PXIe-4309 Specifications

2024-05-09

Contents

PXIe-4309 Specifications

Definitions

Maximum and **minimum** specifications characterize the warranted performance of the instrument within the recommended calibration interval and under the stated operating conditions. These specifications are subject to production verification or guaranteed by design.

Typical specifications are specifications met by the majority of the instruments within the recommended calibration interval and under the stated operating conditions, based on measurements taken during production verification and/or engineering development. The performance of the instrument is not warranted.

Supplemental specifications describe the basic function and attributes of the instrument established by design and are not subject to production verification. They provide information that is relevant for the adequate use of the instrument that is not included in the previous definitions.

Measured specifications describe the measured performance of a representative model.

The following specifications are typical at 25 °C, unless otherwise noted.

- T_{extcal} is the device temperature at last external calibration.
- $T_{selfcal}$ is the device temperature at last self-calibration.

Input Characteristics

> **Note** This product is specifically designed for the precise measurement of signals with low source impedance. For best performance and to minimize settling time, keep the source impedance ≤ 50 Ω from DC to 2 MHz.

Number of ADCs	8 simultaneously sampling ADCs
Number of channels	
Single channel per ADC	8 differential analog input channels
Multichannel per ADC[1]	32 differential analog input channels
ADC resolution	18 bits
Type of ADC	SAR
DNL	No missing codes
INL	Refer to Absolute Accuracy section
Measurement resolution[2]	18 bits - 28 bits
Maximum warranted sample rate[3]	
Auto zero none	
Single channel per ADC	2 MS/s
Multichannel per ADC, High Accuracy	10 kS/s (aggregate)
Multichannel per ADC, Maximum Warranted Throughput	400 kS/s (aggregate)
Auto zero once	
Single channel per ADC	2 MS/s

1 Up to 4 channels per ADC.
2 Depends on the sample rate. Refer to the Noise versus Sampling Rate section for more information.
3 For multichannel, up to 4 channels per ADC. Refer to the PXIe-4309 User Manual for Maximum Sample Rates in Hardware-Timed Single point, On-Demand, and External Sample Clock modes.

Multichannel per ADC, High Accuracy	10 kS/s (aggregate)
Multichannel per ADC, Maximum Warranted Throughput	400 kS/s (aggregate)
Auto zero every sample	
Single channel per ADC	10 kS/s
Multichannel per ADC	10 kS/s (aggregate)

Note Aggregate sample rate is the total number of samples acquired by a single ADC per second. For example, when a single ADC is sampling two channels every 10 us, each channel is sampled at 100kS/s and the aggregate sample rate for that ADC is 200kS/s.

Chopping	
Single channel per ADC	10 kS/s
Multichannel per ADC	10 kS/s (aggregate)
Input coupling	DC
Input range	±0.1 V, ±1.0 V, ±10 V, ±15 V
Input overrange	0.5% of range
Maximum warranted working voltage (signal + common mode)	Maximum warranted difference of 15.5 V of the inputs per ADC

Note On each ADC bank of 4 analog input channels, the maximum warranted voltage difference across the four positive and the four negative inputs can be no more than 15.5 V. For example, if there is +15 V (signal + common mode) on one channel while applying -15 V (signal + common mode) on another channel within an ADC bank, the signal cannot be measured properly due to the 30 V difference, which exceeds the specified limit of 15.5 V. To make both measurements, the -15 V must be measured on a channel from a separate ADC bank.

Overvoltage protection	
Device on/off	±30 V min
Overvoltage protection input current	
Device on	±100 µA
Device off	±10 µA

Absolute Accuracy

DC Voltage Specifications

Table 1. DC Voltage Specifications for Auto Zero None, Auto Zero Once, Auto Zero Every Sample, and Chopping

Mode	Range	Maximum Absolute Accuracy *, **, ††			Temperature Coefficient††
		24 Hour†, ‡ T_{extcal} ± 1 °C $T_{selfcal}$ ± 1 °C	2 Year T_{extcal} ± 5 °C $T_{selfcal}$ ± 1 °C	2 Year T_{extcal} ± 10 °C $T_{selfcal}$ ± 5 °C	0 °C - 55 °C
		± (ppm of reading + µV)			± (ppm of reading + µV) / °C
Auto Zero None	0.1 V	33 + 3.2	60 + 7.6	165 + 11.6	25 + 1
	1.0 V	28 + 7.4	55 + 16.2	140 + 36.2	20 + 5
	10 V	23 + 59.6	50 + 155	115 + 355	15 + 50
	15 V	28 + 89.0	55 + 307	140 + 607	20 + 75
Auto Zero Once	0.1 V	33 + 2.3	60 + 6.7	165 + 7.1	25 + 0.1
	1.0 V	28 + 2.5	55 + 11.3	140 + 11.7	20 + 0.1

Mode	Range	Maximum Absolute Accuracy *, **, ††			Temperature Coefficient††
		24 Hour†, ‡ T_{extcal} ± 1 °C $T_{selfcal}$ ± 1 °C	2 Year T_{extcal} ± 5 °C $T_{selfcal}$ ± 1 °C	2 Year T_{extcal} ± 10 °C $T_{selfcal}$ ± 5 °C	0 °C - 55 °C
		± (ppm of reading + µV)			± (ppm of reading + µV) / °C
	10 V	23 + 9.7	50 + 104.9	115 + 105.3	15 + 0.1
	15 V	28 + 14.1	55 + 232.1	140 + 232.5	20 + 0.1
Auto Zero Every Sample	0.1 V	33 + 0.3	60 + 4.7	165 + 5.1	25 + 0.1
	1.0 V	28 + 0.5	55 + 9.3	140 + 9.7	20 + 0.1
	10 V	23 + 2.7	50 + 55.4	115 + 55.8	15 + 0.1
	15 V	28 + 4.0	55 + 156.1	140 + 156.5	20 + 0.1
Chopping	0.1 V	33 + 0.1	60 + 2.6	165 + 2.6	25 + 0.01
	1.0 V	28 + 0.2	55 + 7.1	140 + 7.2	20 + 0.01
	10 V	23 + 1.3	50 + 52.7	115 + 52.7	15 + 0.01
	15 V	28 + 2.0	55 + 153.0	140 + 153.1	20 + 0.01

*Source Impedance ≤ 50 Ω.

†Relative to External Calibration Source.

‡Assumes Offset Nulling.

**Table 1 applies to multichannel per ADC Sample Rate ≤10 S/s and single channel per ADC Sample Rates ≤ 100kS/s. For Sample rates > 100 kS/s with single channel per ADC, operate in an integer division of 2 M S/s to maintain Table 1 accuracy.

For Sample Rate >10 S/s with multichannel per ADC, refer to the additional error from Accuracy vs Number of Channels per ADC vs Sample Rate section.

††Temperature Coefficient is an adder to the Absolute Accuracy values that does not apply unless operating outside of the stated self-calibration temperature intervals. Temperature Coefficient is included in the Absolute Accuracy values over the stated self-calibration temperature intervals.

Related reference:

- Accuracy vs Number of Channels Per ADC vs Sample Rate

- Noise versus Sampling Rate

DC Voltage Noise Specifications

Table 2. DC Voltage Noise Specifications for Auto Zero None, Auto Zero Once, Auto Zero Every Sample, and Chopping

Mode	Range	Noise*,†		
		10 S/s	10 kS/s	2 MS/s
		µV pk-pk	µV rms	
Auto Zero None	0.1 V	2.2	0.6	6.9
	1.0 V	2.4	0.8	11
	10 V	9.6	5.8	84
	15 V	14	8.7	125
Auto Zero Once	0.1 V	2.2	0.6	6.9
	1.0 V	2.4	0.8	11
	10 V	9.6	5.8	84
	15 V	14	8.7	125
Auto Zero Every Sample	0.1 V	0.2	0.8	N/A
	1.0 V	0.4	1.1	
	10 V	2.6	7.4	
	15 V	3.9	11	
Chopping	0.1 V	0.1	0.5	
	1.0 V	0.2	0.8	
	10 V	1.3	6.2	
	15 V	2	9.2	

*Source Impedance ≤50 Ω

† Noise for Single Channel per ADC. For Multiple Channel per ADC, refer to the Noise versus Sampling Rate section and the Accuracy vs Number of Channels per ADC vs Sample Rate section.

Accuracy vs Number of Channels Per ADC vs Sample Rate

Note The behavior demonstrated in the Accuracy vs Number of Channels per ADC vs Sample Rate graphs only represent data sets in which all the channels on a single ADC bank are at the same input range.

The graphs in this section illustrate the additional sources of error when scanning multiple channels per ADC at sample rates above 10 S/s. There are four sources of additional error that you need to add together: Gain Error, Offset Error, Differential Ghosting Error, and Common Mode Ghosting Error. Each of these errors depends on the sample rate and the number of channels being scanned per ADC.

For figures that depict a differential ghosting error, a change in the differential voltage between a channel and a preceding channel that scans the list of a single ADC causes differential ghosting error on a channel.

For example, consider three channels being scanned at 5 kS/s on a single ADC (channel 0, channel 16, and channel 24) with differential signals of 12 V, 10 V, and 6 V respectively. The change in differential signal for each channel is:

- 2 V (12 V-10 V) for channel 16.
- 4 V (10 V - 6 V) for channel 24.
- 6 V (6 V - 12 V) for channel 0, because channel 24 is before channel 0.

At 5kS/s, the graph shows an error of 5uV/V. So, due to differential ghosting, the additional error for each channel is:

- 10 uV (2 V * 5 uV/V) for channel 16.
- 20 uV on channel 24.
- 30 uV for channel 0.

Common mode ghosting follows the same methodology as differential ghosting, but the error is a function of the common mode voltage of the channels being scanned.

Auto Zero None and Auto Zero Once

The following graphs show the typical accuracy error difference between 1 channel per bank and multiple channels per bank.

Figure 1. Additional Gain Error for Multichannel per ADC over Sample Rate Per Channel >10 S/s

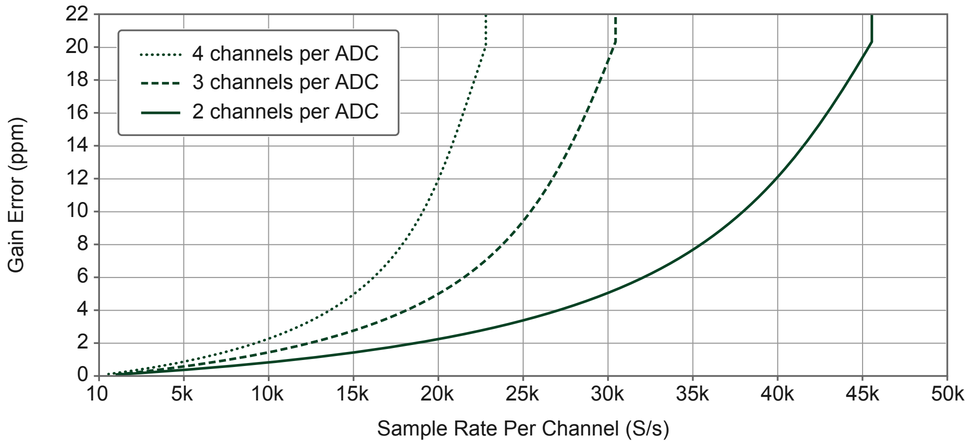


Figure 2. Additional Offset Error for Multichannel Per ADC over Sample Rate Per Channel >10 S/s

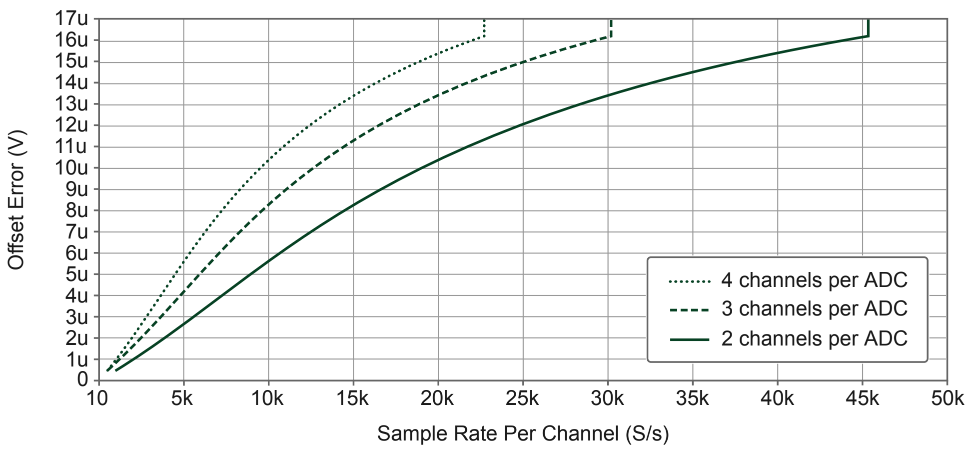


Figure 3. Differential Ghosting Error for Multichannel Per ADC over Sample Rate Per Channel

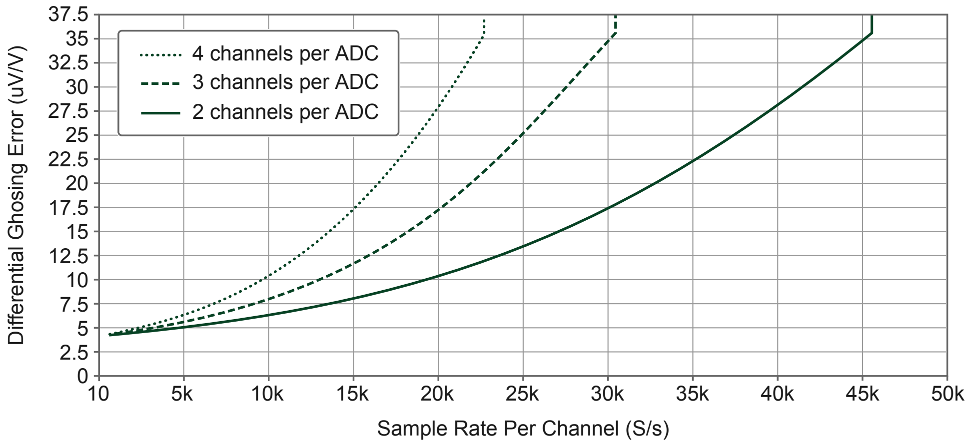
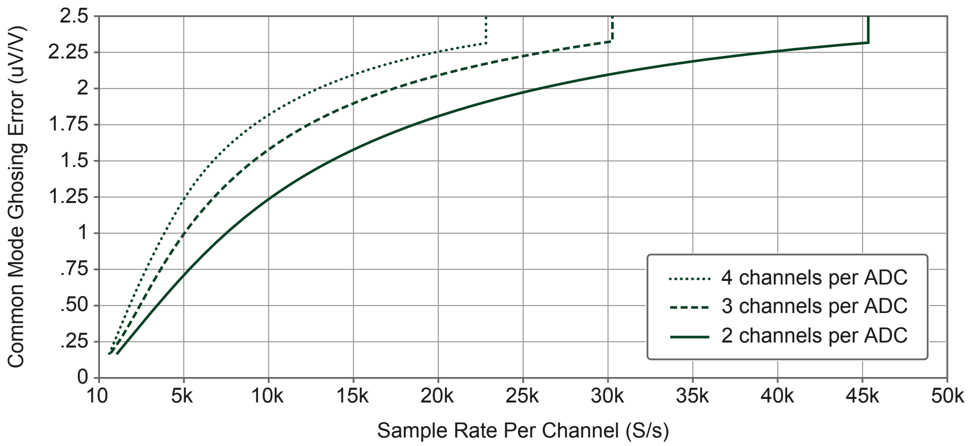


Figure 4. Common Mode Ghosting Error for Multichannel Per ADC over vs Sample Rate Per Channel



Auto Zero Every Sample

Figure 5. Additional Gain Error for Multichannel Per ADC over Sample Rate Per Channel >10 S/s

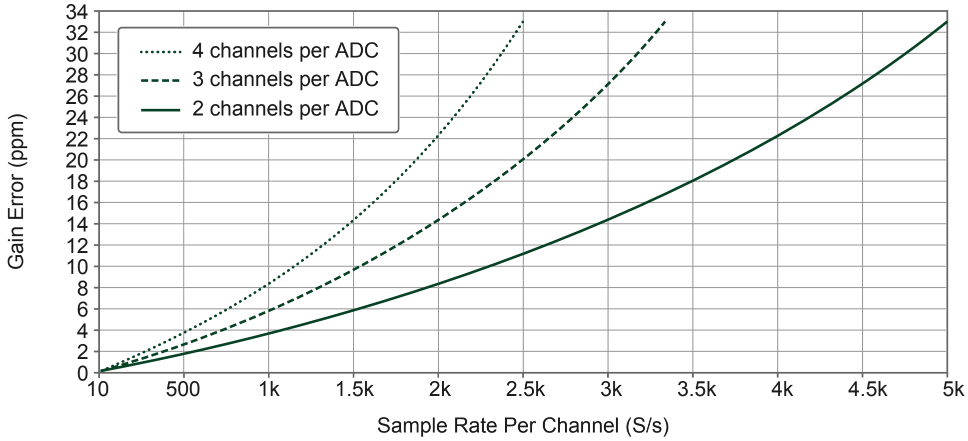


Figure 6. Additional Offset error for Multichannel per ADC over Sample Rate per Channel >10 S/s

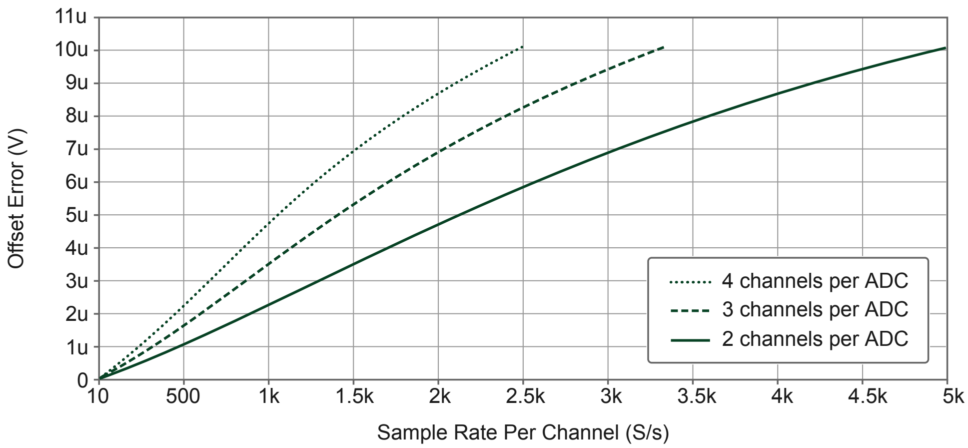


Figure 7. Differential Ghosting Error for Multichannel Per ADC over Sample Rate Per Channel

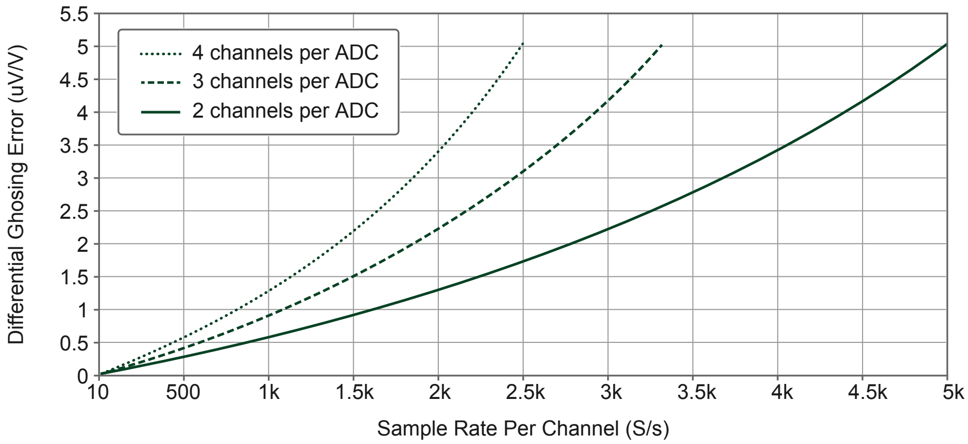
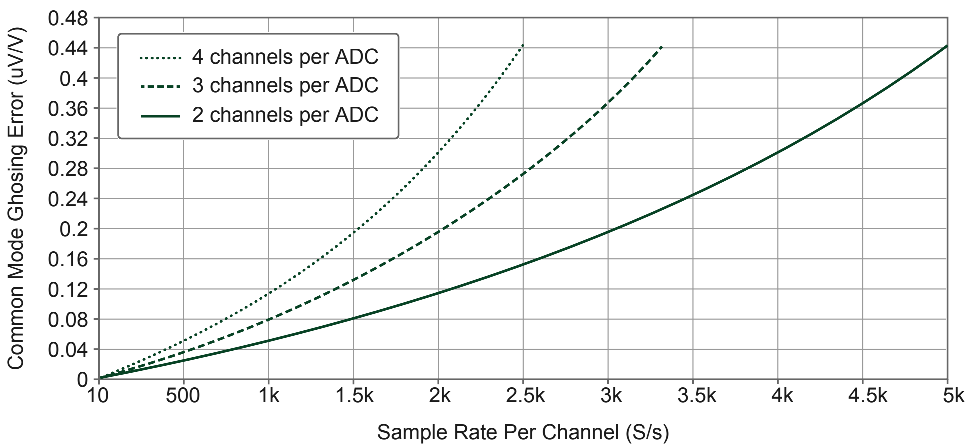


Figure 8. Common Mode Ghosting Error for Multichannel Per ADC over vs Sample Rate Per Channel



Noise versus Sampling Rate

Auto Zero None and Auto Zero Once

Figure 9. Noise versus Sample Rate Per Channel (Single channel per ADC), Measured

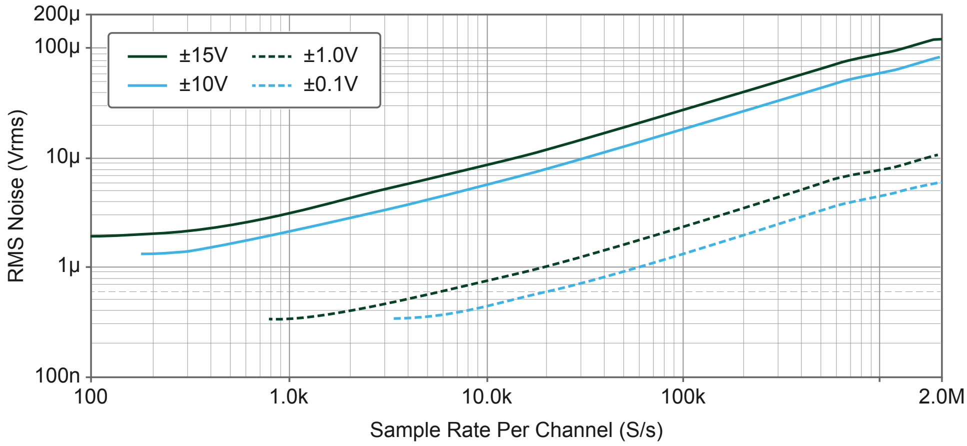
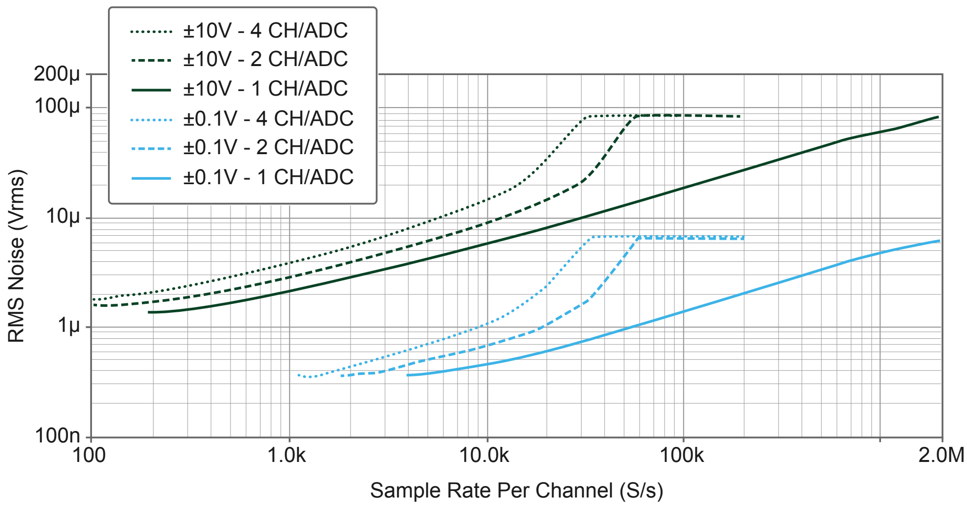


Figure 10. Noise versus Sample Rate Per Channel (Multichannel per ADC), Measured



Auto Zero Every Sample

Figure 11. Noise versus Sample Rate Per Channel (Single Channel Per ADC)

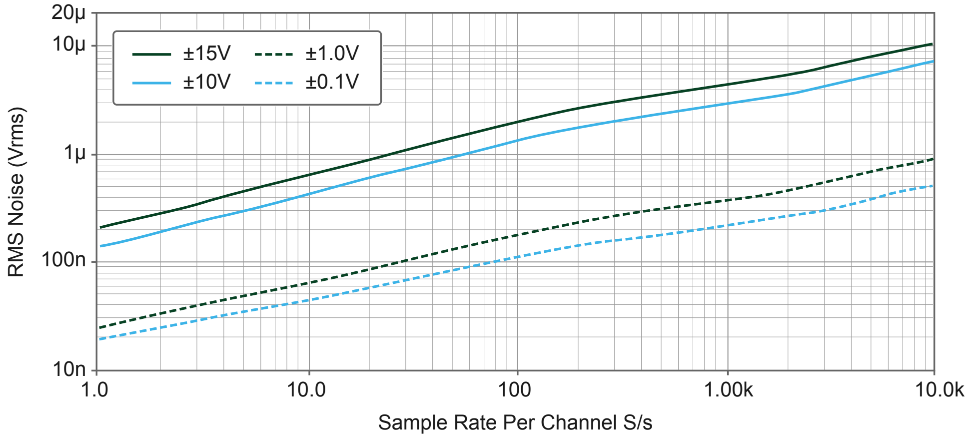
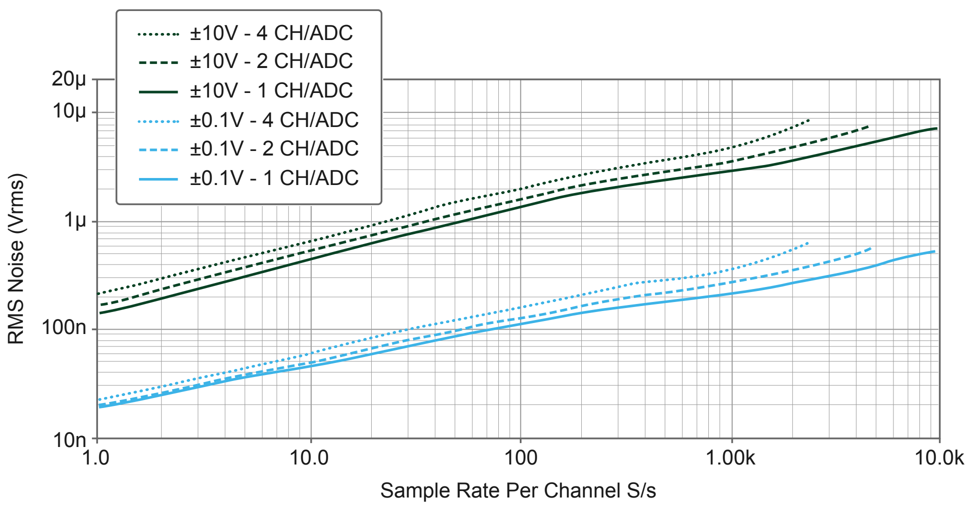


Figure 12. Noise versus Sample Rate Per Channel (Multichannel Per ADC)



Chopping

Figure 13. Noise versus Sample Rate Per Channel (Single Channel Per ADC)

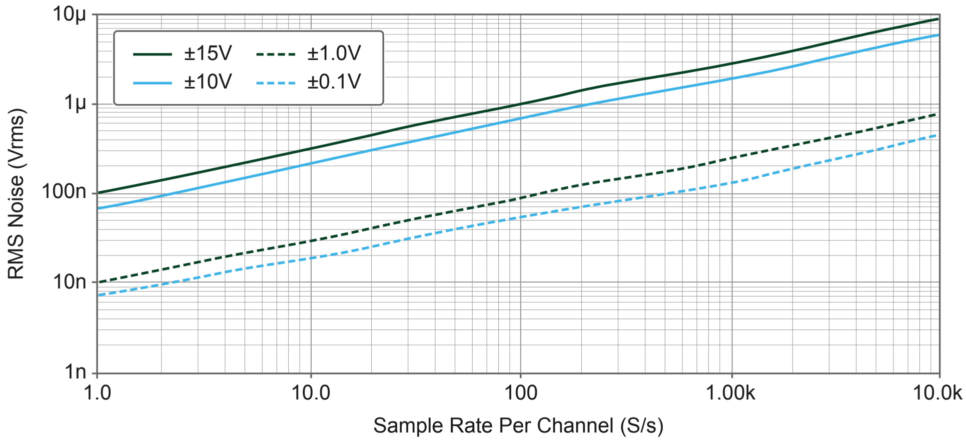
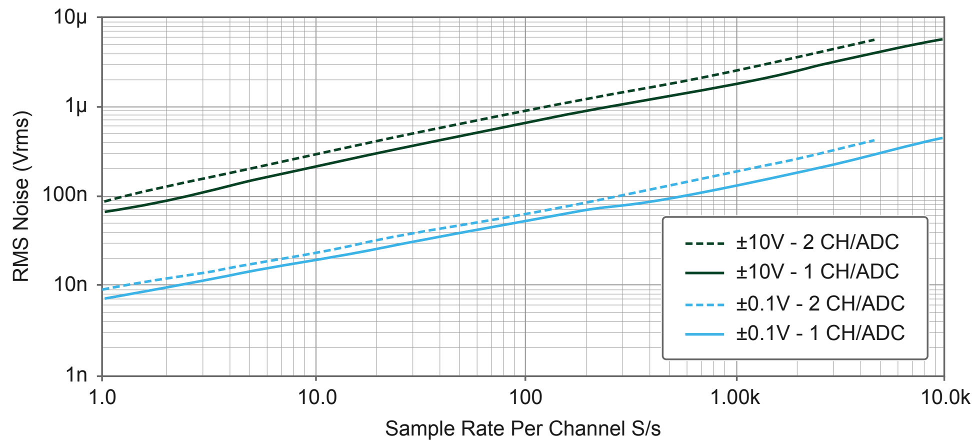


Figure 14. Noise versus Sample Rate Per Channel (Multichannel Per ADC)



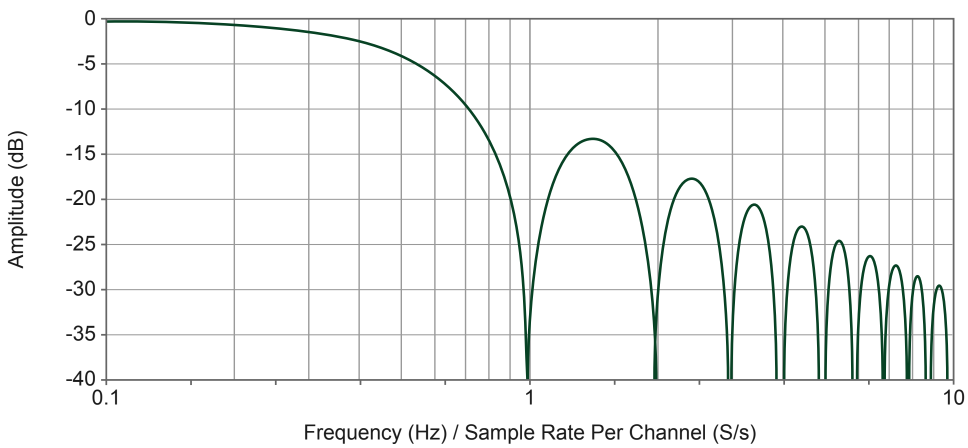
Digital Filter Frequency Response

Note Applies to sampling rates ≤ 1 MS/s for all configurations that use a single channel per ADC.

Note Applies to sampling rates ≤ 90 kS/s (aggregate) for all configurations that use multiple channels per ADC.

> **Note** Does not apply to Hardware-Timed Single Point, On-Demand, and External Sample Clock modes.

Figure 15. Digital Filter Frequency Response



Dynamic Characteristics

Spectral Noise Density

Input voltage noise density at 1 kHz.	
0.1 V	$6.2 nV/\sqrt{Hz}$
1.0 V	$12 nV/\sqrt{Hz}$
10 V	$94 nV/\sqrt{Hz}$
15 V	$136\ nV/\sqrt{Hz}$

Input current noise density at 1 k Hz	$0.5 pA/\sqrt{Hz}$

Auto Zero None and Auto Zero Once

Figure 16. 2 MS/s Spectral Noise Density (Single channel per ADC)

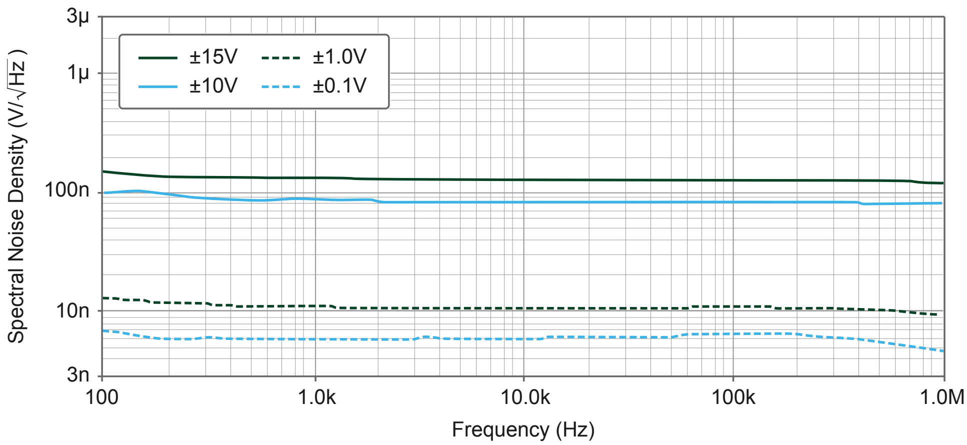


Figure 17. 20 kS/s Spectral Noise Density (Single channel per ADC)

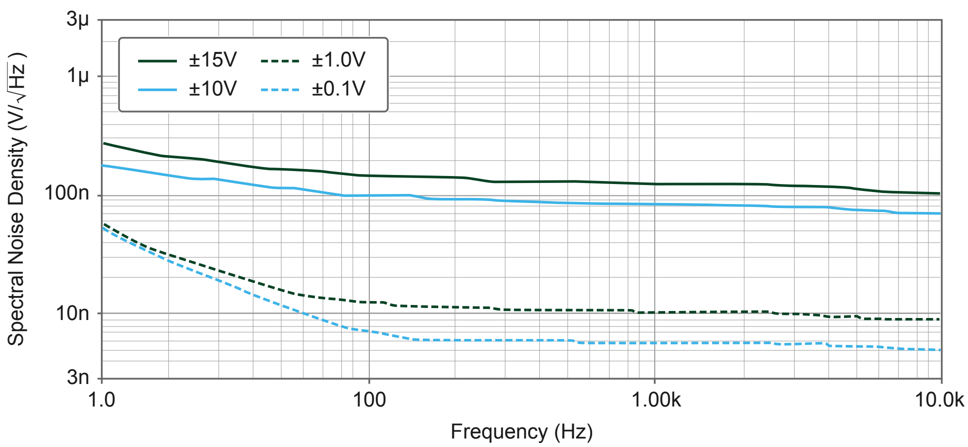


Figure 18. 20 kS/s Spectral Noise Density (Multichannel per ADC)

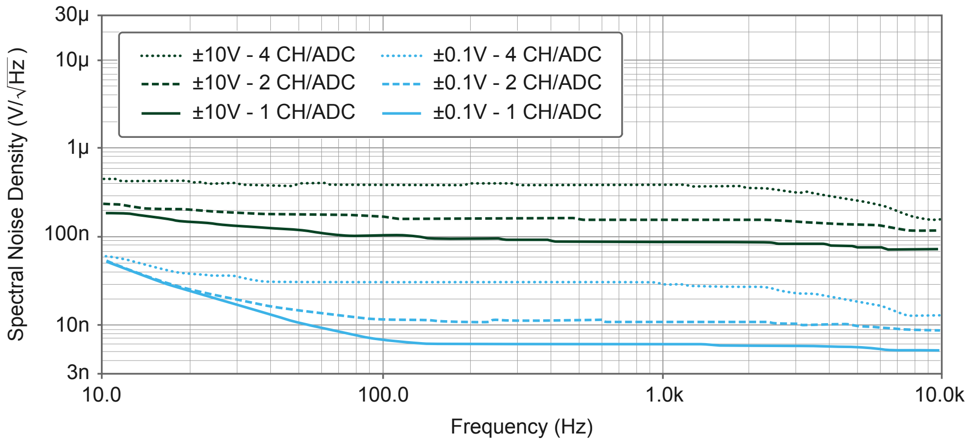


Figure 19. 2 kS/s Spectral Noise Density (Single channel per ADC)

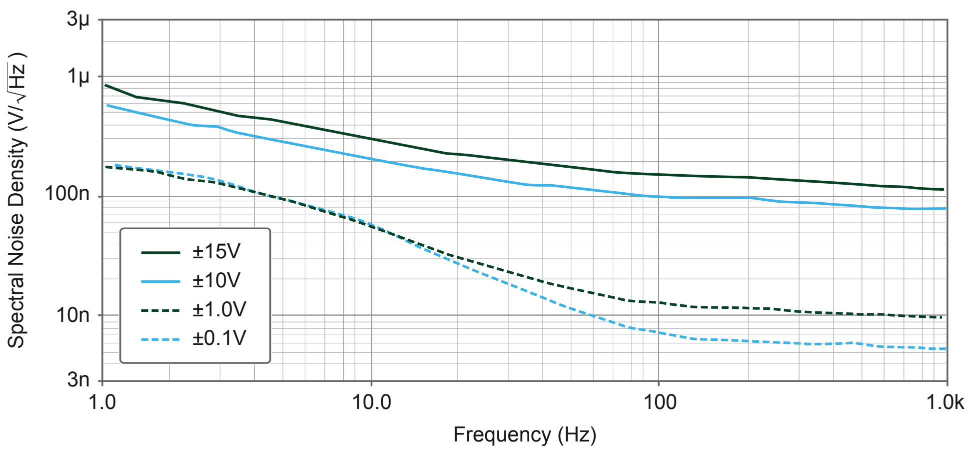
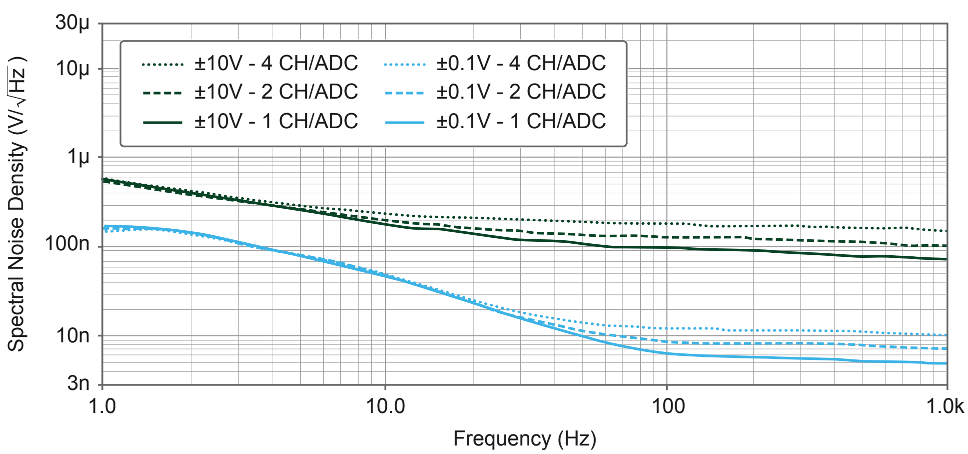


Figure 20. 2 kS/s Spectral Noise Density (Multichannel per ADC)



Auto Zero Every Sample

Figure 21. 2 kS/s Spectral Noise Density (Single channel per ADC)

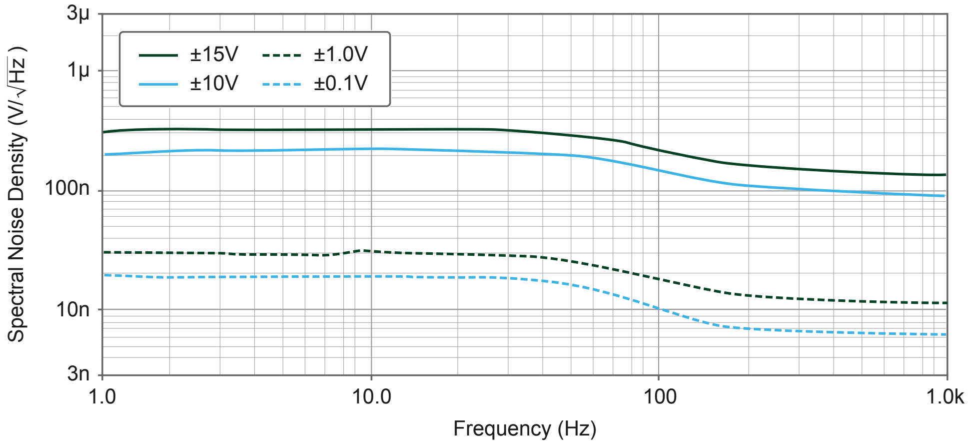
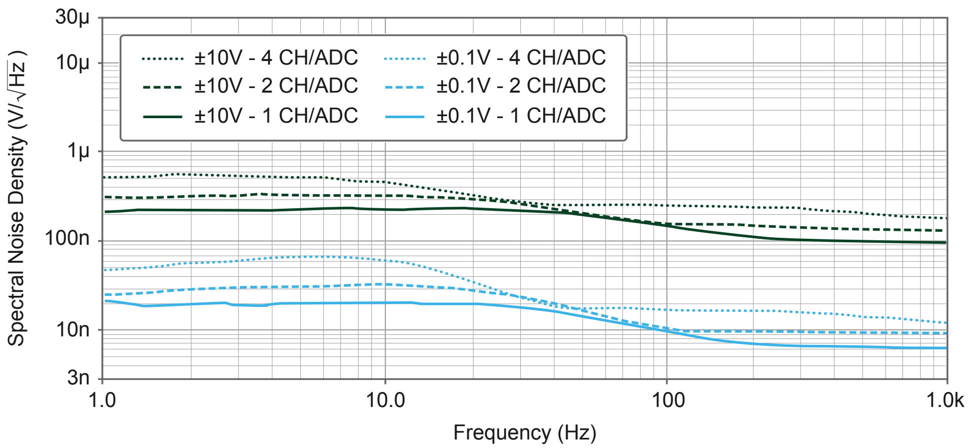


Figure 22. 2 kS/s Spectral Noise Density (Multichannel per ADC)



Chopping

Figure 23. 2 kS/s Spectral Noise Density (Single channel per ADC)

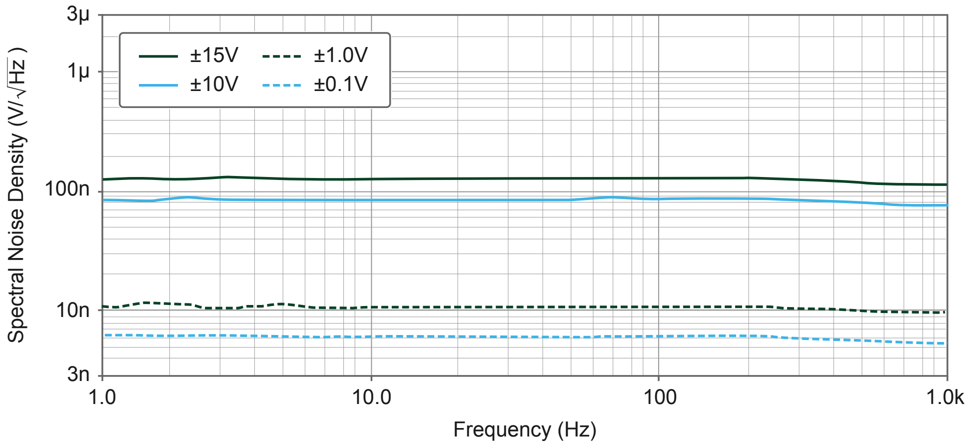
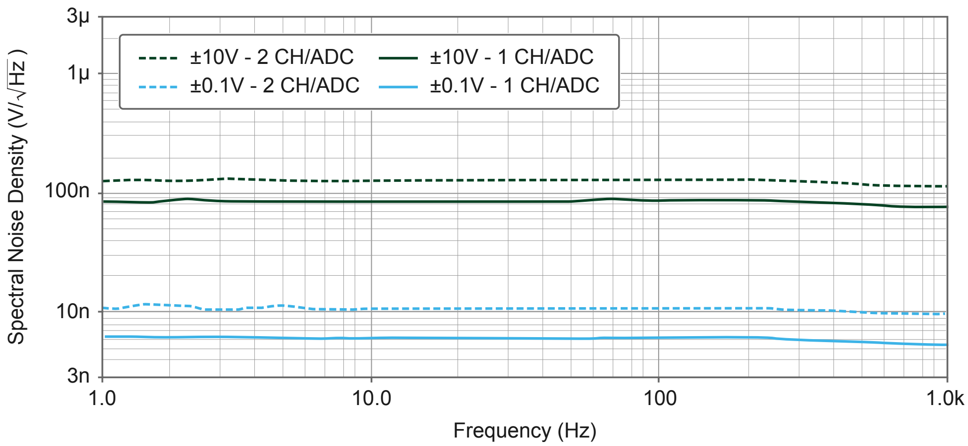


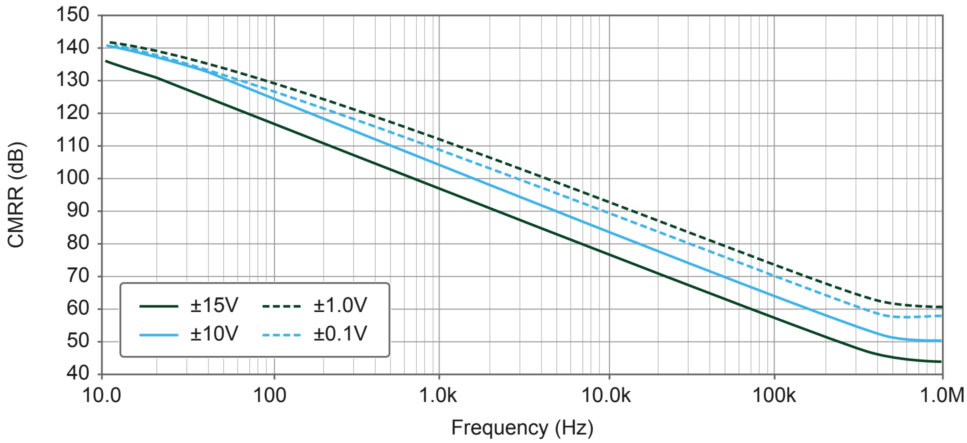
Figure 24. 2 kS/s Spectral Noise Density (Multichannel per ADC)



Common-Mode Rejection Ratio (CMRR)

DC	> 160 dBc
DC - 100 Hz	
0.1 V, 1.0 V	> 126 dBc
10 V	> 120 dBc
15 V	> 114 dBc

Figure 25. Common-Mode Rejection Ratio



Crosstalk, Input Channel Separation

Note To maintain crosstalk performance use separation and/or shielding between signal cables.

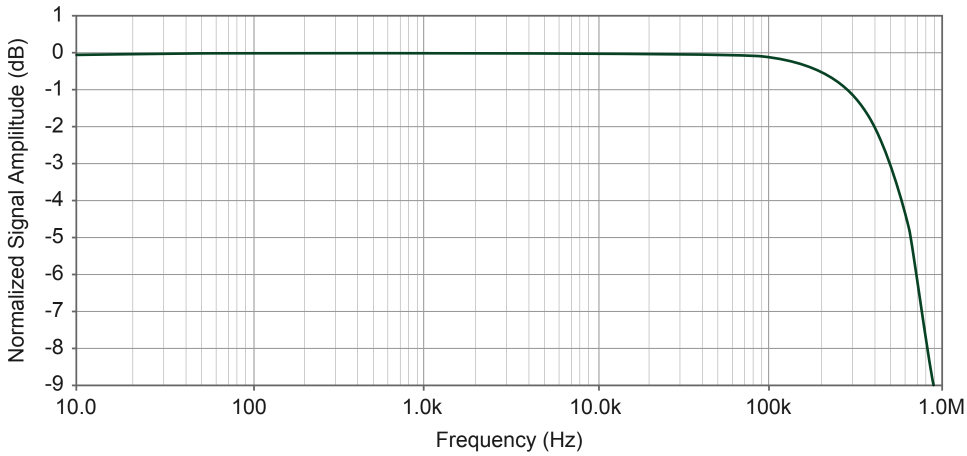
TB-4309 (ST)[4] and TB-4309 (MT)[5]	
1 kHz	Typically ≤ -120 dBc
10 kHz	Typically ≤ -100 dBc
100 kHz	Typically ≤ -80 dBc
500 kHz	Typically ≤ -70 dBc

Bandwidth

-3.0 dB bandwidth	500 kHz

[4] Inputs shorted at terminal block screw terminals.
[5] Inputs shorted at SCB-68 screw terminals using 2 m, 68-pin cable.

Figure 26. Magnitude Response



Flatness

DC - 20 kHz	-6.5 mdB
DC - 80 kHz	-100 mdB

Onboard Calibration Reference

Voltage

Output voltage range	6.741 V – 7.298 V
Output current drive	±1 µA
Temperature coefficient	±1 ppm/°C
Overvoltage protection	±30 V min

Frequency Timebase Characteristics

Resolution	10 ns
Accuracy	
Using internal timebase	±50 ppm
Using external timebase	Equal to accuracy of external timebase

Timing and Synchronization

Number of timing engines	1
Reference clock source	Onboard clock, backplane PXIe_CLK100

Digital Triggers

Purpose	Start trigger, reference trigger, pause trigger
Source	PFI 0, PFI 1, PXI_Trig <0..7>, PXI_Star, PXIe_DStar A, PXIe_DStar B
Polarity	Software-selectable
Debounce filter settings	Disable, 90 ns, 5.12 µs, custom interval

Output Timing Signals

Source	Start trigger, reference trigger, pause trigger, sample clock
Destination	PFI 0, PFI 1, PXI_Trig <0..7>, PXIe_DStarC

PFI 0 and PFI 1 (Front Panel Digital Triggers)

Input	
Logic compatibility	3.3 V or 5 V
High, VIH	2.40 V minimum
Low, VIL	0.95 V maximum
Input impedance	10 kΩ
Input current (0 V ≤ Vin ≤ 5 V)	≤ 500 μA
Overvoltage protection	±30 V minimum
Output	
High, VOH	3.43 V maximum
Sourcing 5 mA	2.88 V minimum
Low, VOL	
Sinking 5 mA	0.33 V maximum
Output impedance	50 Ω
Output current	±30 mA minimum

Overvoltage protection	±30 V minimum

General Specifications

Bus Interface

Form factor	x1 PXI Express peripheral module, specification rev 1.0 compliant
Slot compatibility	PXI Express or PXI Express hybrid slots
DMA channels	1, analog input
FIFO buffer size	1,023 samples
Data transfers	Direct memory access (DMA), programmed I/O

Power Requirements

+12 V	2 A maximum
+3.3 V	1 A maximum

Physical

Dimensions	16 cm × 10 cm (6.3 in. × 3.9 in.) 3U CompactPCI slot

Weight	238 g (8.4 oz)
I/O connector	96-pin male DIN 41612/IEC 60603-2 connector
Measurement Category[6]	I

Caution Do not use the PXIe-4309 for connections to signals or for measurements within Categories II, III, or IV.

Caution The protection provided by the PXIe-4309 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 Specifications

Operating Environment

Ambient temperature range	0 °C to 55 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2. Meets MIL-PRF-28800F Class 3 low temperature limit and MIL-PRF-28800F Class 2 high temperature limit.)
Relative humidity range	10% to 90%, noncondensing (Tested in accordance with IEC 60068-2-56.)

[6] 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.

Maximum altitude	2,000 m (800 mbar)
Pollution Degree	2

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. Meets MIL-PRF-28800F Class 3 limits.)
Relative humidity range	5% to 95%, noncondensing (Tested in accordance with IEC 60068-2-56.)

Shock and Vibration

Operating shock	30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC 60068-2-27. Meets MIL-PRF-28800F Class 2 limits.)
Random vibration	
Operating	5 Hz to 500 Hz, 0.3 grms
Non-operating	5 Hz to 500 Hz, 2.4 grms (Tested in accordance with IEC 60068-2-64. Non-operating test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

Calibration

You can obtain the calibration certificate and information about calibration services for the PXIe-4309 at ni.com/calibration.

Self-calibration	On software command, the module computes gain, offset, and linearity corrections relative to the high-precision internal voltage reference.
Self-calibration interval	Depending on required absolute accuracy, self-calibration is recommended whenever the current device temperature differs by more than the specified temperature range from the device temperature at which the last self-calibration was performed.
Calibration interval	2 years
Warm-up time	15 minutes

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)

At the end of the product life cycle, all products **must** be sent to a WEEE recycling center. For more information about WEEE recycling centers, National Instruments WEEE initiatives, and compliance with WEEE Directive 2002/96/EC on Waste and Electronic Equipment, visit ni.com/environment/weee.

电子信息产品污染控制管理办法（中国 RoHS）

- **中国 RoHS**— NI 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 NI 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.)