

DEVICE SPECIFICATIONS

NI PXIe-4304/4305

32 Ch, 24-bit, ± 42 V, 5 kS/s or 51.2 kS/s Simultaneous Filtered Data Acquisition Module

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This document lists specifications for the NI PXIe-4304/4305 simultaneous filtered data acquisition module. All specifications are subject to change without notice. Visit ni.com/manuals for the most current specifications and product documentation.



Note To maintain forced air cooling in the PXI Express system, refer to the *Maintain Forced-Air Cooling Note to Users*.

Terminology

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.

All performance specifications are *typical* unless otherwise noted. These specifications are valid within the full operating temperature range. Accuracy specifications are valid within ± 5 °C of the calibration or over the full operating range as specifically noted.

Input Characteristics

Number of channels	32 differential analog input channels
ADC resolution	24 bits
Type of ADC	Delta-Sigma
Sampling mode	Simultaneous
Sample rates (f_s)	
PXIe-4304	
Range	1 S/s to 5 kS/s
Resolution	$\leq 181.9 \mu\text{S/s}$
PXIe-4305	
Range	1 S/s to 51.2 kS/s
Resolution	$\leq 181.9 \mu\text{S/s}$
Input coupling	DC
Input ranges (FS)	
Nominal	$\pm 42 \text{ V}$
Max	$\pm 42 \text{ V}$
Maximum working voltage (signal + common mode)	$\pm 42 \text{ V}$
Input impedance	
Device powered on	
AI+ to AI GND	575 K Ω
AI- to AI GND	575 K Ω
AI+ to AI-	1.15 M Ω
CMRR (DC to 60 Hz)	80 dB
FIFO Buffer Size	1,023 samples
Data transfers	Direct memory access (DMA), programmed I/O

Fault Protection (Power On or Off)

AI $\pm$ <0..31>, AIGND	42 V between any two pins
PFI0	30 V to DGND

Accuracy¹

Measurement Conditions	Gain Error (% of Reading)	Offset Error (mV)
Typ (23 °C ±5 °C)	0.027	2.2
Max (23 °C ±5 °C)	0.037	4.5
Max (0 °C to 55 °C)	0.093	11.6

Temperature Stability

Gain stability..... 12 ppm/°C
Offset stability 135 µV/°C

Input Noise

Total buffered mode noise
 $f_s = 5 \text{ kS/s}$ 94 µV_{rms}
 $f_s = 51.2 \text{ kS/s}$ 300 µV_{rms} (PXIe-4305 only)

Table 1. Optional Buffered Mode IIR Filtering Noise Scaling Coefficients

Filter Cut-Off Frequency	Noise Scaling Coefficient (K)
2 kHz	1.1
1 kHz	1.8
200 Hz	3
20 Hz	12
2 Hz	30

Buffered mode noise with IIR filters

$$Input\ Noise = \frac{Total_Buffer_Mode_Noise}{\sqrt{Highest_Rate \times \frac{Hz}{S/s} \times 0.45}} \times \sqrt{K \times Filter_Cut-off_Frequency}$$

¹ Accuracies listed are warranted for the conditions described in the tables and for up to one year from the module external calibration.

Example

The buffer mode noise of the PXIe-4305 with the 1 kHz optional IIR filter is:

Highest_Rate of the PXIe-4305 = 51.2 kS/s

Total_Buffer_Mode_Noise = 300 μV_{rms}

Noise Scaling Coefficient (K) of 1 kHz filter = 1.8

$K \times \text{Filter_Cut-off_Frequency} = 1.8 \times 1 \text{ kHz} = 1.8 \text{ kHz}$

$$\begin{aligned}\text{Input Noise} &= \frac{\text{Total_Buffer_Mode_Noise}}{\sqrt{\text{Highest_Rate} \times \frac{\text{Hz}}{\text{S/s}} \times 0.45}} \times \sqrt{K \times \text{Filter_Cut-off_Frequency}} \\ &= \frac{300 \mu\text{V}_{\text{rms}}}{\sqrt{51.2 \text{ kS/s} \times \frac{\text{Hz}}{\text{S/s}} \times 0.45}} \times \sqrt{1.8 \text{ kHz}} = 83.9 \mu\text{V}_{\text{rms}}\end{aligned}$$

Absolute Accuracy

Absolute Accuracy = Reading $\times$ Gain Error + Offset Error + Noise Uncertainty

$$\text{Noise Uncertainty} = 3 \times \frac{\text{Random Noise}}{\sqrt{\# \text{ Samples}}}$$

Where

Random Noise is the input noise for the sample rate used.

3 converts the RMS value to peak value for a coverage of 3σ .

Samples is the number of samples averaged.

For example, when using an operating temperature of $23^\circ\text{C} \pm 5^\circ\text{C}$, the absolute accuracy at full-scale input with 5000 samples acquired at 5 kS/s is:

Gain Error = 0.037% of Reading

Offset Error = 4.5 mV

$$\text{Noise Uncertainty} = \frac{94 \mu\text{V} \times 3}{\sqrt{5000}} = 4 \mu\text{V}$$

Absolute Accuracy = $42 \text{ V} \times \text{Gain Error} + \text{Offset Error} + \text{Noise Uncertainty} = 20 \text{ mV}$

Phase linearity

PXIe-4304	
($f_{in} = \text{DC to } 2.25 \text{ kHz}$).....	$\pm 1^\circ$
PXIe-4305	
($f_{in} = \text{DC to } 23.04 \text{ kHz}$).....	$\pm 1^\circ$

Spurious free dynamic range (SFDR)

1 kHz, -60 dBFS	120 dB
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Total harmonic distortion (THD)

1 kHz, -1 dBFS	-98 dB
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Crosstalk

1 kHz.....	-95 dB
10 kHz.....	-75 dB (PXIe-4305 only)

Bandwidth and Alias Rejection

Passband

Frequency (for $1 \text{ S/s} \leq f_s < 25 \text{ S/s}$).....	$\leq 0.1 \times f_s$
Frequency (for $25 \text{ S/s} \leq f_s \leq 25.6 \text{ kS/s}$)....	$\leq 0.45 \times f_s$

In band flatness

$f_{in} = \text{DC to } 2.25 \text{ kHz}$	10 mdB max
$f_{in} = 2.25 \text{ kHz to } 23.04 \text{ kHz}$	100 mdB max (PXIe-4305 only)

Stopband

Frequency (for $1 \text{ S/s} \leq f_s < 25 \text{ S/s}$).....	$\geq 0.9 \times f_s$
Frequency (for $25 \text{ S/s} \leq f_s \leq 25.6 \text{ kS/s}$)....	$\geq 0.57 \times f_s$
Rejection.....	100 dB

Alias-free bandwidth

(for $1 \text{ S/s} \leq f_s < 25 \text{ S/s}$).....	$0.1 \times f_s$
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Alias-free bandwidth

(for $25 \text{ S/s} \leq f_s \leq 25.6 \text{ kS/s}$).....	$0.45 \times f_s$
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Minimum frequency

for ADC alias hole	3.320313 MHz
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Rejection at alias hole.....	100 dB
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Uncompensated filter delay¹

Group Delay = Analog Delay + Digital Filter Group Delay ²

Analog delay 6.77 μs

Compensated digital filter group delay..... 1.79742 ms + Variable Filter Delay

Sample Rate	Variable Filter Delay (Samples)
$1\text{ S/s} \leq f_s < 25\text{ S/s}$	4.000
$25.0\text{ S/s} \leq f_s \leq 25.3\text{ S/s}$	57.995
$25.3\text{ S/s} < f_s \leq 50.7\text{ S/s}$	57.991
$50.7\text{ S/s} < f_s \leq 101.3\text{ S/s}$	57.981
$101.3\text{ S/s} < f_s \leq 202.7\text{ S/s}$	57.963
$202.7\text{ S/s} < f_s \leq 405.3\text{ S/s}$	57.926
$405.3\text{ S/s} < f_s \leq 810.6\text{ S/s}$	57.852
$810.6\text{ S/s} < f_s \leq 1621.2\text{ S/s}$	57.703
$1621.2\text{ S/s} < f_s \leq 3242.5\text{ S/s}$	57.406
$3242.5\text{ S/s} < f_s \leq 6485.0\text{ S/s}$	56.813
$6485.0\text{ S/s} < f_s \leq 12970.0\text{ S/s}$	55.625
$12970.0\text{ S/s} < f_s \leq 25939.9\text{ S/s}$	53.250
$25939.9\text{ S/s} < f_s \leq 51200\text{ S/s}$	48.500

Channel to Channel Matching³

Gain matching

Input frequency (f_{in})

DC to 2.25 kHz 17 mdB

2.25 kHz to 23.04 kHz 170 mdB (PXIe-4305 only)

Phase matching $0.035^\circ/\text{kHz} \times f_{in}$

¹ The compensated digital filter group delay is a result of using the anti-alias filtering in buffered mode. Hardware automatically compensates for this group delay when synchronizing. Hardware does not compensate for filter delay from either the analog filter or the optional buffered mode digital filter or the filter used for hardware-timed single point mode.

² Digital filter group delay results from using the optional IIR filter in buffered mode or the IIR filter selected in hardware-timed single point mode.

³ Identical channel configurations.

Optional Buffered Mode IIR Filtering

Filter Cut-Off Frequency	Filter Type	Stopband Attenuation	Passband Ripple
2 kHz Filter	Fourth order, Elliptic Filter	-120 dB	0.2 dB
1 kHz Filter	Fourth order, Elliptic Filter	-120 dB	0.2 dB
200 Hz Filter	Fourth order, Elliptic Filter	-120 dB	0.2 dB
20 Hz Filter	Fourth order, Elliptic Filter	-120 dB	0.2 dB
2 Hz Filter	Fourth order, Elliptic Filter	-120 dB	0.2 dB

Figure 1. Magnitude Response

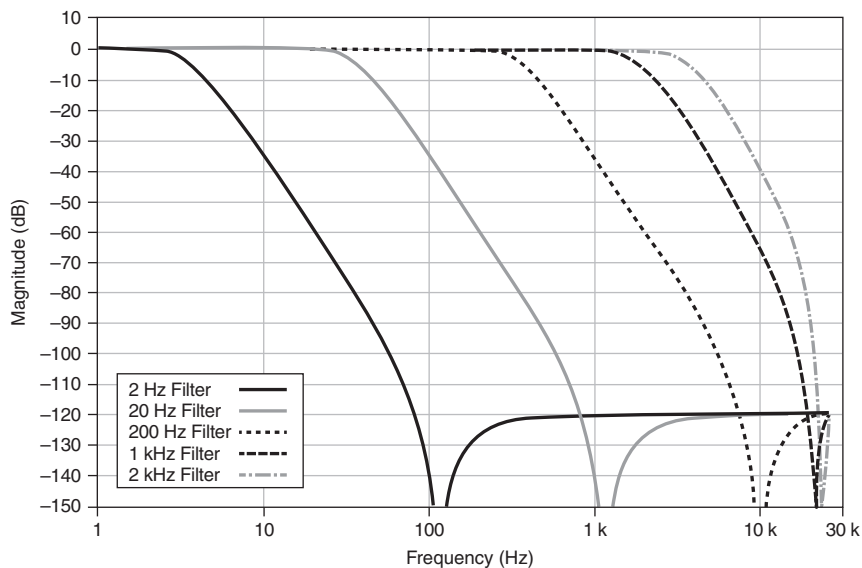


Figure 2. Passband

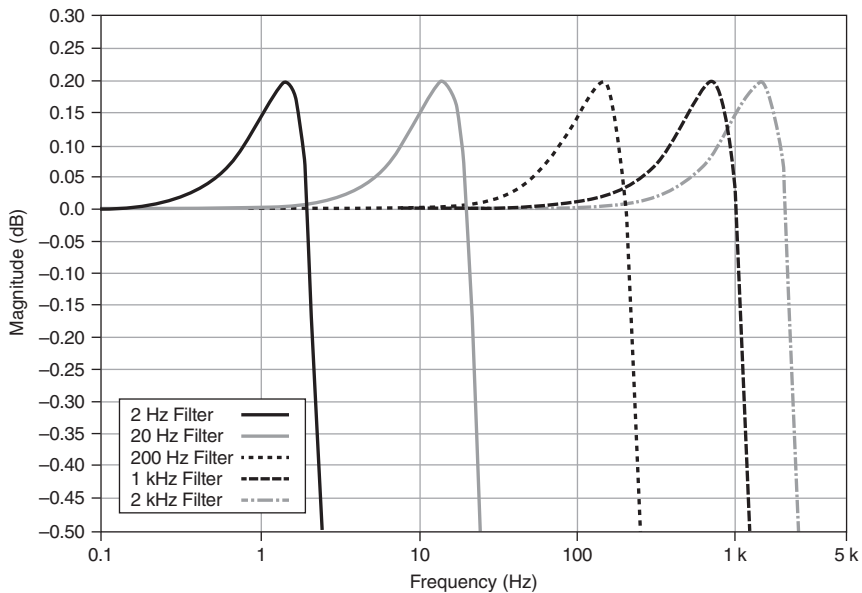


Figure 3. Phase Response

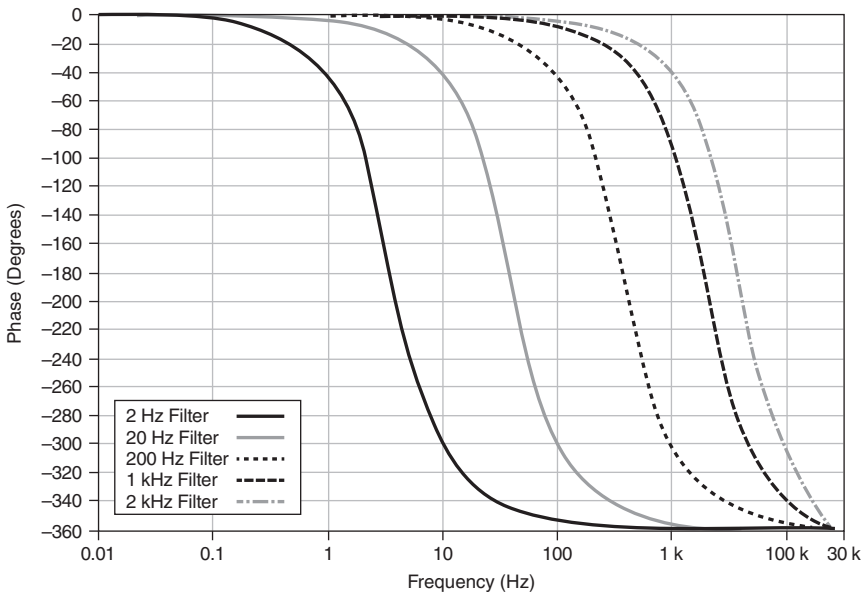
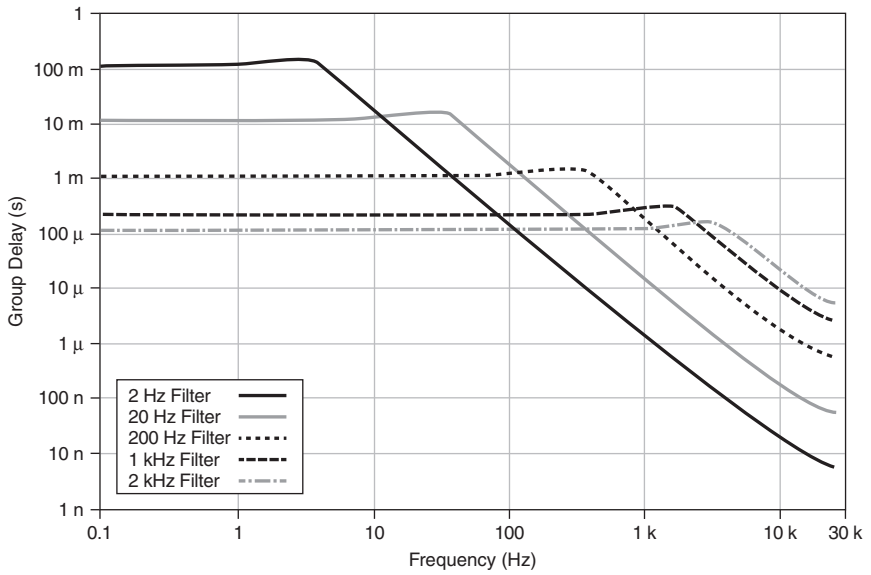


Figure 4. Group Delay**Table 2. Digital Filter Group Delay**

Filter Cut-Off Frequency	Group Delay at 0.1 Hz
2 kHz Filter	113.4 μs
1 kHz Filter	227.4 μs
200 Hz Filter	1.1385 ms
20 Hz Filter	11.3856 ms
2 Hz Filter	113.856 ms

Hardware-Timed Single Point Sample Mode

Acquisition rate¹
Minimum 1 S/s
Maximum
 PXIe-4304 5 kS/s
 PXIe-4305 51.2 kS/s

Table 3. Measured Hardware-Timed Single Point Sample Mode Noise at 23 °C

Filter Cut-Off Frequency	Noise
3 kHz Filter	144.3 μV_{rms}
2 kHz Filter	131.2 μV_{rms}
1 kHz Filter	117.9 μV_{rms}
500 Hz Filter	110.2 μV_{rms}
200 Hz Filter	101.9 μV_{rms}
100 Hz Filter	100.9 μV_{rms}

Hardware-Timed Single Point Filtering

Filter type Fourth order, elliptic filter
Stopband attenuation -120 dB
Passband ripple 0.2 dB

¹ Depends on the system setup and application time. Refer to the *NIPXIe-4304/4305 User Manual* for more information.

Figure 5. Filter Magnitude Response

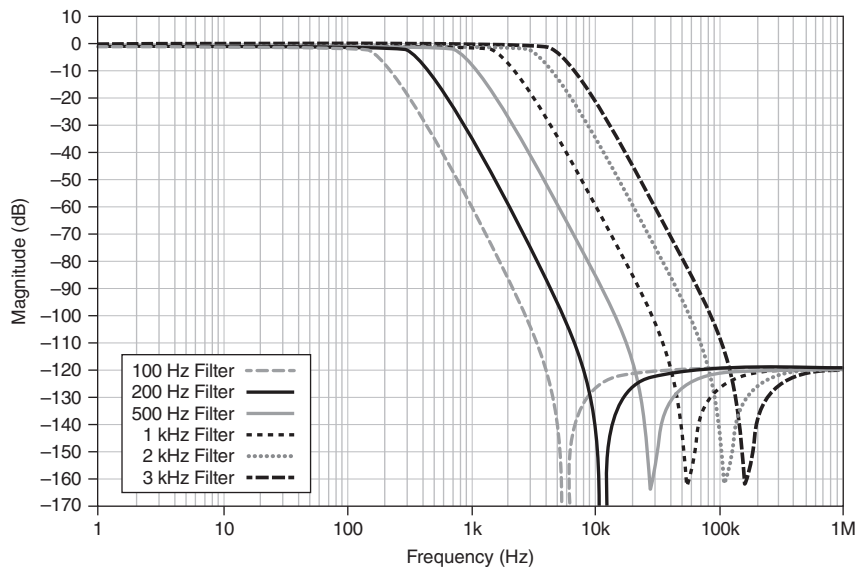


Figure 6. Passband Ripple

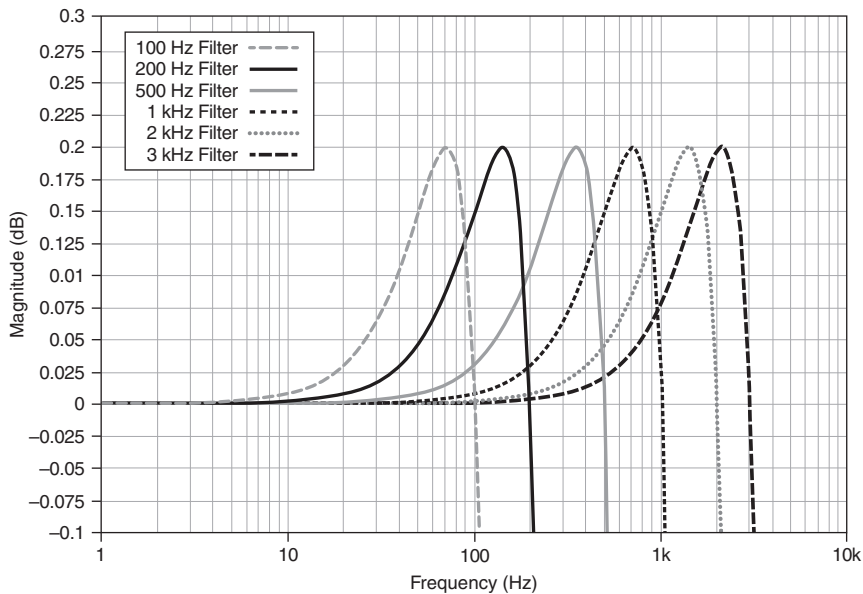


Figure 7. Filter Phase Response

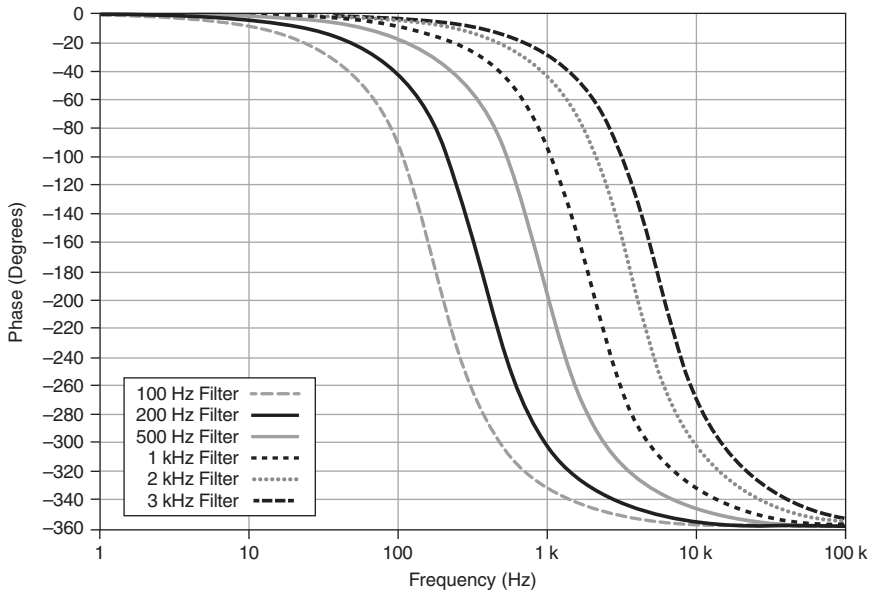


Figure 8. Filter Group Delay

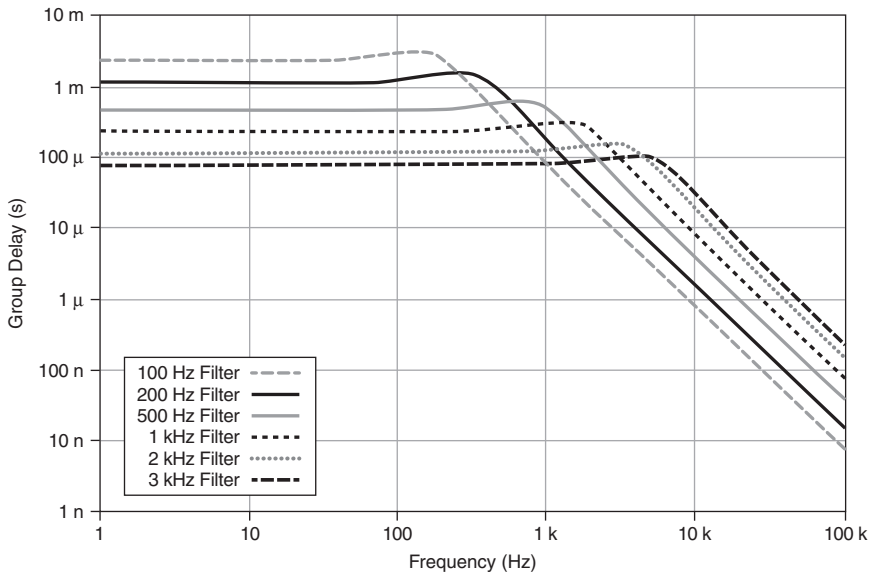


Table 4. Digital Filter Group Delay

Filter Cut-Off Frequency	Group Delay at 1 Hz
3 kHz Filter	75.9 μ s
2 kHz Filter	113.9 μ s
1 kHz Filter	227.7 μ s
500 Hz Filter	455.4 μ s
200 Hz Filter	1.1386 ms
100 Hz Filter	2.28 ms

Hardware-timed single
point ADC group delay¹ 1.6 μ s

Internal Frequency Timebase Characteristics

Frequency 106.25 MHz
Accuracy $\pm$ 50 ppm

Synchronization

Reference clock source Onboard 106.25 MHz clock,
Backplane PXIe_CLK100

Task Resources²

Timing engines 4
Buffered mode streams 4
Hardware-timed single point streams 4
Maximum channels per stream 8

¹ When in hardware-timed single point mode, *Total group delay = ADC group delay + Filter group delay.*
² The PXIe-4304/4305 can operate four independent timing engines simultaneously. Each timing engine can utilize one or more buffered mode or hardware-timed single point streams, but not both types simultaneously. Refer to the *PXIe-4304/4305 User Manual* for more details about timing engines and DSP streams.

Triggers

Analog trigger

Purpose.....	Reference trigger only
Source	AI<0..31>
Level	Full scale (depending on input range), programmable
Mode	Rising-edge, Rising-edge with hysteresis, Falling-edge, Falling-edge with hysteresis, Entering Window, 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.....	Software-selectable
Minimum pulse width.....	100 ns for PXI_TRIG <0..7>, 20 ns for others

Output Timing Signals

Sources.....	Sample Clock, Start Trigger Out, Reference Trigger Out
Destinations	PFI0, PXI_TRIG <0..7>, PXIe_DSTARC
Polarity.....	Software-selectable

PFI Characteristics

Input

Logic compatibility.....	3.3 V to 5 V
High, VIH	2.40 V
Low, VIL.....	0.95 V
Input impedance.....	10 K Ω

Output

High, VOH.....	3.43 V max
Sourcing 5 mA	2.88 V min
Low, VOL sinking 5 mA	0.33 V max
Output impedance	50 Ω
Output current	$\pm$ 5 mA min

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	4, analog input

Calibration

You can obtain the calibration certificate and information about calibration services for the PXIe-4304/4305 at ni.com/calibration.

Recommended warm-up time.....	15 minutes
Calibration interval.....	1 year

Power Requirement

+12 V	1.3 A
+3.3 V	1.1 A

Physical Requirements

Dimensions	Standard 3U PXIe, 16 cm × 10 cm (6.3 in. × 3.9 in.)
Weight.....	156 g (5.5 oz)
I/O connector	96-pin male DIN 41612/IEC 60603-2 connector



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

Maximum altitude.....	2,000 m (800 mbar)
Pollution Degree	2
Indoor use only.	

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.)

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 g _{rms}
Non-operating	5 Hz to 500 Hz, 2.4 g _{rms} (Tested in accordance with IEC 60068-2-64. Non-operating test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

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.



Caution The protection provided by the PXIe-4304/4305 can be impaired if it is used in a manner not described in this documents.

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; Basic 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 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 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 For EMC declarations and certifications, and additional information, refer to the [Online Product Certification](#) section.

CE Compliance

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.

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EU Customers 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.

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