SPECIFICATIONS

PXIe-4139

±60 V, 3 A Precision System PXI Source Measure Unit

These specifications apply to the PXIe-4139.

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
- **niDCPower Aperture Time** property or `NIDCPOWER_ATTR_APERTURE_TIME` attribute 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

Caution 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

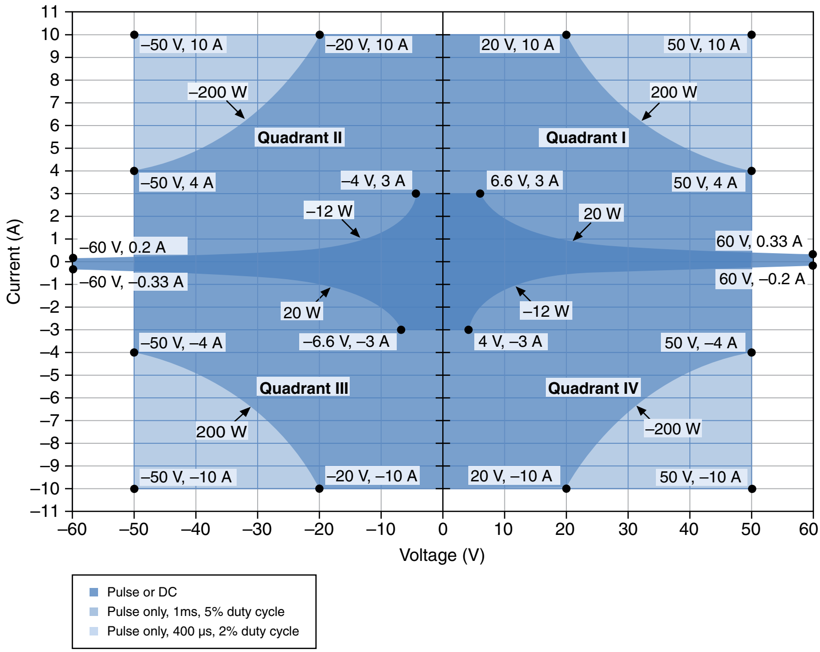
The following table and figure illustrate the voltage and the current source and sink ranges of the PXIe-4139.

[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 10 A, pulse only

Figure 1. Quadrant Diagram



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

[2] The PXIe-4139 does not support configurations involving voltage > |42.4 V| when the **Sequence Step Delta Time Enabled** property 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 Information

Sinking Power vs. Ambient Temperature Derating on page 7

Voltage Programming and Measurement Accuracy/Resolution

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	T_{cal} ± 1 °C	
600 mV	100 nV	2 μV	0.02% + 50 μV	0.016% + 30 μV	0.0005% + 1 μV
6 V	1 μV	6 μV	0.02% + 300 μV	0.016% + 90 μV	
60 V	10 μV	60 μV	0.02% + 3 mV	0.016% + 900 μV	

Related Information

Noise on page 6

Load Regulation on page 10

Remote Sense on page 12

[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-4139 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	T_{cal} ± 1 °C	
1 µA	100 fA	4 pA	0.03% + 100 pA	0.022% + 40 pA	0.0006% + 4 pA
10 µA	1 pA	30 pA	0.03% + 700 pA	0.022% + 300 pA	0.0006% + 22 pA
100 µA	10 pA	200 pA	0.03% + 6 nA	0.022% + 2 nA	0.0006% + 200 pA
1 mA	100 pA	2 nA	0.03% + 60 nA	0.022% + 20 nA	0.0006% + 2 nA
10 mA	1 nA	20 nA	0.03% + 600 nA	0.022% + 200 nA	0.0006% + 20 nA
100 mA	10 nA	200 nA	0.03% + 6 µA	0.022% + 2 µA	0.0006% + 200 nA
1 A	100 nA	2 µA	0.03% + 60 µA	0.027% + 20 µA	0.0006% + 2 µA
3 A	1 µA	20 µA	0.083% + 900 µA	0.083% + 600 µA	0.002% + 20 µA
10 A, pulsing only, typical					

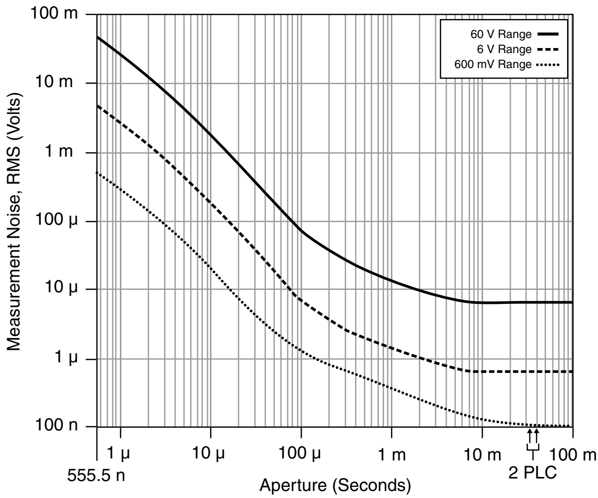
[6] T_{cal} is the internal device temperature recorded by the PXIe-4139 at the completion of the last self-calibration.

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

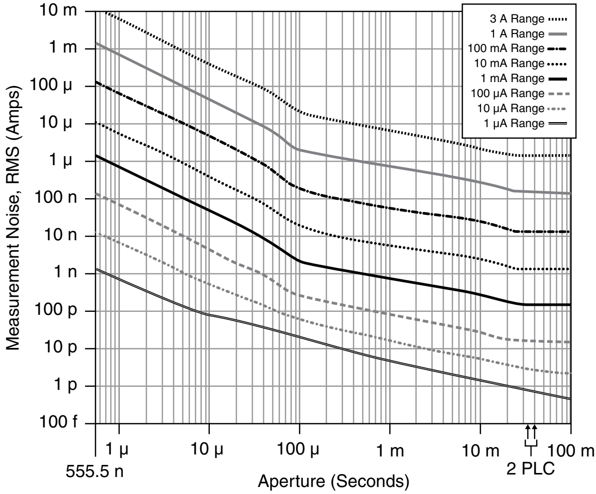
The following figures illustrate noise as a function of measurement aperture for the PXIe-4139.

Figure 2. Voltage Measurement Noise vs. Measurement Aperture, Nominal



Note When the aperture time is set to 2 power-line cycles (PLCs), measurement noise differs slightly depending on whether the **niDCPower Power Line Frequency** property or `NIDCPOWER_ATTR_POWER_LINE_FREQUENCY` attribute is set to 50 Hz or 60 Hz.

Figure 3. Current Measurement Noise vs. Measurement Aperture, Nominal

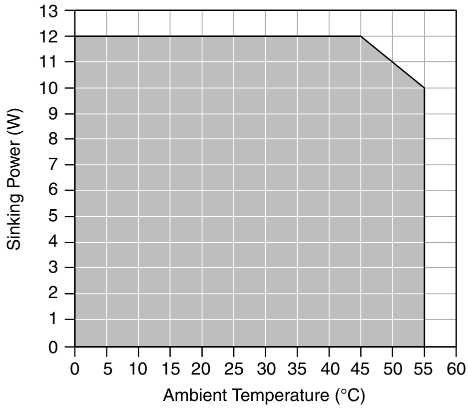


Note When the aperture time is set to 2 power-line cycles (PLCs), measurement noise differs slightly depending on whether the **niDCPower Power Line Frequency** property or `NIDCPOWER_ATTR_POWER_LINE_FREQUENCY` attribute is set to 50 Hz or 60 Hz.

Sinking Power vs. Ambient Temperature Derating

The following figure illustrates sinking power derating as a function of ambient temperature for the PXIe-4139.

Figure 4. Sinking Power vs. Ambient Temperature Derating



Output Resistance Programming Accuracy

Table 4. Output Resistance Programming Accuracy

Current Level/Limit Range	Programmable Resistance Range, Voltage Mode	Programmable Resistance Range, Current Mode	Accuracy ± (% of resistance setting), T_{cal} ± 5 °C
1 µA	0 to ±5 MΩ	±5 MΩ to ±infinity	0.03%
10 µA	0 to ±500 kΩ	±500 kΩ to ±infinity	
100 µA	0 to ±50 kΩ	±50 kΩ to ±infinity	
1 mA	0 to ±5 kΩ	±5 kΩ to ±infinity	
10 mA	0 to ±500 Ω	±500 Ω to ±infinity	
100 mA	0 to ±50 Ω	±50 Ω to ±infinity	
1 A	0 to ±5 Ω	±5 Ω to ±infinity	
3 A	0 to ±500 mΩ	±500 mΩ to ±infinity	
10 A , pulsing only			

[7] T_{cal} is the internal device temperature recorded by the PXIe-4139 at the completion of the last self-calibration.

Extended Range Pulsing [8]

Maximum pulse	
Voltage	50 V
Current	10 A
On time[9]	1 ms
Minimum pulse cycle time	5 ms
Energy	200 mJ
Cycle average power	10 W
Duty cycle	5%

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[10]	
Voltage mode, 50 V step, unloaded[11]	<200 µs, typical
Voltage mode, 5 V step or smaller, unloaded[12]	<70 µs, typical
Current mode, full-scale step, 10 A to 100 µA ranges[13]	<50 µs, typical
Current mode, full-scale step, 10 µA range[13]	<150 µs, typical
Current mode, full-scale step, 1 µA range[13]	<300 µs, typical

The following figures illustrate the effect of the transient response setting on the step response of the PXIe-4139 for different loads.

8 Extended range pulse currents fall outside DC range limits. In-range pulse currents fall within DC range limits. In-range pulses are not subject to extended range pulsing limitations.
9 *Pulse on time* is measured from the start of the leading edge to the start of the trailing edge.
10 Measured as the time to settle to within 0.1% of step amplitude, device configured for fast transient response.
11 Current limit set to ≥50 µA and ≥50% of the selected current limit range.
12 Current limit set to ≥20 µA and ≥20% of selected current limit range.
13 Voltage limit set to ≥2 V, resistive load set to 1 V/selected current range.

Figure 5. 1 mA Range, No Load Step Response, Nominal

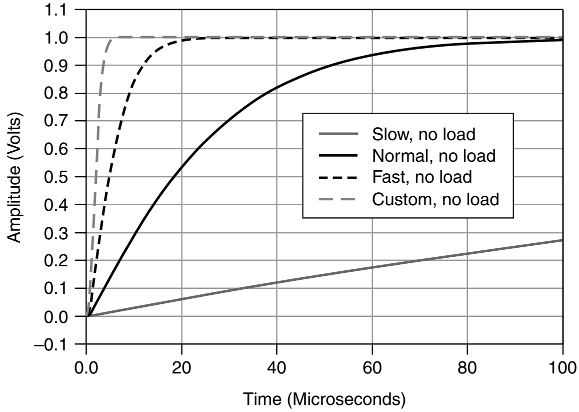
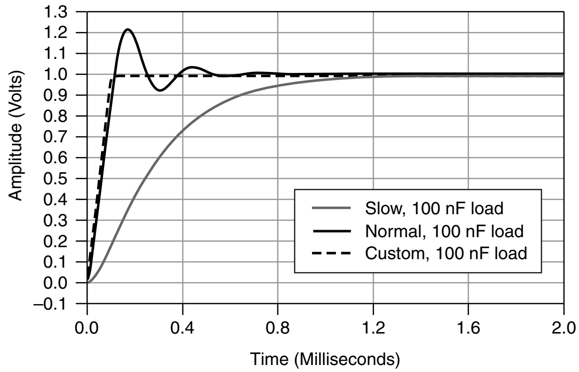


Figure 6. 1 mA Range, 100 nF Load Step Response, Nominal



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, typical

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

Related Information

Voltage Programming and Measurement Accuracy/Resolution on page 4

Current on page 5

Voltage Programming and Measurement Accuracy/Resolution on page 4

Measurement and Update Timing Characteristics

Available sample rates[14]	(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[15]	100,000 updates/s, nominal
Input trigger to	
Source event delay	10 µs, nominal
Source event jitter	1 µs, nominal
Measure event jitter	1 µs, nominal
Pulse timing and accuracy	
Minimum pulse on time[16]	50 µs, nominal
Minimum pulse off time[17]	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

14 When sourcing while measuring, both the **niDCPower Source Delay** and **niDCPower Aperture Time** properties affect the sampling rate. When taking a measure record, only the **niDCPower Aperture Time** property affects the sampling rate.

15 As the source delay is adjusted or if advanced sequencing is used, maximum source rates vary. Limited to 80,000 updates/s when the **Sequence Step Delta Time Enabled** property is set to TRUE.

16 *Pulse on time* is measured from the start of the leading edge to the start of the trailing edge.

17 Pulses fall inside DC limits. *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, characteristic

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

Related Information

Voltage Programming and Measurement Accuracy/Resolution on page 4

Examples of Calculating Accuracy[18]

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 [19]
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% + 100 pA

Calculate the accuracy using the following formula:

$$\text{Accuracy} = 900\,\text{nA} * 0.03\,\% + 100\,\text{pA}$$

$$= 270\,\text{pA} + 100\,\text{pA}$$

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

[19] T_{cal} is the internal device temperature recorded by the PXIe-4139 at the completion of the last self-calibration.

$$= 370\,\text{pA}$$

Therefore, the actual output will be within 370 pA of 900 nA.

Example 2: Calculating 1 °C Accuracy

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

internal device temperature	within T_{cal} ± 1 °C

Solution

Since the device internal temperature is within T_{cal} ± 1 °C and the ambient temperature is within 23 °C ± 5 °C, the appropriate accuracy specification is:

0.022% + 40 pA

Calculate the accuracy using the following formula:

$$\text{Accuracy} = 900\,\text{nA} * 0.022\,\% + 40\,\text{pA}$$

$$= 238\,\text{pA}$$

Therefore, the actual output will be within 238 pA of 900 nA.

Example 3: 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 2, 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} ± 1 °C and the ambient temperature is within 23 °C ± 5 °C, the appropriate accuracy specification is:

0.016% + 30 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:

$$\text{Accuracy} = \left(500\text{ mV} * 0.016\% + 30\mu\text{V}\right) + \frac{600\text{ mV} * 3\text{ppm} + 11\mu\text{V}}{1V\text{of lead drop}} * 3V + \frac{1\mu V}{V * \Omega} * 3V * 2\,\Omega + \frac{1\mu V}{V * \Omega} * 2.5V * 1.5\Omega$$

$$= 80\,\mu\text{V} + 30\,\mu\text{V} + 12.8\mu\text{V} * 3 + 6\mu\text{V} + 3.8\,\mu\text{V}$$

$$= 158.2\,\mu\text{V}$$

Therefore, the actual output will be within 158.2 μV of 500 mV.

Example 4: Calculating Accuracy with Temperature Coefficient

Calculate the accuracy of 900 nA output in the 1 μA range. Assume the same conditions as in Example 2, with the following differences:

ambient temperature	15 °C

Solution

Since the device internal temperature is within T_{cal} ± 1 °C, the appropriate accuracy specification is:

0.022% + 40 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:

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

$$\text{Accuracy} = \left(900\text{ nA} * 0.022\% + 40\text{ pA}\right) + \frac{900\text{ nA} * 0.0006\% + 4pA}{1°C} * 3°C$$

$$= 238\,\text{pA} + 28.2\,\text{pA}$$

$$= 266.2\,\text{pA}$$

Therefore, the actual output will be within 266.2 pA of 900 nA.

Trigger Characteristics

Input triggers	
Types	Start, Source, Sequence Advance, Measure, Pulse
Sources (PXI trigger lines <0...7>)[20]	
Polarity	Configurable
Minimum pulse width	100 ns, nominal
Destinations[21] (PXI trigger lines <0...7>)[20]	
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>)[20]	
Polarity	Configurable
Pulse width	Configurable between 250 ns and 1.6 μs, nominal

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

[21] Input triggers can be re-exported.

Protection

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

Isolation

Caution Do not connect to MAINs. Do not connect to signals or use for the measurements within CAT II, III, or IV.

Isolation voltage, channel-to-earth ground[22]	
Continuous	150 VDC, CAT I
Withstand	1,000 V_{RMS}

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.

Hazardous Voltage Take precautions to avoid electrical shock when operating this product at hazardous voltages.

Note Isolation voltage ratings apply to the voltage measured between any channel pin and the chassis ground connector of the front panel. When operating channels in series or floating on top of external voltage references, ensure that no terminal exceeds this rating.

Guard Output Characteristics

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

Calibration Interval

Recommended calibration interval	1 year

22 Verified with a 5-second dielectric withstand test.

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)

Environment

Maximum altitude	2,000 m (800 mbar) (at 25 °C ambient temperature)
Pollution Degree	2

Indoor use only.

Operating Environment

Ambient temperature range	0 °C to 55 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2. Meets MIL-PRF-28800F Class 3 low temperature limit and MIL-PRF-28800F Class 2 high temperature limit.)
Relative humidity range	10% to 90%, noncondensing (Tested in accordance with IEC 60068-2-56.)

Storage Environment

Ambient temperature range	-40 °C to 70 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2. Meets MIL-PRF-28800F Class 3 limits.)
Relative humidity range	5% to 95%, noncondensing (Tested in accordance with IEC 60068-2-56.)

Shock and Vibration

Operating 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} (Tested in accordance with IEC 60068-2-64.)
Nonoperating	5 Hz to 500 Hz, 2.4 g_{rms} (Tested in accordance with IEC 60068-2-64. Test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

Compliance and Certifications

Hazardous Voltage This icon denotes a warning advising you to take precautions to avoid electrical shock.

Caution You can impair the protection provided by the PXIe-4139 if you use it in a manner not described in this document.

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-4139 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.

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 UL and other 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

- 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, certifications, and additional information, refer to the *Online Product Certification* section.

CE Compliance CE

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)

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/certification*, search by model number or product line, and click the appropriate link in the Certification column.

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）

中国客户 National Instruments 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 National Instruments 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.)

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