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PXIe-7856

SPECIFICATIONS

NI PXIe-7856R

R Series Reconfigurable I/O Module (AI, AO, DIO) for PXI Express,
8 AI, 8 AO, 48 DIO, 1 MS/s AI, Kintex-7 160T FPGA

This document contains the specifications for the NI PXIe-7856R. Specifications are typical at 25 °C unless otherwise noted.



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

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 | 1 μ s |
| Maximum sampling rate (per channel) | 1 MS/s |
| Input impedance | |
| Powered on | 1.25 G Ω 2 pF |
| Powered off/overload | 4 k Ω 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 | | | |
|--------------------------------------|-------|-------|-------|-------|
| | ±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 PXIe-7856R 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

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

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

$$\text{OffsetError} = \text{ResidualOffsetError} + \text{OffsetTempco} \times (\text{TempChangeFromLastInternalCal}) + \text{INL_Error}$$

$$\text{NoiseUncertainty} = \frac{\text{RandomNoise} \times \text{CoverageFactor}}{\sqrt{\text{number_of_readings}}}$$

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:

- $\text{TempChangeFromLastExternalCal} = 10\text{ }^{\circ}\text{C}$
- $\text{TempChangeFromLastInternalCal} = 1\text{ }^{\circ}\text{C}$
- $\text{number_of_readings} = 10,000$
- $\text{CoverageFactor} = 3\sigma$

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

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

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

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

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

$$\text{NoiseUncertainty} = 7.89\text{ }\mu\text{V}$$

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

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

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 | 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 1 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 |

² The minimum measurement voltage range is the largest voltage the NI PXIe-7856R 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

$$\text{Absolute Accuracy} = \text{Output Value} \times (\text{Gain Error}) + \text{Range} \times (\text{Offset Error})$$

$$\text{Gain Error} = \text{Residual Gain Error} + \text{Gain Tempco} \times (\text{Temp Change From Last Internal Cal}) + \text{Reference Tempco} \times (\text{Temp Change From Last External Cal})$$

$$\text{Offset Error} = \text{Residual Offset Error} + \text{AO Offset Tempco} \times (\text{Temp Change From Last Internal Cal}) + \text{INL Error}$$

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

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

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

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

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

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

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

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 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 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}) 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 |

| | |
|-----------------------|----------------------------------|
| Minimum input | -0.3 V |
| Maximum input | 3.6 V |
| Input leakage current | ± 15 μ A maximum |
| Input impedance | 50 k Ω 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 μ A | 0.20 V | 1.00 V |
| 1.5 V | 100 μ A | 0.20 V | 1.25 V |

Table 11. Digital Output Logic Levels (Continued)

| Logic Family | Current | Output Low Voltage (V _{OL}) Maximum | Output High Voltage (V _{OH}) Minimum |
|--------------|-------------|--|---|
| 1.8 V | 100 μ A | 0.20 V | 1.54 V |
| 2.5 V | 100 μ A | 0.20 V | 2.22 V |
| 3.3 V | 100 μ A | 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 | \pm 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 | \pm 15 μ A |
| Characteristic impedance | 50 Ω |
| Power-on state | Tristated |
| Minimum input | -0.3 V |
| Maximum input | 3.6 V |

³ NI recommends minimizing long-term over/under-voltage exposure to the Digital I/O. Prolonged DC voltage stresses that violate the maximum and minimum digital input voltage ratings may reduce device longevity. Over/under-voltage stresses are considered prolonged if the cumulative time in the abnormal condition exceeds 1 year.

| | |
|-------------------------|---|
| 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 reference source | PXI Express 100 MHz (PXIe_CLK100) |
| Timebase accuracy | ±100 ppm, 250 ps peak-to-peak jitter |
| Data transfers | DMA, interrupts, programmed I/O |

Synchronization Resources

| | |
|---------------------|--|
| Input/output source | PXI_Trig<0..7> |
| Input source | PXI_Star, PXIe_DStarA, PXIe_DStarB, PXI_Clk10, PXIe_Clk100, External Clock 1 |
| Output source | PXIe_DStarC |

Bus Interface

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

Maximum 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



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

| | |
|----------------|---|
| Dimensions | 18.5 cm × 17.3 cm × 3.6 cm (7.3 in. × 6.8 in. × 1.4 in.) |
| Weight | 170.5 g (6.01 oz) |
| I/O connectors | 2 × 68-pin VHDCI |

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 PXIe-7856R 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.

Safety

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 61010-1



Note For UL and other safety certifications, refer to the product label or the [Online Product Certification](#) 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; 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 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.



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 For EMC declarations and certifications, and additional information, refer to the [Online Product Certification](#) section.

CE Compliance

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)

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.

Shock and Vibration

| | |
|-------------------|--|
| Operational shock | 30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC 60068-2-27. Meets MIL-PRF-28800F Class 2 limits.) |
| Random vibration | |
| Operating | 5 Hz to 500 Hz, 0.3 g _{rms} |
| Non-operating | .5 Hz to 500 Hz, 2.4 g _{rms} (Tested in accordance with IEC 60068-2-64. Meets MIL-PRF-28800F Class 3.) |

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) | 0 °C to 55 °C |
| Storage temperature (IEC 60068-2-1, IEC 60068-2-2) | -40 °C to 71 °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.

电子信息产品污染控制管理办法（中国 RoHS）



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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 PXIe-7856R

Worldwide Support and Services

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

⁴ Actual value stored in Flash memory

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