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SPECIFICATIONS

NI USB-7856R OEM

R Series for USB Multifunction RIO with Kintex-7 160T FPGA

Français	Deutsch	日本語	한국어	简体中文
ni.com/manuals				

This document contains the specifications for the National Instruments USB-7856R OEM device. Specifications are typical at 25 °C unless otherwise noted.

Caution Using the NI USB-7856R OEM device in a manner not described in this document may impair the protection the NI USB-7856R OEM device provides.

Analog Input

Number of channels....8

Input modes....DIFF, NRSE, RSE (software-selectable; selection applies to all channels)

Type of ADC....Successive approximation register (SAR)

Resolution....16 bits

Conversion time....1 µs

Maximum sampling rate....1 MS/s (per channel)

Input impedance

- Powered on....1.25 GΩ ‖ 2 pF
- Powered off/overload....4.0 kΩ min

Input signal range....±1 V, ±2 V, ±5 V, ±10 V (software-selectable)

Input bias current....±5 nA

Input offset current....±5 nA

Input coupling....DC

Overvoltage protection

- Powered on....±42 V max
- Powered off....±35 V max

Table 1. AI Operating Voltage Ranges Over Temperature

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

[1] The minimum measurement voltage range is the largest voltage the NI USB-7856R OEM device is guaranteed to accurately measure.

Table 2. AI Absolute Accuracy (Calibrated) (Continued)

Specifications	Range			
	±10 V	±5 V	±2 V	±1 V
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			
	±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

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

$$GainError = ResidualGainError + GainTempco * (TempChangeFromLastInternalCal) + ReferenceTempco * (TempChangeFromLastExternalCal)$$

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

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

Refer to the following equation for an example of calculating absolute accuracy.

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

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

$$GainError = 164.4\ ppm$$

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

$$OffsetError = 63.1\ ppm$$

$$NoiseUncetainty = \frac{263\ \mu V * 3}{\sqrt{10,\ 000}}$$

$$NoiseUncertainty = 7.89\ \mu V$$

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

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

DC Transfer Characteristics

INL.....Refer to the AI Accuracy Table

DNL.....±0.4 LSB typ, ±0.9 LSB max

No missing codes.....16 bits guaranteed

CMRR, DC to 60 Hz.....-100 dB

Dynamic Characteristics

Bandwidth

- Small signal.....1 MHz
- Large signal.....500 kHz

Settling Time

Range (V)	Step Size (V)	Accuracy		
		±16 LSB	±4 LSB	±2 LSB
±10	±20.0	1.50 µs	3.50 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	1.00 µs
	±0.02	0.50 µs	0.50 µs	0.50 µs

Crosstalk.....-80 dB, DC to 100 kHz

Analog Output

Output type.....Single-ended, voltage output

Number of channels.....8

Resolution.....16 bits

Update time.....1.0 µs

Maximum update rate.....1 MS/s

Type of DAC.....Enhanced R-2R

Range.....±10 V

Output coupling.....DC

Output impedance.....0.5 Ω

Minimum current drive.....±2.5 mA

Protection.....Short circuit to ground

Overvoltage protection

Powered on.....±15 V max

Powered off.....±10 V max

Power-on state.....User-configurable

Power-on glitch.....-1 V for 1 µs

Table 4. AO Operating Voltage Ranges for Over Temperature

Range	Measurement Voltage, AO+ to AO GND		
	Min (V)[2]	Typ (V)	Max (V)
±10 V	±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 5. 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

[2] The minimum measurement voltage range is the largest voltage the NI USB-7856R OEM device is guaranteed to accurately measure.

Table 5. AO Absolute Accuracy (Calibrated) (Continued)

Specifications	±10 V Range
INL Error (ppm of range)	61
Absolute Accuracy at Full Scale (µV)	2,498

Table 6. 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

$$AbsoluteAccuracy = OutputValue * (GainError) + Range * (OffsetError)$$

$$GainError = ResidualGainError + GainTempco * (TempChangeFromLastInternalCal) + ReferenceTempco * (TempChangeFromLastExternalCal)$$

$$OffsetError = ResidualOffsetError + AOOffsetTempco * (TempChangeFromLastInternalCal) + INL\_Error$$

Refer to the following equation for an example of calculating absolute accuracy.

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

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

$$GainError = 87.3\ ppm + 12.6\ ppm * 1 + 4\ ppm * 10$$

$$GainError = 139.9\ ppm$$

$$OffsetError = 41.1\ ppm + 7.8\ ppm * 1 + 61\ ppm$$

$$OffsetError = 109.9\ ppm$$

$$AbsoluteAccuracy = 10\ V * (GainError) + 10\ V * (OffsetError)$$

$$AbsoluteAccuracy = 2,498\ \mu V$$

DC Transfer Characteristics

INL.....Refer to the AO Accuracy Table

DNL.....±0.5 LSB typ, ±1 LSB max

Monotonicity.....16 bits, guaranteed

Dynamic Characteristics

Table 7. Settling Time

Step Size	Accuracy		
	±16 LSB	±4 LSB	±2 LSB
±20.0 V	5.1 µs	5.8 µs	7.5 µs
±2.0	3.0 µs	3.7 µs	4.3 µs
±0.2	1.7 µs	2.9 µs	3.4 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 max

Overvoltage protection.....±30 V

Overcurrent protection.....650 mA

Digital I/O

Table 8. Channel Frequency

Connector	Number of Channels	Maximum Frequency
Connector 1	16	10 MHz
Connector 2	16	10 MHz
Connector 3	16	10 MHz

Compatibility.....LVTTL

Logic family.....User-selectable

Default software setting.....3.3 V

Table 9. Digital Input Logic Levels

Logic Family	Input Low Voltage, V_{IL} (Max)	Input High Voltage, V_{IH} (Min)
1.2 V	0.42 V	0.84 V
1.5 V	0.51 V	1.01 V
1.8 V	0.61 V	1.21 V
2.5 V	0.70 V	1.60 V
3.3 V	0.80 V	2.00 V

Maximum input.....3.6 V

Table 10. Digital Output Logic Levels

Logic Family	Current	Output Low Voltage, V_{OL} (Max)	Output High Voltage, V_{OH} (Min)
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

Table 10. Digital Output Logic Levels (Continued)

Logic Family	Current	Output Low Voltage, V_{OL} (Max)	Output High Voltage, V_{OH} (Min)
3.3 V	100 µA	0.20 V	3.00 V
	4 mA	0.40 V	2.40 V

Output current

Source.....4.0 mA

Sink.....4.0 mA

Input leakage current.....±15 µA max

Input impedance.....50 kΩ typ, pull-down

Power-on state.....Programmable, by line

Protection.....±20 V, single line

Digital I/O voltage switching time.....2 ms max

Note Refer to *NI RIO Software Help* for more information about switching times.

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, 80, 120, 160, or 200 MHz

Timebase accuracy, onboard clock.....±100 ppm

Calibration

Recommended warm-up time.....15 minutes

Calibration interval.....1 year

Onboard calibration reference

DC level[3].....5.000 V (±2 mV)

Temperature coefficient.....±4 ppm/°C max

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 USB-7856R OEM device

Bus Interface

USB compatibility.....USB 2.0 Hi-Speed or Full-Speed[4]

Data transfers.....DMA, interrupts, programmed I/O

Number of DMA channels.....3

Power Requirement

Input voltage.....9 V to 30 V

Max power.....20 W

Overvoltage protection.....40 V

Note You must use a UL Listed ITE power supply marked LPS with the NI USB-7856R OEM device.

Physical

Note If you need to clean the device, wipe it with a dry, clean towel.

Dimensions (PCB).....17.5 cm × 16.3 cm (6.9 in. × 6.4 in.)

Weight.....183 g (6.45 oz)

I/O connectors.....Analog- 1 × 50 pin box header,
Digital- 3 × 34 pin box header

[3] Actual value stored in Flash memory

[4] Operating on a full-speed bus will result in lower performance and you might not be able to achieve maximum sampling/update rates.

Maximum Working Voltage

Maximum working voltage refers to the signal voltage plus the common-mode voltage.

Channel-to-earth.....±12 V, Measurement Category I

Channel-to-channel.....±24 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.

Caution Do not use the NI USB-7856R OEM device for connection to signals in Measurement Categories II, III, or IV.

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

Environmental

Operating temperature.....-40 °C to 70 °C
(IEC 60068-2-1, IEC 60068-2-2)

Storage temperature.....-40 °C to 85 °C
(IEC 60068-2-1, IEC 60068-2-2)

Operating humidity.....10% to 90% RH, noncondensing
(IEC 60068-2-56)

Storage humidity (IEC 60068-2-56).....5% to 95% RH, noncondensing

Pollution Degree.....2

Maximum altitude.....2,000 m

Indoor use only.

Online Product Certification

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 not only to the environment but also 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 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 Electrical 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`.)

Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At *ni.com/support* you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

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