PCIe-7846 Specifications

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Contents

NI PCIe-7846 Specifications

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

Analog Input

Number of channels	8
Input modes (software-selectable; selection applies to all channels)	DIFF, NRSE, RSE
Type of ADC	Successive approximation register (SAR)
Resolution	16 bits
Conversion time	2 µs
Maximum sampling rate (per channel)	500 kS/s
Input impedance	
Powered on	1.25 GΩ ‖ 2 pF
Powered off/overload	4 kΩ minimum
Input signal range (software-selectable)	±1 V, ±2 V, ±5 V, ±10 V

Input bias current	±5 nA
Input offset current	±5 nA
Input coupling	DC
Overvoltage protection	
Powered on	±42 V maximum
Powered off	±35 V maximum

Table 1. AI Operating Voltage Ranges Over Temperature

Range (V)	Measurement Voltage, AI+ to AI-			Maximum Working Voltage (Signal + Common Mode)
	Minimum (V)[1]	Typical (V)	Maximum (V)	
±10	±10.37	±10.5	±10.63	±12 V of ground
±5	±5.18	± 5.25	±5.32	±10 V of ground
±2	±2.07	±2.1	±2.13	±8.5 V of ground
±1	±1.03	±1.05	±1.06	±8 V of ground

AI Absolute Accuracy

Absolute accuracy at full scale numbers is valid immediately following internal calibration and assumes the device is operating within 10 °C of the last external calibration. Accuracies listed are valid for up to one year from the device external calibration.

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

Table 2. AI Absolute Accuracy (Calibrated)

Specifications	Range				
	±20 V	±10 V	±5 V	±2 V	±1 V
Residual Gain Error (ppm of Reading)		104.4	105.9	110.6	118.4
Gain Tempco (ppm/°C)		20	20	20	20
Reference Tempco (ppm/°C)		4	4	4	4
Residual Offset Error (ppm of Range)		16.4	16.4	16.4	16.4
Offset Tempco (ppm of Range/°C)		4.18	4.17	4.41	4.63
INL Error (ppm of range)		42.52	46.52	46.52	50.52
Random Noise, σ (μV_{rms})		263	156	90	74
Absolute Accuracy at Full Scale (µV)		2,283	1,170	479	252

Table 3. AI Absolute Accuracy (Uncalibrated)

Specifications	Range				
	±20 V	±10 V	±5 V	±2 V	±1 V
Residual Gain Error (ppm of Reading)		2,921	3,021	3,021	3,021
Gain Tempco (ppm/°C)		20	20	20	20
Reference Tempco (ppm/°C)		4	4	4	4
Residual Offset Error (ppm of Range)		661	671	700	631
Offset Tempco (ppm of Range/°C)		4.18	4.17	4.41	4.63
INL Error (ppm of range)		42.52	46.52	46.52	50.52
Random Noise, σ (μV_{rms})		263	156	90	74
Absolute Accuracy at Full Scale (µV)		36,895	19,018	7,667	3,769

Calculating Absolute Accuracy

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

$$GainError = ResidualGainError + GainTempco \times (TempChangeFromLastInternalCal) + ReferenceTempco \times (TempChangeFromLastExternalCal)$$

$$OffsetError = ResidualOffsetError + OffsetTempco \times (TempChangeFromLastInternalCal) + INL\_Error$$

$$NoiseUncertainty = \frac{RandomNoise \times CoverageFactor}{\sqrt{number\_of\_readings}}$$

Refer to the following equation for an example of calculating absolute accuracy for a 10 V reading.

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

$$GainError = 104.4\ ppm + 20\ ppm \times 1 + 4\ ppm \times 10$$

$$GainError = 164.4\ ppm$$

$$OffsetError = 16.4\ ppm + 4.18\ ppm\ 1 + 42.52\ ppm$$

$$OffsetError = 63.1\ ppm$$

$$NoiseUncertainty = \frac{263\ \mu V \times 3}{\sqrt{10{,}000}}$$

$$NoiseUncertainty = 7.89\ \mu V$$

$$AbsoluteAccuracy = 10\ V \times (GainError) + 10\ V \times (OffsetError) + NoiseUncertainty$$

$$AbsoluteAccuracy = 2{,}283\ \mu V$$

DC Transfer Characteristics

INL	Refer to the AI Accuracy Table
DNL	±0.4 LSB typical, ±0.9 LSB maximum
No missing codes	16 bits guaranteed

CMRR, DC to 60 Hz	-100 dB

Dynamic Characteristics

Bandwidth	
Small signal	1 MHz
Large signal	500 kHz

Table 4. Settling Time

Range (V)	Step Size (V)	Accuracy		
		±16 LSB	±4 LSB	±2 LSB
±20				
±10	±20.0	1.50 µs	4.00 µs	7.00 µs
	±2.0	0.50 µs	0.50 µs	1.00 µs
	±0.2	0.50 µs	0.50 µs	0.50 µs
±5	±10	1.50 µs	3.50 µs	7.50 µs
	±1	0.50 µs	0.50 µs	1.00 µs
	±0.1	0.50 µs	0.50 µs	0.50 µs
±2	±4	1.00 µs	3.50 µs	8.00 µs
	±0.4	0.50 µs	0.50 µs	1.00 µs
	±0.04	0.50 µs	0.50 µs	0.50 µs
±1	±2	1.00 µs	3.50 µs	12.00 µs
	±0.2	0.50 µs	0.50 µs	2.00 µs
	±0.02	0.50 µs	0.50 µs	0.50 µs

Crosstalk	-80 dB, DC to 100 kHz, at 50 Ω

Analog Output

Output type	Single-ended, voltage output
Number of channels	8
Resolution	16 bits
Update time	1 µs
Maximum update rate	1 MS/s
Type of DAC	Enhanced R-2R
Range	±10 V
Output coupling	DC
Output impedance	0.5 Ω
Current drive	±2.5 mA
Protection	Short circuit to ground

Overvoltage protection	
Powered on	±15 V maximum
Powered off	±10 V maximum

Power-on state	User-configurable
Power-on glitch	-1 V for 2 µs
Power-down glitch	-500 mV for 100 µs

Table 5. AO Operating Voltage Ranges for Over Temperature

Range (V)	Measurement Voltage, AO+ to AO GND		
	Minimum (V)[2]	Typical (V)	Maximum (V)
±10	±10.1	±10.16	±10.22

AO Absolute Accuracy

Absolute accuracy at full scale numbers is valid immediately following internal calibration and assumes the device is operating within 10 °C of the last external calibration. Accuracies listed are valid for up to one year from the device external calibration.

Absolute accuracy at full scale on the analog output channels is determined using the following assumptions:

- TempChangeFromLastExternalCal = 10 °C
- TempChangeFromLastInternalCal = 1 °C

Table 6. AO Absolute Accuracy (Calibrated)

Specifications	±10 V Range
Residual Gain Error (ppm of Reading)	87.3
Gain Tempco (ppm/°C)	12.6
Reference Tempco (ppm/°C)	4
Residual Offset Error (ppm of Range)	41.1
Offset Tempco (ppm of Range/°C)	7.8
INL Error (ppm of range)	61
Absolute Accuracy at Full Scale (µV)	2,498

Table 7. AO Absolute Accuracy (Uncalibrated)

Specifications	±10 V Range
Residual Gain Error (ppm of Reading)	2,968.6
Gain Tempco (ppm/°C)	12.6
Reference Tempco (ppm/°C)	4
Residual Offset Error (ppm of Range)	1,004.1
Offset Tempco (ppm of Range/°C)	7.8
INL Error (ppm of range)	61
Absolute Accuracy at Full Scale (µV)	40,941

Calculating Absolute Accuracy

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

$$GainError = ResidualGainError + GainTempco \times (TempChangeFromLastInternalCal) + ReferenceTempco \times (TempChangeFromLastExternalCal)$$

$$OffsetError = ResidualGainError + AOOffsetTempco \times (TempChangeFromLastInternalCal) + INL\_Error$$

Refer to the following equation for an example of calculating absolute accuracy for a 10 V reading.

Absolute accuracy at full scale on the analog output channels is determined using the following assumptions:

- TempChangeFromLastExternalCal = 10 °C
- TempChangeFromLastInternalCal = 1 °C

$\text{GainError} = 87.3\ \text{ppm} + 12.6\ \text{ppm} \times\ 1 + 4\ \text{ppm} \times\ 10$

$\text{GainError} = 139.9\ \text{ppm}$

$\text{OffsetError} = 41.1\ \text{ppm} + 7.8\ \text{ppm} \times\ 1 + 61\ \text{ppm}$

$\text{OffsetError} = 109.9\ \text{ppm}$

$\text{AbsoluteAccuracy} = 10\ V \times (\text{GainError}) + 10\ V \times (\text{OffsetError})$

$\text{AbsoluteAccuracy} = 2{,}498\ \mu\text{V}$

DC Transfer Characteristics

INL	Refer to the AO Accuracy Table
DNL	±0.5 LSB typical, ±1 LSB maximum
Monotonicity	16 bits, guaranteed

Dynamic Characteristics

Table 8. Settling Time

Step Size (V)	Accuracy		
	±16 LSB	**±4 LSB**	**±2 LSB**
±20.0	5.3 µs	6.5 µs	7.8 µs
±2.0	3.2 µs	3.9 µs	4.4 µs
±0.2	1.8 µs	2.8 µs	3.8 µs

Slew rate	10 V/µs
Noise	250 µV RMS, DC to 1 MHz

Glitch energy at midscale transition	±10 mV for 3 μs

5V Output

Output voltage	4.75 V to 5.1 V
Output current	0.5 A maximum
Overvoltage protection	±30 V
Overcurrent protection	650 mA

Digital I/O

Table 9. Channel Frequency

Connector	Number of Channels	Maximum Frequency
Connector 0	16	10 MHz
Connector 1	32	80 MHz

Compatibility	LVTTL, LVCMOS
Logic family	Software-selectable
Default software setting	3.3 V

Table 10. Digital Input Logic Levels

Logic Family	Input Low Voltage (V_{IL})		Input High Voltage (V_{IH})	
	Minimum	Maximum	Minimum	Maximum
1.2 V	-0.3 V	0.40 V	0.84 V	1.5 V
1.5 V	-0.3 V	0.50 V	1.05 V	1.8 V
1.8 V	-0.3 V	0.60 V	1.25 V	2.1 V
2.5 V	-0.3 V	0.70 V	1.70 V	2.8 V
3.3 V	-0.3 V	0.80 V	2.00 V	3.6 V

Input leakage current	±15 µA maximum
Input impedance	50 kΩ typical, pull-down

Table 11. Digital Output Logic Levels

Logic Family	Current	Output Low Voltage (V_{OL}) Maximum	Output High Voltage (V_{OH}) Minimum
1.2 V	100 µA	0.20 V	1.00 V
1.5 V	100 µA	0.20 V	1.25 V
1.8 V	100 µA	0.20 V	1.54 V
2.5 V	100 µA	0.20 V	2.22 V
3.3 V	100 µA	0.20 V	3.00 V
	4 mA	0.40 V	2.40 V

Maximum DC output current per channel	
Source	4.0 mA

Sink	4.0 mA
Output impedance	50 Ω
Power-on state	Programmable, by line
Protection	±20 V, single line[3]
Digital I/O voltage selection	Programmable, per connector, and defined at compilation (not run-time configurable)
Direction control of digital I/O channels	Per channel
Minimum I/O pulse width	6.25 ns
Minimum sampling period	5 ns

External Clock

Direction	Input into device
Maximum input leakage	±15 µA
Characteristic impedance	50 Ω

Power-on state	Tristated
Minimum input	Inherited from programmed digital voltage selection per connector
Maximum input	Inherited from programmed digital voltage selection per connector
Logic level	Inherited from programmed digital voltage selection per connector
Maximum input frequency	80 MHz

Reconfigurable FPGA

FPGA type	Kintex-7 160T
Number of flip-flops	202,800
Number of LUTs	101,400
Embedded Block RAM	11,700 kbits
Number of DSP48 slices	600
Timebase	40 MHz, 80 MHz, 120 MHz, 160 MHz, or 200 MHz
Default timebase	40 MHz

Timebase accuracy	±100 ppm, 250 pspeak-to-peak jitter
Data transfers	DMA, interrupts, programmed I/O

Synchronization Resources

Input/output source	RTSI<0..7>

Bus Interface

Form factor	x4 PCI Express, specification v1.0 compliant
Slot compatibility	x4, x8, and x16 PCI Express slots
Data transfers	DMA, interrupts, programmed I/O
Number of DMA channels	16

Power Requirements

Power requirements are dependent on the digital output loads and configuration of the LabVIEW FPGA VI used in your application.

+3.3 V	3 A

+12 V	2 A

Physical Characteristics

Weight	141.4 g (4.99 oz)
Printed circuit board dimensions	16.8 cm × 11.1 cm(6.60 in. × 4.38 in.)
Form factor	standard height, half length, single slot
I/O connectors	2 × 68-pin VHDCI

Safety Voltages

Connect only voltages that are below these limits.

Channel-to-earth	±12 V, Measurement Category I
Channel-to-channel	±24 V, Measurement Category I

Caution Do not connect the NI PCIe-7846 to signals or use for measurements within Measurement Categories II, III, or IV.

Attention Ne connectez pas le NI PCIe-7846 à des signaux et ne l'utilisez pas pour effectuer des mesures dans les catégories de mesure II, III ou IV.

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.

> **Note** Measurement Categories CAT I and CAT O are equivalent. These test and measurement circuits are for other circuits not intended for direct connection to the MAINS building installations of Measurement Categories CAT II, CAT III, or CAT IV.

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 UL and other safety certifications, refer to the product label or the Product Certifications and Declarations section.

Electromagnetic Compatibility Standards

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 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.

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)
- 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 Guidelines

Notice This model is intended for use in indoor applications only.

Operating Environment

Operating temperature, local[4]	0 °C to 55 °C (IEC 60068-2-1 and IEC 60068-2-2)

Operating humidity	10% RH to 90% RH, noncondensing (IEC 60068-2-78)

Storage Environment

Temperature	
Operating[5]	0 °C to 55 °C
Storage	-20 °C to 70 °C
Humidity	
Operating	10% RH to 90% RH, noncondensing
Storage	5% RH to 95% RH, noncondensing
Pollution Degree	2
Maximum altitude	2,000 m (at 25 °C ambient temperature)

Maximum Altitude and Pollution Degree

Refer to the manual for the chassis you are using for more information about meeting these specifications.

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

Pollution degree	2

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`.)

Calibration

Recommended warm-up time	15 minutes
Calibration interval	1 year

Onboard calibration reference	
DC level[6]	5.000 V (±2 mV)
Temperature coefficient	±4 ppm/°C maximum
Long-term stability	±25 ppm/1,000 h

Note Refer to Calibration Certifications at ni.com/calibration to generate a calibration certificate for the NI PCIe-7846

NI Services

Visit ni.com/support to find support resources including documentation, downloads, and troubleshooting and application development self-help such as tutorials and examples.

Visit ni.com/services to learn about NI service offerings such as calibration options, repair, and replacement.

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

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