

SPECIFICATIONS

PXIe-4136

±200 V, 1 A System PXI Source Measure Unit

These specifications apply to the PXIe-4136.

Contents

Definitions.....2

Conditions.....2

Cleaning Statement.....2

Device Capabilities.....2

Voltage.....4

Current.....4

Noise.....5

Sinking Power vs. Ambient Temperature Derating.....5

Overvoltage Protection.....6

Transient Response and Settling Time.....6

Load Regulation.....8

Measurement and Update Timing Characteristics.....8

Remote Sense.....10

Safety Interlock.....10

Examples of Calculating Accuracy Specifications.....11

Trigger Characteristics.....14

Protection14

Safety Voltage and Current.....15

Guard Output Characteristics.....16

Calibration Interval.....16

Power Requirement.....16

Physical.....16

Environmental Guidelines.....16

 Environmental Characteristics.....17

Safety Compliance Standards.....17

Electromagnetic Compatibility.....17

Environmental Management.....18

 Waste Electrical and Electronic Equipment (WEEE).....18

 电子信息产品污染控制管理办法（中国 RoHS）.....18

Product Certifications and Declarations.....18

NI Services.....18

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 temperature¹ of $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$
- 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

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-4136 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

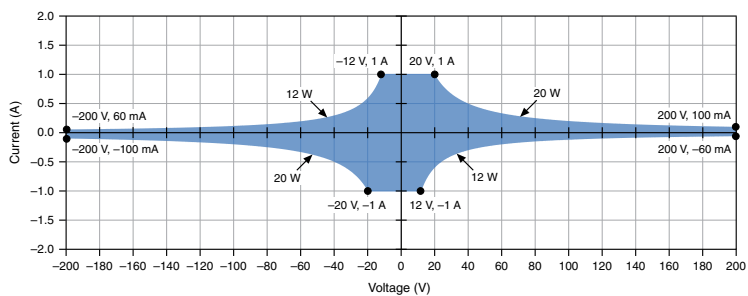
The following table and figure illustrate the voltage and the current source and sink ranges of the PXIe-4136.

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	1 μ A
6 V	10 μ A
20 V	100 μ A
200 V ²	1 mA
	10 mA
	100 mA
	1 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.

² Voltage levels and limits > |40 VDC| require the safety interlock input to be closed.

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	0.020% + 100 µV	0.0005% + 1 µV
6 V	10 µV	12 µV	0.020% + 640 µV	
20 V	100 µV	40 µV	0.022% + 2 mV	
200 V	1 mV	400 µV	0.025% + 20 mV	

Related Information

[Load Regulation](#) on page 8

[Remote Sense](#) on page 10

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

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-4136 at the completion of the last self-calibration.

⁶ T_{cal} is the internal device temperature recorded by the PXIe-4136 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
			$T_{cal} \pm 5\text{ °C}^6$	
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	0.04% + 120 µA	0.0006% + 2 µA

Noise

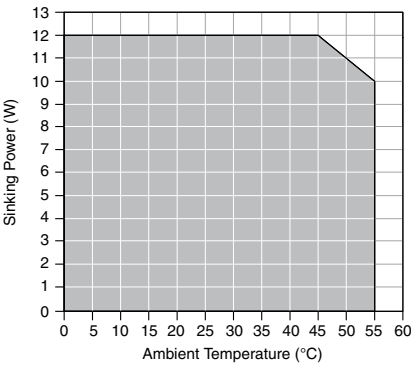
Wideband source noise	<20 mV peak-to-peak in 20 V range, device configured for normal transient response, 10 Hz to 20 MHz , typical
-----------------------	---

Sinking Power vs. Ambient Temperature Derating

The following figure illustrates sinking power derating as a function of ambient temperature for the PXIe-4136.

⁶ T_{cal} is the internal device temperature recorded by the PXIe-4136 at the completion of the last self-calibration.

Figure 2. Sinking Power vs. Ambient Temperature Derating



Overvoltage Protection

Accuracy ⁷ (% of OVP limit + offset)	0.1% + 200 mV, typical
Temperature coefficient (% of OVP limit + offset)/°C	0.01% + 3 mV/°C , typical
Measurement location	Local sense
Maximum OVP limit value	210 V
Minimum OVP limit value	2 V

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
--------------------	---

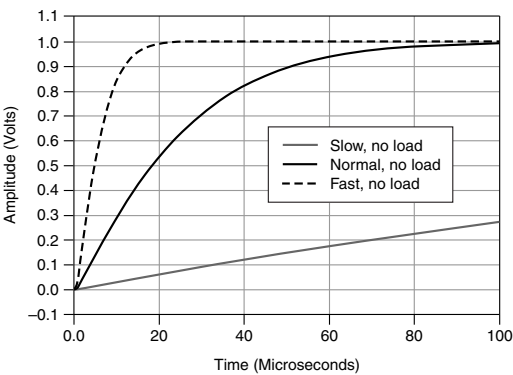
⁷ Overvoltage protection accuracy is valid with an ambient temperature of 23 °C ± 5 °C and with T_{cal} ±5 °C. T_{cal} is the internal device temperature recorded by the PXIe-4136 at the completion of the last self-calibration.

Settling time⁸

Voltage mode, 180 V step, unloaded ⁹	<500 μ s, typical
Voltage mode, 5 V step or smaller, unloaded ¹⁰	<70 μ s, typical
Current mode, full-scale step, 3 A to 100 μ A ranges ¹¹	<50 μ s, typical
Current mode, full-scale step, 10 μ A range ¹¹	<150 μ s, typical
Current mode, full-scale step, 1 μ A range ¹¹	<300 μ s, typical

The following figures illustrate the effect of the transient response setting on the step response of the PXIe-4136 for different loads.

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



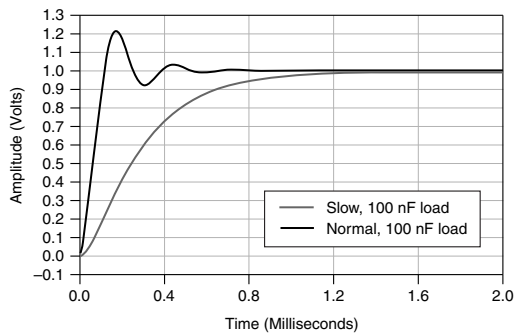
⁸ Measured as the time to settle to within 0.1% of step amplitude, device configured for fast transient response.

⁹ Current limit set to $\geq 60 \mu$ A and $\geq 60\%$ of the selected current limit range.

¹⁰ Current limit set to $\geq 20 \mu$ A and $\geq 20\%$ of selected current limit range.

¹¹ Voltage limit set to ≥ 2 V, resistive load set to 1 V/selected current range.

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



Load Regulation

Voltage	
Device configured for local sense	200 mV per A of output load change (measured between output channel terminals) , typical
Device configured for remote sense	100 μ V per A of output load change (measured between sense terminals) , typical
Current, device configured for local or remote sense	Load regulation effect included in current accuracy specifications, typical

Related Information

[Voltage](#) on page 4

Measurement and Update Timing Characteristics

Available sample rates ¹²	(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

¹² 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.

Maximum source update rate¹³

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

Pulse timing and accuracy¹⁴

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 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.


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 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 per volt of HI lead drop plus 1 μ V per volt of lead drop per ohm of corresponding sense lead resistance to voltage accuracy specifications
Maximum sense lead resistance	100 Ω
Maximum lead drop per lead	3 V, maximum 202 V between HI and LO terminals




Note Exceeding the maximum lead drop per lead value may cause the driver to report a sense lead error.

Related Information


[Voltage](#) on page 4

Safety Interlock

The safety interlock feature is designed to prevent users from coming in contact with hazardous voltage generated by the SMU in systems that implement protective barriers with controlled user access points.



Caution Hazardous voltages of up to the maximum voltage of the PXIe-4136 may appear at the output terminals if the safety interlock terminal is closed. Open the safety interlock terminal when the output connections are accessible. With the safety interlock terminal open, the output voltage level/limit is limited to ± 40 V DC, and protection will be triggered if the voltage measured between the device HI and LO terminals exceeds $\pm(42$ V peak ± 0.4 V).



Attention Des tensions dangereuses allant jusqu'à la tension maximale du PXIe-4136 peuvent apparaître aux terminaux de sortie si le terminal de verrouillage de sécurité est fermé. Ouvrez le terminal de verrouillage de sécurité lorsque les connexions de sortie sont accessibles. Lorsque le terminal de verrouillage de sécurité est ouvert, le niveau ou la limite de tension de sortie est limité à ± 40 V CC, et la

protection se déclenchera si la tension mesurée entre les terminaux HI et LO de l'appareil dépasse $\pm (42 \text{ V}_{pic} \pm 0,4 \text{ V})$.



Caution Do not apply voltage to the safety interlock connector inputs. The interlock connector is designed to accept passive, normally open contact closure connections only.



Attention N'appliquez pas de tension aux entrées du connecteur de verrouillage de sécurité. Le connecteur de verrouillage est conçu pour accepter uniquement des connexions à fermeture de contact passives, normalement ouvertes.

Safety interlock terminal open

Output	$<\pm 42.4 \text{ V peak}$
Setpoint	$<\pm 40 \text{ V DC}$

Safety interlock terminal closed

Output	Maximum voltage of the device
Setpoint	Maximum selected voltage range

Related Information

For more information about Safety Interlock operation, refer to the [NI DC Power Supplies and SMUs Help](#).

Examples of Calculating Accuracy Specifications¹⁷

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 $T_{cal} \pm 5 \text{ °C}$ ¹⁸
Self-calibration	within the last 24 hours

Solution

Because the device internal temperature is within $T_{cal} \pm 5 \text{ °C}$ and the ambient temperature is within $23 \text{ °C} \pm 5 \text{ °C}$, the appropriate accuracy specification is the following value:

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-4136 at the completion of the last self-calibration.

$$0.03\% + 200 \text{ pA}$$

Calculate the accuracy using the following formula:

$$\begin{aligned}\text{Accuracy} &= 900 \text{ nA} * 0.03 \% + 200 \text{ pA} \\ &= 270 \text{ pA} + 200 \text{ pA} \\ &= 470 \text{ pA}\end{aligned}$$

Therefore, the actual output is 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

Because the device internal temperature is within $T_{cal} \pm 5^\circ \text{C}$ and the ambient temperature is within $23^\circ \text{C} \pm 5^\circ \text{C}$, the appropriate accuracy specification is the following value:

$$0.02\% + 100 \mu\text{V}$$

Because the device is using remote sense, use the following 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:

$$\begin{aligned}\text{Accuracy} &= \left(500 \text{ mV} * 0.02 \% + 100 \mu\text{V} \right) + \frac{600 \text{ mV} * 3 \text{ ppm} + 11 \mu\text{V}}{1 \text{ V of lead drop}} * 3 \text{ V} \\ &\quad + \frac{1 \mu\text{V}}{\text{V} * \Omega} * 3 \text{ V} * 2 \Omega + \frac{1 \mu\text{V}}{\text{V} * \Omega} * 2.5 \text{ V} * 1.5 \Omega \\ &= 100 \mu\text{V} + 100 \mu\text{V} + 12.8 \mu\text{V} * 3 + 6 \mu\text{V} + 3.8 \mu\text{V}\end{aligned}$$

= 248.2 μV

Therefore, the actual output is 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

Because the device internal temperature is within T_{cal} ±5 °C, the appropriate accuracy specification is the following value:

0.03% + 200 pA

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

0.0006% + 4 pA

Calculate the accuracy using the following formula:

TemperatureVariation = (23 °C – 5 °C) – 15°C = 3 °C

Accuracy = (500 nA * 0.03 % + 200 pA) + $\frac{900 \text{ nA} * 0.0006 \% + 4 \text{ pA}}{1 \text{ }^{\circ}\text{C}} * 3 \text{ }^{\circ}\text{C}$

= 350 pA + 28.2 pA

= 378.2 pA

Therefore, the actual output is within 378.2 pA of 900 nA.

Related Information

[Voltage](#) on page 4

[Current](#) on page 4

Trigger Characteristics

Input triggers	
Types	Start, Source, Sequence Advance, Measure, Pulse
Sources (PXI trigger lines <0...7>) ¹⁹	
Polarity	Configurable
Minimum pulse width	100 ns, nominal
Destinations ²⁰ (PXI trigger lines <0...7>)	
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>)	
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
Sink overload protection	Automatic shutdown, output disconnect relay opens

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.

Overtemperature	Automatic shutdown, output disconnect relay opens
Safety interlock	Disable high voltage output, output disconnect relay opens



Related Information

[Safety Interlock](#) on page 10

Safety Voltage and Current

- **Notice** The protection provided by the PXIe-4136 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	±200 V
Channel-to-earth ground isolation	
Continuous	250 VDC, CAT I
Withstand	1,000 V RMS, verified by a 5 s withstand

- **Caution** Do not connect the PXIe-4136 to signals or use for measurements within Measurement Categories II, III, or IV.
- **Attention** Ne connectez pas le PXIe-4136 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	±1 A
------------------	------

Guard Output Characteristics

Cable guard	
Output impedance	3 kΩ, nominal
Offset voltage	1 mV, typical

Calibration Interval

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

Power Requirement



Caution You can impair the protection provided by the PXIe-4136 if you use it in a manner not described in this document.

PXI Express power requirement	2.5 A from the 3.3 V rail and 2.7 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)
Safety interlock connector	3.55 mm (4 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.

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.

电子信息产品污染控制管理办法（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.

Information is subject to change without notice. Refer to the *NI Trademarks and Logo Guidelines* at ni.com/trademarks for information on NI trademarks. Other product and company names mentioned herein are trademarks or trade names of their respective companies. For patents covering NI products/technology, refer to the appropriate location: **Help»Patents** in your software, the `patents.txt` file on your media, or the *National Instruments Patent Notice* at ni.com/patents. You can find information about end-user license agreements (EULAs) and third-party legal notices in the `readme` file for your NI product. Refer to the *Export Compliance Information* at ni.com/legal/export-compliance for the NI global trade compliance policy and how to obtain relevant HTS codes, ECCNs, and other import/export data. NI MAKES NO EXPRESS OR IMPLIED WARRANTIES AS TO THE ACCURACY OF THE INFORMATION CONTAINED HEREIN AND SHALL NOT BE LIABLE FOR ANY ERRORS. U.S. Government Customers: The data contained in this manual was developed at private expense and is subject to the applicable limited rights and restricted data rights as set forth in FAR 52.227-14, DFAR 252.227-7014, and DFAR 252.227-7015.

© 2015—2021 National Instruments Corporation. All rights reserved.

374880G-01