# PXIe-4138 Specifications

2025-03-10

# Contents

# PXIe-4138 Specifications

These specifications apply to the PXIe-4138.

## Definitions

***Warranted*** specifications describe the performance of a model under stated operating conditions and are covered by the model warranty.

***Characteristics*** describe values that are relevant to the use of the model under stated operating conditions but are not covered by the model warranty.

- ***Typical*** specifications describe the performance met by a majority of models.
- ***Nominal*** specifications describe an attribute that is based on design, conformance testing, or supplemental testing.

Specifications are ***Warranted*** unless otherwise noted.

## Conditions

Specifications are valid under the following conditions unless otherwise noted.

- Ambient temperature[1] of 23 °C ± 5 °C
- Calibration interval of 1 year
- 30 minutes warm-up time
- Self-calibration performed within the last 24 hours
- NI-DCPower Aperture Time property is set to 2 power-line cycles (PLC)
- Fans set to the highest setting if the PXI Express chassis has multiple fan speed settings

1. The ambient temperature of a PXI system is defined as the temperature at the chassis fan inlet (air intake).

# Cleaning Statement

> **Notice** Clean the hardware with a soft, nonmetallic brush. Make sure that the hardware is completely dry and free from contaminants before returning it to service.

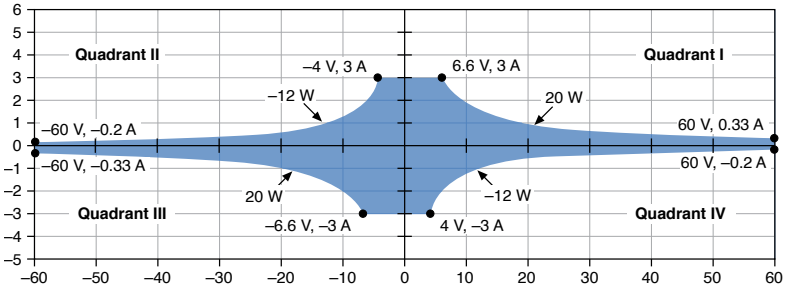
# Device Capabilities

The following table and figure illustrate the voltage and the current source and sink ranges of the PXIe-4138.

**Table 1.** Current Source and Sink Ranges

| DC voltage ranges | DC current source and sink ranges |
|---|---|
| • 600 mV<br>• 6 V<br>• 60 V [2] | • 1 µA<br>• 10 µA<br>• 100 µA<br>• 1 mA<br>• 10 mA<br>• 100 mA<br>• 1 A<br>• 3 A |

**Figure 1.** Quadrant Diagram




DC sourcing power is limited to 20 W, regardless of output voltage. [3]

2. The PXIe-4138 does not support configurations involving voltage > |42.4 V| when Sequence Step Delta Time Enabled is set to TRUE.
3. Power limit defined by voltage measured between HI and LO terminals.

**Caution** Limit DC power sinking to 12 W. Additional derating applies to sinking power when operating at an ambient temperature of >45 °C. If the PXI Express chassis has multiple fan speed settings, set the fans to the highest setting.

**Related reference:**

- Sinking Power vs. Ambient Temperature Derating

# Voltage

**Table 2.** Voltage Programming and Measurement Accuracy/Resolution

| Range | Resolution (noise limited) | Noise (0.1 Hz to 10 Hz, peak to peak), Typical | Accuracy (23 °C ±5 °C) ± (% of voltage + offset) [4] | Tempco ± (% of voltage + offset)/°C, 0 °C to 55 °C |
|---|---|---|---|---|
| | | | $T_{cal}$±5 °C[5] | |
| 600 mV | 1 µV | 4 µV | 0.02% + 100 µV | 0.0005% + 1 µV |
| 6 V | 10 µV | 12 µV | 0.02% + 600 µV | |
| 60 V | 100 µV | 120 µV | 0.02% + 6 mV | |

**Related reference:**

- Load Regulation
- Remote Sense

4. Accuracy is specified for no load output configurations. Refer to ***Load Regulation*** and ***Remote Sense*** sections for additional accuracy derating and conditions.
5. $T_{cal}$ is the internal device temperature recorded by the PXIe-4138 at the completion of the last self-calibration.

# Current

**Table 3.** Current Programming and Measurement Accuracy/Resolution

| Range | Resolution (noise limited) | Noise (0.1 Hz to 10 Hz, peak to peak), Typical | Accuracy (23 °C ± 5 °C) ± (% of current + offset) | Tempco ± (% of current + offset)/°C, 0 °C to 55 °C |
|---|---|---|---|---|
| | | | $T_{cal}$ ±5 °C [6] | |
| 1 µA | 1 pA | 8 pA | 0.03% + 200 pA | 0.0006% + 4 pA |
| 10 µA | 10 pA | 60 pA | 0.03% + 1.4 nA | 0.0006% + 22 pA |
| 100 µA | 100 pA | 400 pA | 0.03% + 12 nA | 0.0006% + 200 pA |
| 1 mA | 1 nA | 4 nA | 0.03% + 120 nA | 0.0006% + 2 nA |
| 10 mA | 10 nA | 40 nA | 0.03% + 1.2 µA | 0.0006% + 20 nA |
| 100 mA | 100 nA | 400 nA | 0.03% + 12 µA | 0.0006% + 200 nA |
| 1 A | 1 µA | 4 µA | 0.03% + 120 µA | 0.0006% + 2 µA |
| 3 A | 10 µA | 40 µA | 0.083% + 1.8 mA | 0.002% + 20 µA |

# Noise

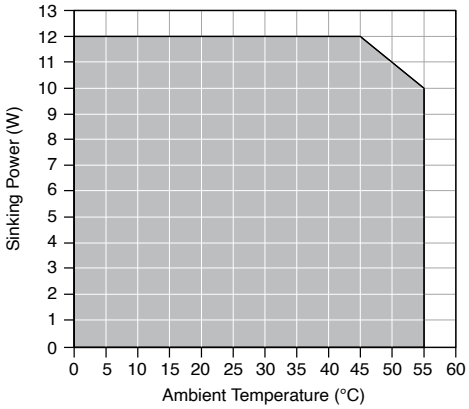
| | |
|---|---|
| Wideband source noise | <20 mV peak-to-peak in 60 V range, device configured for normal transient response, 10 Hz to 20 MHz, typical |

# Sinking Power vs. Ambient Temperature Derating

The following figure illustrates sinking power derating as a function of ambient temperature.

6. $T_{cal}$ is the internal device temperature recorded by the PXIe-4138 at the completion of the last self-calibration.

**Figure 1.** Sinking Power vs. Ambient Temperature Derating




### Related reference:

- Device Capabilities

# Transient Response and Settling Time

| | |
|---|---|
| Transient response | <70 µs to recover within 0.1% of voltage range after a load current change from 10% to 90% of range, device configured for fast transient response, typical |
| **Settling time**[7] | |
| Voltage mode, 50 V step, unloaded[8] | <200 µs, typical |
| Voltage mode, 5 V step or smaller, unloaded[9] | <70 µs, typical |
| Current mode, full-scale step, 3 A to 100 µA ranges[10] | <50 µs, typical |
| Current mode, full-scale step, 10 µA range[10] | <150 µs, typical |
| Current mode, full-scale step, 1 µA range[10] | <300 µs, typical |

7. Measured as the time to settle to within 0.1% of step amplitude, device configured for fast transient response.

The following figures illustrate the effect of the transient response setting on the step response of the PXIe-4138 for different loads.

**Figure 1.** 1 mA Range, No Load Step Response, Nominal

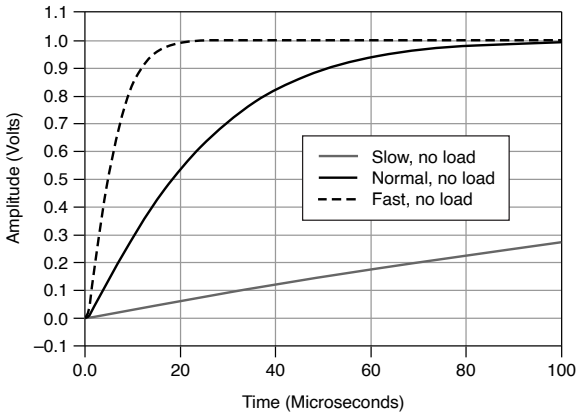
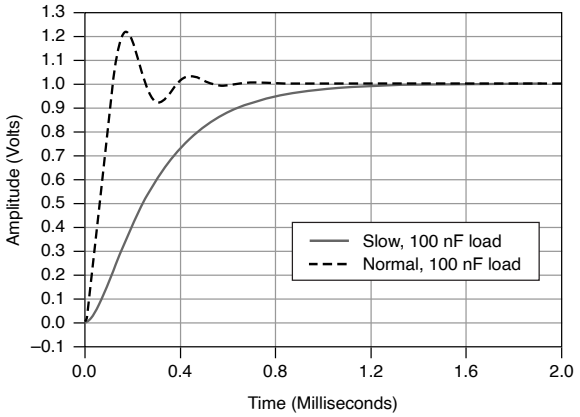



**Figure 1.** 1 mA Range, 100 nF Load Step Response, Nominal




# Load Regulation

| Voltage | |
|---|---|
| Device configured for local sense | 100 µV per mA of output load change (measured between output channel terminals), typical |
| Device configured for remote sense | Load regulation effect included in voltage accuracy specifications |

8. Current limit set to ≥50 µA and ≥50% of the selected current limit range.
9. Current limit set to ≥20 µA and ≥20% of selected current limit range.
10. Voltage limit set to ≥2 V, resistive load set to 1 V/selected current range.

| | |
|---|---|
| Current, device configured for local or remote sense | Load regulation effect included in current accuracy specifications |

**Related reference:**

- Voltage
- Current

## Expected Relay Life

| | |
|---|---|
| Output Connected | ≥100 k cycles |

**Note** To avoid excessive relay wear, do not set Output Connected to **TRUE** when a non-zero voltage is connected to the output.

## Measurement and Update Timing Characteristics

| | |
|---|---|
| Available sample rates[11] | (1.8 MS/s)/N where N = 1, 2, 3, … $2^{24}$, nominal |
| Sample rate accuracy | Equal to PXIe_CLK100 accuracy, nominal |
| Maximum measure rate to host | 1.8 MS/s per channel, continuous, nominal |
| **Maximum source update rate**[12] | |
| Sequence mode | 100,000 updates/s (10 µs/update), nominal |

11. When sourcing while measuring, both the Source Delay and Aperture Time affect the sampling rate. When taking a measure record, only the Aperture Time affects the sampling rate.
12. As the source delay is adjusted or if advanced sequencing is used, maximum source rates vary. Timed output mode is enabled in Sequence Mode by setting Sequence Step Delta Time Enabled to True.

| | |
|---|---|
| Timed output mode | 80,000 updates/s (12.5 µs/update), nominal |
| **Input trigger to** | |
| Source event delay | 10 µs, nominal |
| Source event jitter | 1 µs, nominal |
| Measure event jitter | 1 µs, nominal |
| Shutdown[13] | 100 µs, typical |
| **Pulse timing and accuracy**[14] | |
| Minimum pulse on time[15] | 50 µs, nominal |
| Minimum pulse off time [16] | 50 µs, nominal |
| Pulse on time or off time programming resolution | 100 ns, nominal |
| Pulse on time or off time programming accuracy | ±5 µs, nominal |
| Pulse on time or off time jitter | 1 µs, nominal |

13. Time from PXI Trigger sent until SMU output goes to high impedance.
14. Shorter minimum on times for in-range pulses can be achieved using Sequence mode or Timed Output mode with Output Function set to Voltage or Current.
15. ***Pulse on time*** is measured from the start of the leading edge to the start of the trailing edge.
16. ***Pulse off time*** is measured from the start of the trailing edge to the start of a subsequent leading edge.

## Remote Sense

| | |
|---|---|
| Voltage accuracy | Add (3 ppm of voltage range + 11 µV) per volt of HI lead drop plus 1 µV per volt of lead drop per Ω of corresponding sense lead resistance to voltage accuracy specifications. |
| Maximum sense lead resistance | 100 Ω |
| Maximum lead drop per lead | 3 V |

**Note** Exceeding the maximum lead drop per lead value may result in additional error.

**Related reference:**

- Voltage

## Examples of Calculating Accuracy

**Note** Specifications listed in examples are for demonstration purposes only and do not necessarily reflect specifications for this device.

# Example 1: Calculating 5 °C Accuracy

Calculate the accuracy of 900 nA output in the 1 µA range under the following conditions:

| | |
|---|---|
| ambient temperature | 28 °C |
| internal device temperature | within $T_{cal}$ ± 5 °C[17] |

| | |
|---|---|
| self-calibration | within the last 24 hours. |

Solution

Since the device internal temperature is within $T_{cal}$ ± 5 °C and the ambient temperature is within 23 °C ± 5 °C, the appropriate accuracy specification is:

0.03% + 200 pA

Calculate the accuracy using the following formula:

Accuracy = 900 nA * 0.03 % + 200pA

= 270pA + 200pA

= 470pA

Therefore, the actual output will be within 470 pA of 900 nA.

# Example 2: Calculating Remote Sense Accuracy

Calculate the remote sense accuracy of 500 mV output in the 600 mV range. Assume the same conditions as in Example 1, with the following differences:

| | |
|---|---|
| HI path lead drop | 3 V |
| HI sense lead resistance | 2 Ω |
| LO path lead drop | 2.5 V |
| LO sense lead resistance | 1.5 Ω |

Solution

Since the device internal temperature is within $T_{cal}$ ± 5 °C and the ambient temperature is within 23 °C ± 5 °C, the appropriate accuracy specification is:

17. $T_{cal}$ is the internal device temperature recorded by the PXIe-4138 at the completion of the last self-calibration.

0.02% + 100 µV

Since the device is using remote sense, use the remote sense accuracy specification:

Add (3 ppm of voltage range + 11 µV) per volt of HI lead drop plus 1 µV per volt of lead drop per Ω of corresponding sense lead resistance to voltage accuracy specifications.

Calculate the remote sense accuracy using the following formula:

$$\text{Accuracy} = \left(500\,\text{mV} * 0.02\,\% + 100\mu\text{V}\right) + \frac{600\,\text{mV} * 3\text{ppm} + 11\mu\text{V}}{1\,\text{V of lead drop}} * 3\,\text{V} + \frac{1\mu\text{V}}{\text{V} * \Omega} * 3\,\text{V} * 2\,\Omega + \frac{1\mu\text{V}}{\text{V} * \Omega} * 2.5\,\text{V} * 1.5\Omega$$

$$= 100\mu\text{V} + 100\mu\text{V} + 12.8\mu\text{V} * 3 + 6\mu\text{V} + 3.8\mu\text{V}$$

$$= 248.2\mu\text{V}$$

Therefore, the actual output will be within 248.2 µV of 500 mV.

# Example 3: Calculating Accuracy with Temperature Coefficient

Calculate the accuracy of 900 nA output in the 1 µA range. Assume the same conditions as in Example 1, with the following differences:

| | |
|---|---|
| ambient temperature | 15 °C |

Solution

Since the device internal temperature is within $T_{cal}$ ± 5 °C, the appropriate accuracy specification is:

0.03% + 200 pA

Since the ambient temperature falls outside of 23 °C ± 5 °C, use the following temperature coefficient per degree Celsius outside the 23 °C ± 5 °C range:

0.0006% + 4 pA

Calculate the accuracy using the following formula:

$$\text{TemperatureVariation} = (23\ ^\circ C - 5\ ^\circ C) - 15\ ^\circ C = 3\ ^\circ C$$

$$\text{Accuracy} = \left(900\ \text{nA} * 0.03\ \% + 200\text{pA}\right) + \frac{900\ \text{nA} * 0.0006\ \% + 4pA}{1\ ^\circ C} * 3\ ^\circ C$$

$$= 470\text{pA} + 28.2\text{pA}$$

$$= 498.2\text{pA}$$

Therefore, the actual output will be within 498.2 pA of 900 nA.

# Trigger Characteristics

## Input Triggers

| | |
|---|---|
| Types | Start, Source, Sequence Advance, Measure, Pulse, Shutdown |
| **Sources (PXI trigger lines <0...7>)** [18] | |
| Polarity | Configurable |
| Minimum pulse width | 100 ns, nominal |
| **Destinations**[19] **(PXI trigger lines <0...7>)**[18] | |
| Polarity | Active high (not configurable) |
| Pulse width | >200 ns, typical |

18. Pulse widths and logic levels are compliant with ***PXI Express Hardware Specification Revision 1.0 ECN 1***.
19. Input triggers can be re-exported.

## Output Triggers (Events)

| | |
|---|---|
| Types | Source Complete, Sequence Iteration Complete, Sequence Engine Done, Measure Complete, Pulse Complete, Ready for Pulse |
| **Destinations (PXI trigger lines <0...7>)**[18] | |
| Polarity | Configurable |
| Pulse width | Configurable between 250 ns and 1.6 µs, nominal |

# Protection

| **Output channel protection** | |
|---|---|
| Overcurrent or overvoltage | Automatic shutdown, output disconnect relay opens |
| Overtemperature | Automatic shutdown, output disconnect relay opens |

# Safety Voltage and Current

**Notice** The protection provided by the PXIe-4138 can be impaired if it is used in a manner not described in the user documentation.

**Warning** Take precautions to avoid electrical shock when operating this product at hazardous voltages.

**Caution** Isolation voltage ratings apply to the voltage measured between any channel pin and the chassis ground. When operating channels in series or floating on top of external voltage references, ensure that no terminal

exceeds this rating.

**Attention** Les tensions nominales d'isolation s'appliquent à la tension mesurée entre n'importe quelle broche de voie et la masse du châssis. Lors de l'utilisation de voies en série ou flottantes en plus des références de tension externes, assurez-vous qu'aucun terminal ne dépasse cette valeur nominale.

| | |
|---|---|
| DC voltage | ±60 V |
| **Channel-to-earth ground isolation** | |
| Continuous | 150 VDC, CAT I |
| Withstand | 1,000 V RMS, verified by a 5 s withstand |

**Caution** Do not connect the PXIe-4138 to signals or use for measurements within Measurement Categories II, III, or IV.

**Attention** Ne connectez pas le PXIe-4138 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.

| | |
|---|---|
| DC current range | ±3 A |

## Guard Output Characteristics

| **Cable guard** | |
|---|---|
| Output impedance | 2 kΩ, nominal |
| Offset voltage | 1 mV, typical |

## Calibration Interval

| | |
|---|---|
| Recommended calibration interval | 1 year |

## Power Requirement

| | |
|---|---|
| PXI Express power requirement | 2.5 A from the 3.3 V rail and 2.2 A from the 12 V rail |

## Physical

| | |
|---|---|
| Dimensions | 3U, one-slot, PXI Express/CompactPCI Express module<br>2.0 cm × 13.0 cm × 21.6 cm (0.8 in. × 5.1 in. × 8.5 in.) |

| | |
|---|---|
| Weight | 419 g (14.8 oz) |
| Front panel connectors | 5.08 mm (8 position) |

# Environmental Guidelines

**Notice** This product is intended for use in indoor applications only.

**Notice** Cover all empty slots using filler panels.

## Environmental Characteristics

| | |
|---|---|
| **Temperature** | |
| Operating | 0 °C to 55 °C |
| Storage | -40 °C to 71 °C |
| **Humidity** | |
| Operating | 10% to 90%, noncondensing |
| Storage | 5% to 95%, noncondensing |
| Pollution Degree | 2 |
| Maximum altitude | 2,000 m (800 mbar) (at 25 °C ambient temperature) |
| **Shock and Vibration** | |

| | |
|---|---|
| Operating vibration | 5 Hz to 500 Hz, 0.3 g RMS |
| Non-operating vibration | 5 Hz to 500 Hz, 2.4 g RMS |
| Operating shock | 30 g, half-sine, 11 ms pulse |

## 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 safety certifications, refer to the product label or the Product Certifications and Declarations 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
- AS/NZS CISPR 11: Group 1, Class A emissions

**Note** Group 1 equipment is any industrial, scientific, or medical equipment that does not intentionally generate radio frequency energy for the treatment of material or inspection/analysis purposes.

**Notice** For EMC declarations and certifications, and additional information,

refer to the Product Certifications and Declarations section.

**Note** If your device is hardware revision F or earlier, a snap-on ferrite bead is required to remain in EMC compliance. Refer to the ***PXIe-4138 Getting Started Guide*** included in your original shipping kit for information about this bead.

To determine which revision of a device you have, open Measurement & Automation Explorer (MAX) and select the device in question. The hardware revision is displayed in the settings pane on the right-hand side.

# 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`.)

# 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.

# 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.

NI corporate headquarters is located at 11500 N Mopac Expwy, Austin, TX, 78759-3504, USA.