 User Manual* for more details.

Passband ripple	±5 mdB (DC to 800 kHz)
Stopband attenuation	≥ 120 dB, f_{in} ≥ 3.9 MHz
Effective number of bits (ENOB)	
10 V range	13.2
5 V range	13.5
1 V range	13.5
0.5 V range	13.1

Figure 22. Time Domain Step Response, 5 V Range, Sampled at 20 MSample/s



Note The measured step response is affected by both the fixed anti-aliasing analog filtering and the digital filter used. Signal measured for step response had a rise/fall time of less than 15 ns.

General Specifications

This section lists general specification information for the PXIe-4480.

Bus Interface

Form factor	x4 PXI Express peripheral module, Specification rev. 1.0 compliant
Slot compatibility	PXI Express or PXI Express hybrid slots
DMA channels	3, analog input

Power Requirements

Voltage (V)	Current (A), Max (Typical)
+3.3	2.0 (1.5)
+12	3.0 (2.5)

Physical

Dimensions (not including connectors)	16 cm x 10 cm (6.3 in. x 3.9 in.) 3U CompactPCI slot
Analog input connector	InfiniBand 12x
Digital trigger connector (PFI0)	SMB male
Front-panel LEDs	2 (Access, Active)
Weight	264 g (9.3 oz)
Measurement Category	1[9]

Caution Do not use the PXIe-4480 for connections to signals or for measurements within Categories II, III, or IV.

Caution The protection provided by the PXIe-4480 can be impaired if it is used in a manner not described in this document.

Caution Clean the hardware with a soft, nonmetallic brush. Make sure that the hardware is completely dry and free from contaminants before returning it to service.

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 (800 mbar)
Pollution degree	2

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

Indoor use only.

Storage Environment

Ambient temperature range	-40 °C to 71 °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-288800F, Class 3.)

Calibration

External calibration interval	2 years
Warm-up time	15 minutes

Safety

This product is designed to meet the requirements of the following electrical equipment safety standards for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA C22.2 No. 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 61326-1 (IEC 61326-1): Class A emissions; Controlled immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- EN 55022 (CISPR 22): Class A emissions
- EN 55024 (CISPR 24): Immunity
- AS/NZS CISPR 11: Group 1, Class A emissions
- AS/NZS CISPR 22: Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions

Note Group 1 equipment (per CISPR 11) is any industrial, scientific, or medical equipment that does not intentionally generate radio frequency energy for the treatment of material or inspection/analysis purposes.

Note In the United States (per FCC 47 CFR), Class A equipment is intended for use in commercial, light-industrial, and heavy-industrial locations. In Europe, Canada, Australia and New Zealand (per CISPR 11) Class A equipment is intended for use only in heavy-industrial locations.

Note For EMC declarations and certifications, and additional information, refer to the *Online Product Certification* section.

CE Compliance CE

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

- 2014/35/EU; Low-Voltage Directive (safety)
- 2014/30/EU; 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*, 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 *Minimize Our Environmental Impact* web page at *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 product life cycle, all NI products must be disposed of according to local laws and regulations. For more information about how to recycle NI products in your region, visit *ni.com/environment/weee*.

电子信息产品污染控制管理办法（中国 RoHS）

中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令(RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请登录 `ni.com/environment/rohs_china`。(For information about China RoHS compliance, go to `ni.com/environment/rohs_china`.)

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Visit *ni.com/services* for NI Factory Installation Services, repairs, extended warranty, and other services.

Visit *ni.com/register* to register your NI product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

A Declaration of Conformity (DoC) is our claim of compliance with the Council of the European Communities using the manufacturer's declaration of conformity. This system affords the user protection for electromagnetic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting *ni.com/certification*. If your product supports calibration, you can obtain the calibration certificate for your product at *ni.com/calibration*.

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376247B-01 October 31, 2017