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SPECIFICATIONS

NI USB-7855R OEM

R Series for USB Multifunction RIO with Kintex-7 70T FPGA

This document contains the specifications for the NI USB-7855R OEM device. Specifications are typical at 25 °C unless otherwise noted.

Caution Using the NI USB-7855R OEM device in a manner not described in this document may impair the protection the NI USB-7855R 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 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

[1] The minimum measurement voltage range is the largest voltage the NI USB-7855R 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 (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 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 (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.

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

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

$$GainError = 164.4\ \text{ppm}$$

$$OffsetError = 16.4\ \text{ppm} + 4.18\ \text{ppm} \times\ 1 + 42.52\ \ \text{ppm}$$

$$OffsetError = 63.1\ \ \text{ppm}$$

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

$$NoiseUncertainty = 7.89\ \mu V$$

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

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

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
±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

[2] The minimum measurement voltage range is the largest voltage the NI USB-7855R OEM device is guaranteed to accurately measure.

Table 6. AO Absolute Accuracy (Calibrated) (Continued)

Specifications	±10 V Range
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

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

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

$$OffsetError = ResidualOffsetError + AOOffsetTempco \times (TempChangeFromLastInternalCal) + INL_Error$$

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

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

$$GainError = 139.9\ ppm$$

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

$$OffsetError = 109.9\,ppm$$

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

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

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

Table 11. Digital Output Logic Levels (Continued)

Logic Family	Current	Output Low Voltage, V_{OL} (Maximum)	Output High Voltage, V_{OH} (Minimum)
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 70T
Number of flip-flops	82,000
Number of LUTs	41,000
Embedded block RAM	4,860 kbits
Number of DSP48 slices	240
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-7855R OEM device.

Physical Characteristics

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

Dimensions	175.3 mm × 162.6 mm (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

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,

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

special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

Caution Do not use the NI USB-7855R 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.

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

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

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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-7855R OEM device

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[4] Actual value stored in Flash memory

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