USB-7856 OEM Specifications

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Contents

NI USB-7856R OEM device Specifications

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

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 minimum
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 maximum
Powered off	±35 V maximum

Table 1. AI Operating Voltage Ranges Over Temperature

Range	Measurement Voltage, AI+ to AI-			Maximum Working Voltage (Signal + Common Mode)
	Minimum (V)[1]	Typical (V)	Maximum (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
Random Noise, σ (µVrms)	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	2,921	3,021	3,021	3,021

Specifications	Range			
	±10 V	±5 V	±2 V	±1 V
Reading)				
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 (µVrms)	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 × 1 + 4 ppm × 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 µV

AbsoluteAccuracy = 10 V × (GainError) + 10 V × (OffsetError) + NoiseUncertainty

AbsoluteAccuracy = 2,283 µV

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
±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
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 1 µs

Table 5. AO Operating Voltage Ranges for Over Temperature

Range	Measurement Voltage, AO+ to AO GND		
	Minimum (V)[2]	Typical (V)	Maximum (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 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

Specifications	±10 V Range
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

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

$$GainError = 139.9\ ppm$$

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

$$OffsetError = 109.9\ ppm$$

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

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

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	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 µVrms, 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 1	16	10 MHz
Connector 2	16	10 MHz
Connector 3	16	10 MHz

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

Table 10. Digital Input Logic Levels

Logic Family	Input Low Voltage, V_{IL} (Maximum)	Input High Voltage, V_{IH} (Minimum)
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 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

Output current	
Source	4.0 mA
Sink	4.0 mA
Input leakage current	±15 µA maximum
Input impedance	50 kΩ typical, pull-down
Output impedance	50 Ω
Power-on state	Programmable, by line
Protection	±20 V, single line
Digital I/O voltage switching time	2 ms maximum

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 MHz, 80 MHz, 120 MHz, 160 MHz, or 200 MHz
Timebase accuracy, onboard clock	±100 ppm

Bus Interface

USB compatibility	USB 2.0 Hi-Speed or Full-Speed[3]
Data transfers	DMA, interrupts, programmed I/O
Number of DMA channels	3

Power Requirement

Input voltage	9 V to 30 V
Maximum power	20 W
Overvoltage protection	40 V

Caution You must use either the power supply provided in the shipping kit, or another UL Listed ITE power supply marked LPS with the NI USB-7856R OEM device .

Physical Characteristics

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

Dimensions	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

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 USB-7856R OEM device to signals or use for measurements within Measurement Categories II, III, or IV.

Attention Ne connectez pas le NI USB-7856R OEM device 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.

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

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

Operating temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 °C to 70 °C
Storage temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 °C to 85 °C
Operating humidity (IEC 60068-2-78)	10% RH to 90% RH, noncondensing
Storage humidity (IEC 60068-2-78)	5% RH to 95% RH, noncondensing
Pollution Degree	2
Maximum altitude	2,000 m

Indoor use only.

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[4]	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 USB-7856R OEM device

Worldwide Support and 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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