PCIe-6376 Specifications

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PCIe-6376 Specifications

Definitions

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

Characteristics 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.

Analog Input

Note Floating inputs can cause unnecessary power consumption and higher operating temperatures. NI recommends connecting unused analog input channels to AI GND.

Number of channels	8 differential
ADC resolution	16 bits
DNL	No missing codes
INL	Refer to the ***AI Absolute Accuracy*** section.

Sample rate (simultaneous sampling on all channels sampled)	
Maximum	3.571 MS/s
Minimum	No minimum
Timing resolution	10 ns
Timing accuracy	50 ppm of sample rate
Input coupling	DC
Input range	±1 V, ±2 V, ±5 V, ±10 V
Maximum working voltage for all analog inputs	
Positive input (AI+)	±11 V for all ranges, Measurement Category I
Negative input (AI-)	±11 V for all ranges, Measurement Category I

Caution Do not use for measurements within Categories II, III, and IV.

CMRR (at 60 Hz)	75 dB
Bandwidth	1 MHz

THD	-80 dBFS	
Input impedance		
Device on		
AI+ to AI GND	>100 GΩ in parallel with 100 pF	
AI- to AI GND	>100 GΩ in parallel with 100 pF	
Device off		
AI+ to AI GND	2 kΩ	
AI- to AI GND	2 kΩ	
Input bias current	±10 pA	
Crosstalk (at 100 kHz)		
Adjacent channels	-80 dB	
Non-adjacent channels	-100 dB	
Input FIFO size	8,182 samples shared among channels used	
Data transfers	DMA (scatter-gather), programmed I/O	
Overvoltage protection for AI <0..7>, APFI 0		

Device on	±36 V
Device off	±15 V
Input current during overvoltage conditions	±20 mA max/AI pin

Analog Triggers

Number of triggers	1
Source	AI <0..7> , APFI 0
Functions	Start Trigger, Reference Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase
Source level	
AI <0..7>	±Full scale
APFI 0	±10 V
Resolution	16 bits
Modes	Analog edge triggering, analog edge triggering with hysteresis, and analog window triggering
Bandwidth (-3 dB)	

AI <0..7>	3.4 MHz
APFI 0	3.9 MHz
Accuracy	±1% of range
APFI 0 characteristics	
Input impedance	10 kΩ
Coupling	DC
Protection, power on	±30 V
Protection, power off	±15 V

AI Absolute Accuracy (Warranted)

Table 1. AI Absolute Accuracy

Nominal Range Positive Full Scale	Nominal Range Negative Full Scale	Residual Gain Error (ppm of Reading)	Offset Tempco (ppm of Range/°C)	Random Noise, σ (µVrms)	Absolute Accuracy at Full Scale (µV)
10	-10	114	35	252	2,688
5	-5	120	36	134	1,379
2	-2	120	42	71	564
1	-1	138	50	61	313

Note For more information about absolute accuracy at full scale, refer to the ***AI Absolute Accuracy Example*** section.

Gain tempco	8 ppm/°C
Reference tempco	5 ppm/°C
Residual offset error	15 ppm of range
INL error	46 ppm of range

Note Accuracies listed are valid for up to two years from the device external calibration.

AI Absolute Accuracy Equation

$$AbsoluteAccuracy = Reading \cdot (GainError) + Range \cdot (OffsetError) + NoiseUncertainty$$

- $GainError = ResidualAIGainError + GainTempco \cdot (TempChangeFromLastInternalCal) + ReferenceTempco \cdot (TempChangeFromLastExternalCal)$
- $OffsetError = ResidualAIOffsetError + OffsetTempco \cdot (TempChangeFromLastInternalCal) + INLError$
- $NoiseUncertainty = \frac{\text{Random Noise} \cdot 3}{\sqrt{100}}$
  for a coverage factor of 3 σ and averaging 100 points.

AI Absolute Accuracy Example

Absolute accuracy at full scale on the analog input channels is determined using the

following assumptions:

- ***TempChangeFromLastExternalCal*** = 10 °C
- ***TempChangeFromLastInternalCal*** = 1 °C
- ***number_of_readings*** = 10,000
- ***CoverageFactor*** = 3 σ

For example, on the 10 V range, the absolute accuracy at full scale is as follows:

- ***GainError*** = 114 ppm + 8 ppm · 1 + 5 ppm · 10 = 172 ppm
- ***OffsetError*** = 15 ppm + 35 ppm ·1 + 46 ppm = 96 ppm
- ***Noise Uncertainty*** = $\frac{252\ \mu V \cdot\ 3}{\sqrt{10,\ 000}}$ = 7.6 µV
- ***AbsoluteAccuracy*** = 10 V · (***GainError***) + 10 V · (***OffsetError***) + ***NoiseUncertainty*** = 2688 µV

Analog Output

Number of channels	2
DAC resolution	16 bits
DNL	±1 LSB, max
Monotonicity	16 bit guaranteed
Accuracy	Refer to the ***AO Absolute Accuracy*** section.
Maximum update rate (simultaneous)	

1 channel	3.3 MS/s
2 channels	3.3 MS/s
Minimum update rate	No minimum
Timing accuracy	50 ppm of sample rate
Timing resolution	10 ns
Output range	±10 V, ±5 V, ±external reference on APFI 0
Output coupling	DC
Output impedance	0.4 Ω
Output current drive	±5 mA
Overdrive protection	±25 V
Overdrive current	10 mA
Power-on state	±5 mV
Power-on/off glitch	1.5 V peak for 200 ms

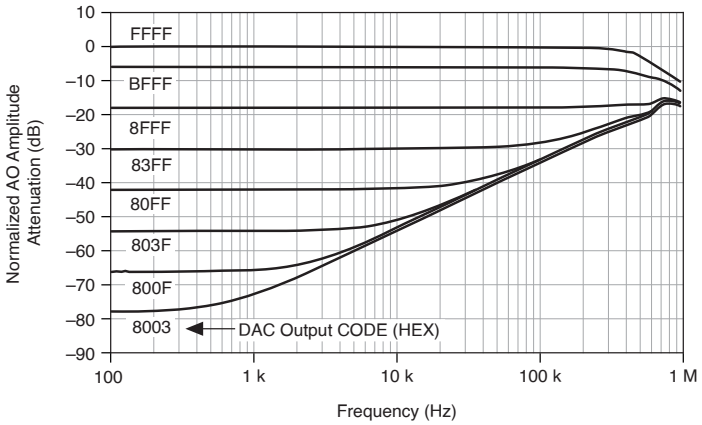
Output FIFO size	8,191 samples shared among channels used
Data transfers	DMA (scatter-gather), programmed I/O
AO waveform modes	Non-periodic waveform, periodic waveform regeneration mode from onboard FIFO, periodic waveform regeneration from host buffer including dynamic update
Settling time, full-scale step, 15 ppm (1 LSB)	2 µs
Slew rate	20 V/µs
Glitch energy at midscale transition, ±10 V range	6 nV · s

External Reference

APFI 0 characteristics	
Input impedance	10 kΩ
Coupling	DC
Protection, device on	±30 V

Protection, device off	± 15 V
Range	±11 V
Slew rate	±20 V/µs

Figure 1. Analog Output External Reference Bandwidth



AO Absolute Accuracy (Warranted)

Absolute accuracy at full-scale numbers is valid immediately following self calibration and assumes the device is operating within 10 °C of the last external calibration.

Table 2. AO Absolute Accuracy

Nominal Range Positive Full Scale	Nominal Range Negative Full Scale	Residual Gain Error (ppm of Reading)	Gain Tempco (ppm/°C)	Reference Tempco (ppm/°C)	Residual Offset Error (ppm of Range)	Offset Tempco (ppm of Range/°C)	INL Error (ppm of Range)	Absolute Accuracy at Full Scale (µV)
10	-10	129	17	5	65	1	64	3,256
5	-5	135	8	5	65	1	64	1,616

Note Accuracies listed are valid for up to two years from the device external

calibration.

AO Absolute Accuracy Equation

$$AbsoluteAccuracy = OutputValue \cdot (GainError) + Range \cdot (OffsetError)$$

- $GainError = ResidualGainError + GainTempco \cdot (TempChangeFromLastInternalCal) + ReferenceTempco \cdot (TempChangeFromLastExternalCal)$
- $OffsetError = ResidualOffsetError + OffsetTempco \cdot (TempChangeFromLastInternalCal) + INLError$

Digital I/O/PFI

Static Characteristics

Number of channels	24 total, 8 (P0.<0..7>), 16 (PFI <0..7>/P1, PFI <8..15>/P2)
Ground reference	D GND
Direction control	Each terminal individually programmable as input or output
Pull-down resistor	50 kΩ typical, 20 kΩ minimum
Input voltage protection	±20 V on up to two pins

Caution Stresses beyond those listed under the ***Input voltage protection*** specification may cause permanent damage to the device.

Waveform Characteristics (Port 0 Only)

Terminals used	Port 0 (P0.<0..7>)
Port/sample size	Up to 8 bits
Waveform generation (DO) FIFO	2,047 samples
Waveform acquisition (DI) FIFO	255 samples
DI Sample Clock frequency	0 to 10 MHz, system and bus activity dependent
DO Sample Clock frequency	
Regenerate from FIFO	0 to 10 MHz
Streaming from memory	0 to 10 MHz, system and bus activity dependent
Data transfers	DMA (scatter-gather), programmed I/O
Digital line filter settings	160 ns, 10.24 µs, 5.12 ms, disable

PFI/Port 1/Port 2 Functionality

Functionality	Static digital input, static digital output, timing input, timing output
Timing output	Many AI, AO, counter, DI, DO timing signals

sources	
Debounce filter settings	90 ns, 5.12 µs, 2.56 ms, custom interval, disable; programmable high and low transitions; selectable per input

Recommended Operating Conditions

Input high voltage (V_{IH})	
Minimum	2.2 V
Maximum	5.25 V
Input low voltage (V_{IL})	
Minimum	0 V
Maximum	0.8 V
Output high current (I_{OH})	
P0.<0..7>	-24 mA maximum
PFI <0..15>/P1/P2	-16 mA maximum
Output low current (I_{OL})	
P0.<0..7>	24 mA maximum

PFI <0..15>/P1/P2	16 mA maximum

Digital I/O Characteristics

Positive-going threshold (VT+)	2.2 V maximum
Negative-going threshold (VT-)	0.8 V minimum
Delta VT hysteresis (VT+ - VT-)	0.2 V minimum
I_{IL} input low current (V_{IN} = 0 V)	-10 µA maximum
I_{IH} input high current (V_{IN} = 5 V)	250 µA maximum

Figure 2. P0.<0..7>: I_{OH} versus V_{OH}

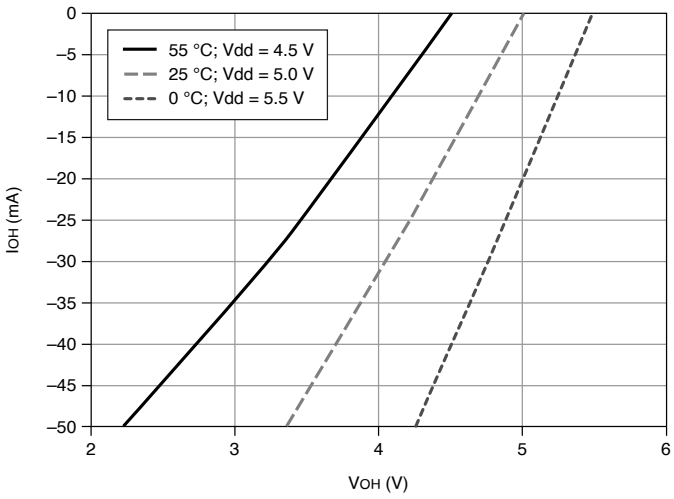


Figure 3. PFI <0..15>/P1/P2: I_{OH} versus V_{OH}

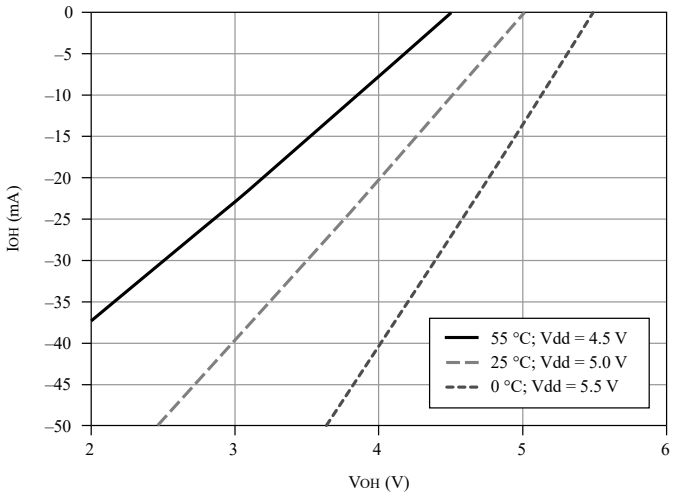


Figure 4. P0.<0..7>: I_{OL} versus V_{OL}

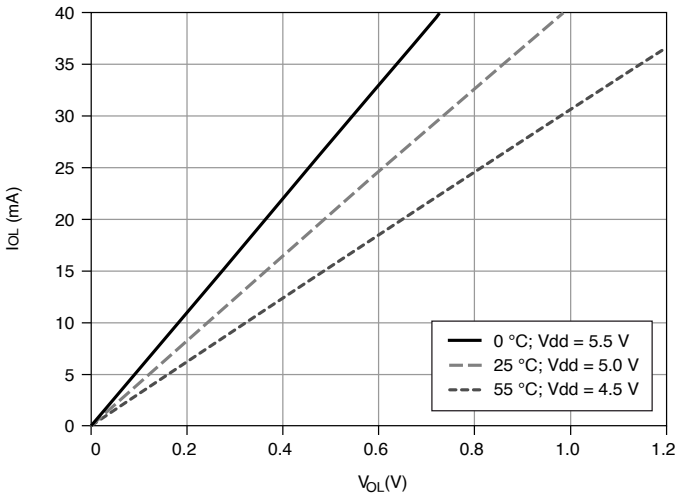
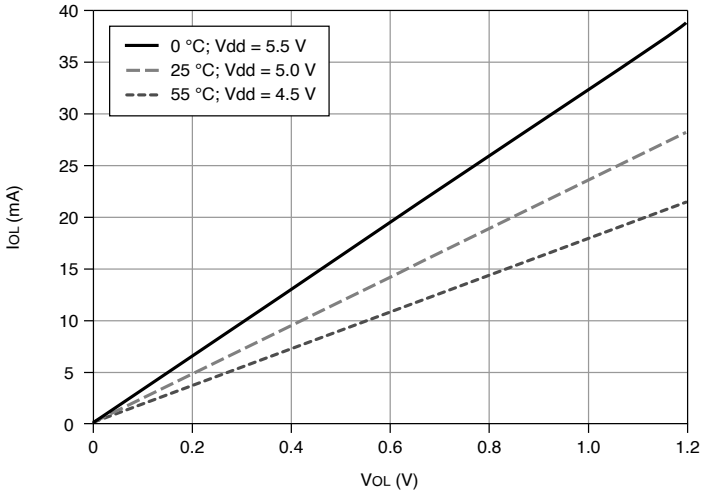


Figure 5. PFI <0..15>/P1/P2: I_{OL} versus V_{OL}



Timing I/O

Number of counter/ timers	4
Resolution	32 bits
Counter measurements	Edge counting, pulse, pulse width, semi-period, period, two-edge separation
Position measurements	X1, X2, X4 quadrature encoding with Channel Z reloading; two-pulse encoding
Output applications	Pulse, pulse train with dynamic updates, frequency division, equivalent time sampling
Internal base clocks	100 MHz, 20 MHz, 100 kHz
External base clock frequency	0 MHz to 25 MHz
Base clock accuracy	50 ppm
Inputs	Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down, Sample Clock
Routing options for inputs	Any PFI, RTSI, analog trigger, many internal signals

FIFO	127 samples per counter
Data transfers	Dedicated scatter-gather DMA controller for each counter/timer, programmed I/O

Frequency Generator

Number of channels	1
Base clocks	20 MHz, 10 MHz, 100 kHz
Divisors	1 to 16
Base clock accuracy	50 ppm

Output can be available on any PFI terminal.

Phase-Locked Loop (PLL)

Number of PLLs	1

Table 3. Reference Clock Locking Frequencies

Reference Signal	Locking Input Frequency (MHz)
RTSI <0..7>	10, 20
PFI <0..7>	10, 20

Output of PLL	100 MHz Timebase; other signals derived from 100 MHz Timebase including 20 MHz and 100 kHz Timebases

External Digital Triggers

Source	Any PFI, RTSI
Polarity	Software-selectable for most signals
Analog input function	Start Trigger, Reference Trigger, Pause Trigger, Sample Clock, Convert Clock, Sample Clock Timebase
Analog output function	Start Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase
Counter/timer functions	Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down, Sample Clock
Digital waveform generation (DO) function	Start Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase
Digital waveform acquisition (DI) function	Start Trigger, Reference Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase

Device-to-Device Trigger Bus

Input source	RTSI <0..7>

Output destination	RTSI <0..7>
Output selections	10 MHz Clock, frequency generator output; many internal signals
Debounce filter settings	90 ns, 5.12 µs, 2.56 ms, custom interval, disable; programmable high and low transitions; selectable per input

Bus Interface

Form factor	x4 PCI Express, specification v1.1 compliant
Slot compatibility	x4, x8, and x16 PCI Express slots[1]
DMA channels	7 DMA, analog output, digital input, digital output, counter/timer 0, counter/timer 1, counter/timer 2, counter/timer 3

Power Requirements

Caution The protection provided by the PCIe-6376 can be impaired if it is used in a manner not described in the user documentation.

+3.3 V	4.75 W
+12 V	15.6 W

Current Limits

Caution Exceeding the current limits may cause unpredictable behavior by the device and/or PC/chassis.

+5 V terminal (connector 0)	1 A maximum [2]
P0/P1/P2/PFI terminals combined	1.7 A maximum

Physical

Printed circuit board dimensions	16.8 cm × 11.1 cm (6.60 in. × 4.38 in.)
Weight	120 g (4.1 oz)
I/O connectors	
PCIe device connector	68-Pos Right Angle Single Stack PCB-Mount VHDCI (Receptacle)
Cable connector	68-Pos Offset IDC Cable Connector (Plug) (SHC68-*)
Form factor	Standard height, half length, single slot
Integrated air mover (fan)	No

Note For more information about the connectors used for DAQ devices, refer to the document, ***NI DAQ Device Custom Cables, Replacement***

> ***Connectors, and Screws***, by going to ni.com/info and entering the Info Code `rdspmb`.

Calibration

Recommended warm-up time	15 minutes
Calibration interval	2 years

Safety Voltages

Connect only voltages that are below these limits.

Channel-to-earth ground	±11 V, Measurement Category I

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS voltage. MAINS is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

Environmental

This product meets the requirements of the following environmental standards for electrical equipment for measurement, control, and laboratory use.

Maximum altitude	2,000 m (800 mbar) (at 25 °C ambient temperature)

Pollution degree	2

Indoor use only.

Note Clean the device with a soft, non-metallic brush. Make sure that the device is completely dry and free from contaminants before returning it to service.

Operating Environment

Operating temperature, local[3]	0 °C to 50 °C
Operating humidity	10% to 90% RH, noncondensing
System slot airflow	0.4 m/s (80 LFM)

Storage Environment

Ambient temperature range	-20 °C to 70 °C
Relative humidity range	5% to 95% RH, noncondensing

Safety Compliance Standards

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 safety certifications, refer to the product label or the Product Certifications and Declarations 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; Industrial immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions

Note In Europe, Australia and New Zealand (per CISPR 11) Class A equipment is intended for use only in non-residential 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.

Notice For EMC declarations and certifications, and additional information, refer to the Product Certifications and Declarations section.

CE Compliance CE

- 2011/65/EU; Restriction of Hazardous Substances (RoHS)

Product Certifications and Declarations

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for NI products, visit ni.com/product-certifications, search by model number, and click the appropriate link.

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 ***Engineering a Healthy Planet*** 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.

EU and UK Customers

- **Waste Electrical and Electronic Equipment (WEEE)**—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`.)