SPECIFICATIONS

PXIe-4138

±60 V, 3 A System PXI Source Measure Unit

These specifications apply to the PXIe-4138.

Contents

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 ºC
- 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

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.

Notice If the PXIe-4138 is uninstalled, 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

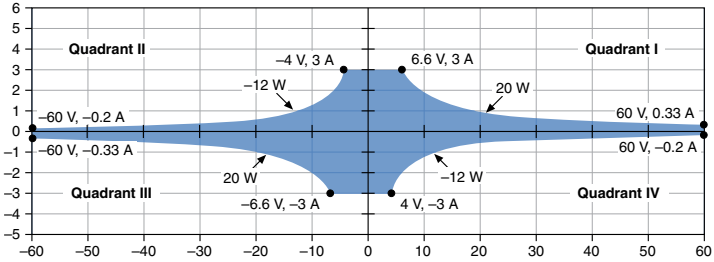
The following table and figure illustrate the voltage and the current source and sink ranges of the PXIe-4138.

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

Table 1. Current Source and Sink Ranges

DC voltage ranges	DC current source and sink ranges
600 mV 6 V 60 V[2]	1 µA 10 µA 100 µA 1 mA 10 mA 100 mA 1 A 3 A

Figure 1. Quadrant Diagram



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

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 Information

Sinking Power vs. Ambient Temperature Derating on page 5

[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.

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 Information

Load Regulation on page 7

Remote Sense on page 9

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

[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.

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

Table 3. Current Programming and Measurement Accuracy/Resolution (Continued)

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]	
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

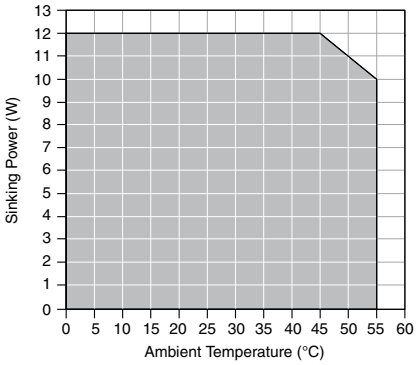
Wideband source noise	<20 mV peak-to-peak in 60 V range, device configured for normal transient response, 10 Hz to 20 MHz , typical

Sinking Power vs. Ambient Temperature Derating

The following figure illustrates sinking power derating as a function of ambient temperature for the PXIe-4138.

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

Figure 2. Sinking Power vs. Ambient Temperature Derating



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

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

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

Figure 3. 1 mA Range, No Load Step Response, Nominal

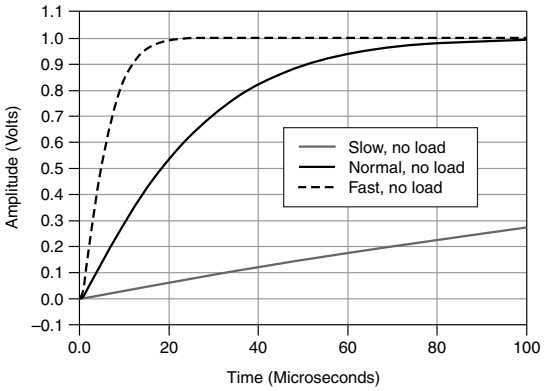
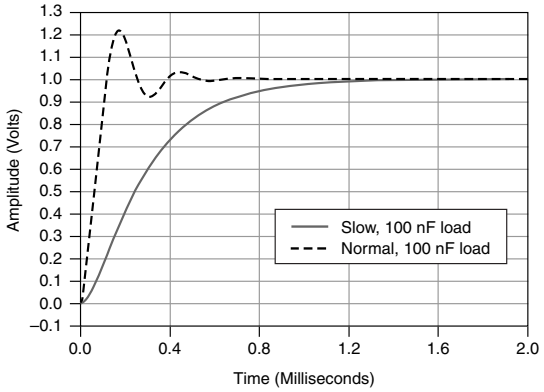


Figure 4. 1 mA Range, 100 nF Load Step Response, Nominal



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

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

Related Information

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Current on page 4

Voltage on page 4

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
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

[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.

[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.

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

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 Information

Voltage on page 4

Examples of Calculating Accuracy[17]

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 [18]
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

[17] Specifications listed in examples are for demonstration purposes only and do not necessarily reflect specifications for this device.

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

Calculate the accuracy using the following formula:

$$\text{Accuracy} = 900\,\text{nA} * 0.03\,\% + 200\,\text{pA}$$

$$= 270\,\text{pA} + 200\,\text{pA}$$

$$= 470\,\text{pA}$$

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:

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:

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

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

$$= 248.2\,\mu V$$

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:

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

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

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

$$= 498.2\ \text{pA}$$

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>)	
Polarity	Configurable
Minimum pulse width	100 ns, nominal
Destinations[20] (PXI trigger lines <0...7>)[19]	
Polarity	Active high (not configurable)
Pulse width	>200 ns, typical
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>)[19]	
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.

[19] Pulse widths and logic levels are compliant with *PXI Express Hardware Specification Revision 1.0 ECN 1*.

[20] Input triggers can be re-exported.

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 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 *Commitment to the Environment* 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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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.

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