SPECIFICATIONS

PXIe-6396

8 AI (18-Bit, 14 MS/s/ch), 2 AO, 24 DIO, PXI Multifunction I/O Module

This document lists specifications for the PXIe-6396 (18-Bit, 14 MS/s/ch), 2 AO, 24 DIO, PXI Multifunction I/O module.

The PXIe-6396 differs in several ways from other SMIO devices. For more information about special considerations for this device, go to *ni.com/info* and enter the infocode `smio14ms`.

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 *Typical* unless otherwise noted.

Conditions

Specifications are valid at 25 °C unless otherwise noted.

Analog Input

Number of channels	8 differential
ADC resolution	18 bits
DNL	No missing codes guaranteed
INL	Refer to the *AI Absolute Accuracy* section.

Sample rate	
Maximum with onboard sample clock	14.29 MS/s
Maximum with external sample clock	15 MS/s
Minimum	20 kS/s
Timing resolution	10 ns
Timing accuracy	50 ppm of sample rate
Input coupling	DC
Input range	±1 V, ±2 V, ±5 V, ±10 V
Maximum working voltage for all analog inputs	
Positive input (AI+)	±11 V for all ranges, Measurement Category I
Negative input (AI-)	±11 V for all ranges, Measurement Category I

Caution Do not use for measurements within Categories II, III, and IV.

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.

CMRR (DC to 60 Hz)	70 dB
Bandwidth	1 MHz

Table 1. Total Harmonic Distortion (THD)

Input Range (V)	THD (dB at 100 kHz)
±10	-95
±5	-100
±2	-100
±1	-100

Input impedence	
Device on	
AI+ to AI GND	>100 GΩ in parallel with 50 pF
AI- to AI GND	>100 GΩ in parallel with 50 pF
Device off	
AI+ to AI GND	10 kΩ
AI- to AI GND	10 kΩ

Input bias current	±10 pA
Crosstalk (at 100 kHz)	
Adjacent channels	-90 dB
Non-adjacent channels	-100 dB
Input FIFO size	4,095 samples shared among channels used, 4,096 samples dedicated per channel
Data transfers	DMA (scatter-gather), programmed I/O (SW timed)
Overvoltage protection for all analog input channels	
Device on	±36 V
Device off	±15 V
Input current during overvoltage conditions	±10 mA max/AI pin

Analog Triggers

Number of triggers	1
Source	AI <0..7>, APFI 0
Functions	Start Trigger, Reference Trigger, Sample Clock, Sample Clock Timebase
Source level	
AI <0..7>	±Full scale
APFI 0	±10 V
Resolution	16 bits
Modes	Analog edge triggering, analog edge triggering with hysteresis, and analog window triggering
Bandwidth (-3 dB)	
AI <0..7>	1.5 MHz
APFI 0	2.5 MHz
Accuracy	±1% of range
APFI 0 characteristics	
Input impedance	10 kΩ
Coupling	DC
Protection, power on	±30 V
Protection, power off	±15 V

AI Absolute Accuracy

Table 2. AI Absolute Accuracy

Nominal Range Positive Full Scale	Nominal Range Negative Full Scale	Residual Gain Error (ppm of Reading)	Offset Tempco (ppm of Range/°C)	Random Noise, σ (µVrms)	Absolute Accuracy at Full Scale (µV)
10	-10	48	34	230	1769
5	-5	55	35	130	929
2	-2	55	37	66	380
1	-1	65	42	50	210

Note For more information about absolute accuracy at full scale, refer to the *AI Absolute Accuracy Example* section.

Gain tempco	10 ppm/°C
Reference tempco	1 ppm/°C
Residual offset error	20 ppm of range
INL error	13 ppm of range[1]

Note Accuracies listed are valid for up to two years from the device external calibration.

AI Absolute Accuracy Equation

$AbsoluteAccuracy = Reading \cdot (GainError) + Range \cdot (OffsetError) + NoiseUncertainty$

$GainError = ResidualAIGainError + GainTempco \cdot (TempChangeFromLastInternalCal) + ReferenceTempco \cdot (TempChangeFromLastExternalCal)$

$OffsetError = ResidualAIOffsetError + OffsetTempco \cdot (TempChangeFromLastInternalCal) + INLError$

$NoiseUncertainty = \frac{\text{Random Noise} \cdot 3}{\sqrt{100}}$ for a coverage factor of 3 σ and averaging 100 points.

[1] When within range. At sample rates ≥ 10 MS/s, add an additional 35 ppm of range.

AI Absolute Accuracy Example

Absolute accuracy at full scale on the analog input channels is determined using the following assumptions:

- *TempChangeFromLastExternalCal* = 10 °C
- *SampleRate* ≥ 10 MS/s
- *TempChangeFromLastInternalCal* = 1 °C
- *number_of_readings* = 10,000
- *CoverageFactor* = 3 σ

For example, on the 10 V range, the absolute accuracy at full scale is as follows:

GainError = 48 ppm + 10 ppm · 1 + 1 ppm · 10 = 68 ppm

OffsetError = 20 ppm + 34 ppm ·1 + 92 ppm = 102 ppm

$$Noise\ Uncertainty = \frac{230\ \mu V \cdot 3}{\sqrt{10,000}} = 6.9\ \mu V$$

AbsoluteAccuracy = 10 V · (*GainError*) + 10 V · (*OffsetError*) + *NoiseUncertainty* = 1707 µV

Analog Output

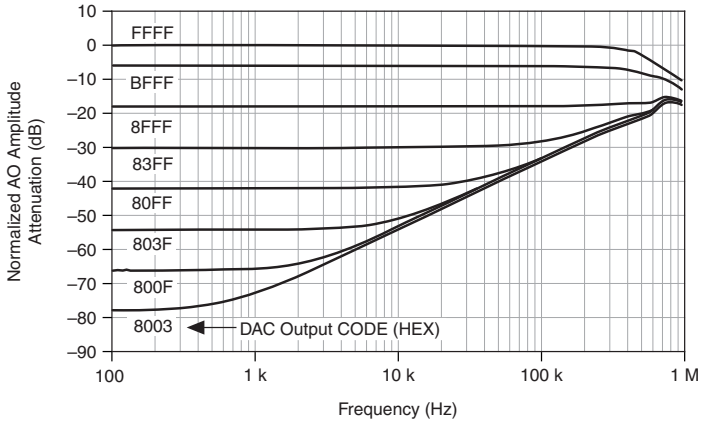
Number of channels	2
DAC resolution	16 bits
DNL	±1 LSB, max
Monotonicity	16 bit guaranteed
Accuracy	Refer to the *AO Absolute Accuracy* section.
Maximum update rate (simultaneous)	
1 channel	3.3 MS/s
2 channels	3.3 MS/s
Minimum update rate	No minimum
Timing accuracy	50 ppm of sample rate
Timing resolution	10 ns
Output range	±10 V, ±5 V, ±external reference on APFI 0
Output coupling	DC
Output impedance	0.4 Ω
Output current drive	±5 mA
Overdrive protection	±25 V
Overdrive current	10 mA

Power-on state	±5 mV
Power-on/off glitch	1.5 V peak for 200 ms
Output FIFO size	8,191 samples shared among channels used
Data transfers	DMA (scatter-gather), programmed I/O
AO waveform modes	Non-periodic waveform, periodic waveform regeneration mode from onboard FIFO, periodic waveform regeneration from host buffer including dynamic update
Settling time, full-scale step, 15 ppm (1 LSB)	2 µs
Slew rate	20 V/µs
Glitch energy at midscale transition, ±10 V range	6 nV · s

External Reference

APFI 0 characteristics	
Input impedance	10 kΩ
Coupling	DC
Protection, device on	±30 V
Protection, device off	± 15 V
Range	±11 V
Slew rate	±20 V/µs

Figure 1. Analog Output External Reference Bandwidth



AO Absolute Accuracy

Absolute accuracy at full-scale numbers is valid immediately following self calibration and assumes the device is operating within 10 °C of the last external calibration.

Table 3. AO Absolute Accuracy

Nominal Range Positive Full Scale	Nominal Range Negative Full Scale	Residual Gain Error (ppm of Reading)	Gain Tempco (ppm/°C)	Reference Tempco (ppm/°C)	Residual Offset Error (ppm of Range)	Offset Tempco (ppm of Range/ °C)	INL Error (ppm of Range)	Absolute Accuracy at Full Scale (µV)
10	-10	129	17	5	65	1	64	3,256
5	-5	135	8	5	65	1	64	1,616

Note Accuracies listed are valid for up to two years from the device external calibration.

AO Absolute Accuracy Equation

$AbsoluteAccuracy = OutputValue \cdot (GainError) + Range \cdot (OffsetError)$

$GainError = ResidualGainError + GainTempco \cdot (TempChangeFromLastInternalCal) + ReferenceTempco \cdot (TempChangeFromLastExternalCal)$

$OffsetError = ResidualOffsetError + OffsetTempco \cdot (TempChangeFromLastInternalCal) + INLError$

Digital I/O/PFI

Static Characteristics

Number of channels	24 total, 8 (P0.<0..7>), 16 (PFI <0..7>/P1, PFI <8..15>/P2)
Ground reference	D GND
Direction control	Each terminal individually programmable as input or output
Pull-down resistor	50 kΩ typical, 20 kΩ minimum
Input voltage protection	±20 V on up to two pins

Caution Stresses beyond those listed under the *Input voltage protection* specification may cause permanent damage to the device.

Waveform Characteristics (Port 0 Only)

Terminals used	Port 0 (P0.<0..7>)
Port/sample size	Up to 8 bits
Waveform generation (DO) FIFO	2,047 samples
Waveform acquisition (DI) FIFO	255 samples
DI Sample Clock frequency	0 to 10 MHz, system and bus activity dependent
DO Sample Clock frequency	
Regenerate from FIFO	0 MHz to 10 MHz
Streaming from memory	0 MHz to 10 MHz, system and bus activity dependent
Data transfers	DMA (scatter-gather), programmed I/O
Digital line filter settings	160 ns, 10.24 µs, 5.12 ms, disable

PFI/Port 1/Port 2 Functionality

Functionality	Static digital input, static digital output, timing input, timing output
Timing output sources	Many AI, AO, counter, DI, DO timing signals
Debounce filter settings	90 ns, 5.12 µs, 2.56 ms, custom interval, disable; programmable high and low transitions; selectable per input

Recommended Operating Conditions

Input high voltage (V_{IH})	
Minimum	2.2 V
Maximum	5.25 V
Input low voltage (V_{IL})	
Minimum	0 V
Maximum	0.8 V
Output high current (I_{OH})	
P0.<0..7>	-24 mA maximum
PFI <0..15>/P1/P2	-16 mA maximum

Output low current (I_{OL})	
P0.<0..7>	24 mA maximum
PFI <0..15>/P1/P2	16 mA maximum

Digital I/O Characteristics

Positive-going threshold (VT+)	2.2 V maximum
Negative-going threshold (VT-)	0.8 V minimum
Delta VT hysteresis (VT+ - VT-)	0.2 V minimum
I_{IL} input low current (V_{IN} = 0 V)	-10 µA maximum
I_{IH} input high current (V_{IN} = 5 V)	250 µA maximum

Figure 2. P0.<0..7>: I_{OH} versus V_{OH}

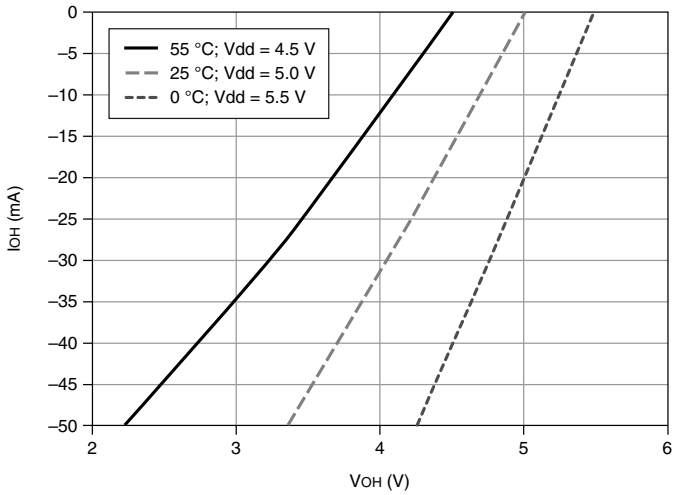


Figure 3. P0.<0..7>: I_{OL} versus V_{OL}

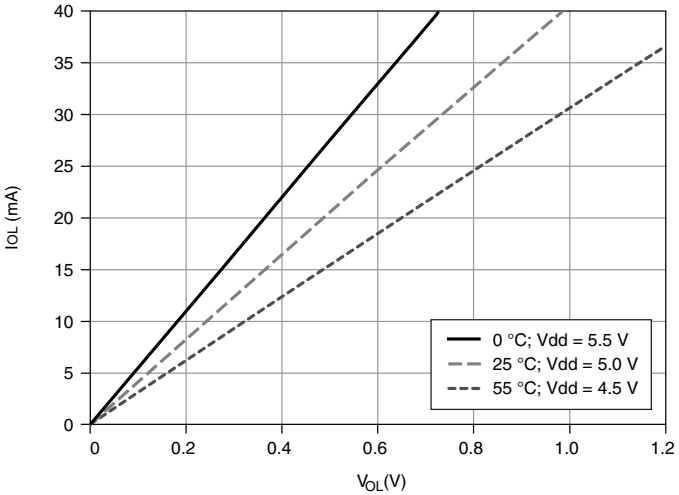


Figure 4. PFI <0..15>/P1/P2: I_{OH} versus V_{OH}

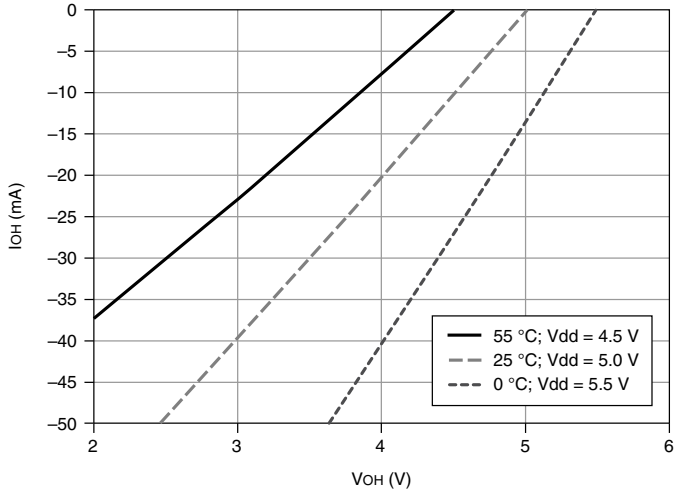
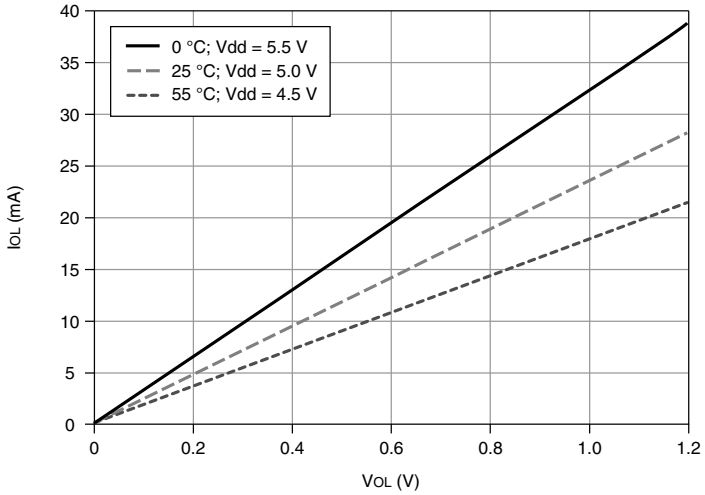


Figure 5. PFI <0..15>/P1/P2: I_{OL} versus V_{OL}



General-Purpose Counters

Number of counter/timers	4
Resolution	32 bits
Counter measurements	Edge counting, pulse, pulse width, semi-period, period, two-edge separation
Position measurements	X1, X2, X4 quadrature encoding with Channel Z reloading; two-pulse encoding
Output applications	Pulse, pulse train with dynamic updates, frequency division, equivalent time sampling
Internal base clocks	100 MHz, 20 MHz, 100 kHz
External base clock frequency	0 MHz to 25 MHz; 0 MHz to 100 MHz on PXIe_DSTAR<A,B>
Base clock accuracy	50 ppm
Inputs	Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down, Sample Clock
Routing options for inputs	Any PFI, PXIe_DSTAR<A,B>, PXI_TRIG, PXI_STAR, analog trigger, many internal triggers

FIFO	127 samples per counter
Data transfers	Dedicated scatter-gather DMA controller for each counter/timer, programmed I/O

Frequency Generator

Number of channels	1
Base clocks	20 MHz, 10 MHz, 100 kHz
Divisors	1 to 16
Base clock accuracy	50 ppm

Output can be available on any PFI terminal.

Phase-Locked Loop (PLL)

Note The PXIe-6396 differs in several ways from other SMIO devices. For more information about timebases relating to this device, go to *ni.com/info* and enter the infocode `smio14ms`.

Number of PLLs	1

Table 4. Reference Clock Locking Frequencies

Reference Signal	PXI Express Locking Input Frequency (MHz)
PXIe_DSTAR<A,B>	10, 20, 100
PXI_STAR	10, 20
PXIe_CLK100	100
PXI_TRIG <0..7>	10, 20
PFI <0..15>	10, 20

Output of PLL	100 MHz Timebase; other signals derived from 100 MHz Timebase including 20 MHz and 100 kHz Timebases

External Digital Triggers

Source	Any PFI, PXIe_DSTAR<A,B>, PXI_TRIG, PXI_STAR
Polarity	Software-selectable for most signals
Analog input function	Start Trigger, Reference Trigger, Sample Clock, Convert Clock, Sample Clock Timebase
Analog output function	Start Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase
Counter/timer functions	Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down, Sample Clock
Digital waveform generation (DO) function	Start Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase
Digital waveform acquisition (DI) function	Start Trigger, Reference Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase

Device-to-Device Trigger Bus

Input source	PXI_TRIG <0..7>, PXI_STAR, PXIe_DSTAR<A,B>
Output destination	PXI_TRIG <0..7>, PXIe_DSTARC
Output selections	10 MHz Clock; frequency generator output; many internal signals
Debounce filter settings	90 ns, 5.12 µs, 2.56 ms, custom interval, disable; programmable high and low transitions; selectable per input

Bus Interface

Form factor	x1 PXI Express peripheral module, specification rev 1.0 compliant
Slot compatibility	x1 and x4 PXI Express or PXI Express hybrid slots
DMA channels	8, can be used for analog input, analog output, digital input, digital output, counter/timer 0, counter/timer 1, counter/timer 2, counter/timer 3

All PXIe devices may be installed in PXI Express slots or PXI Express hybrid slots.

Power Requirements

Caution The protection provided by the device can be impaired if the device is used in a manner not described in the *X Series User Manual*.

+3.3 V	6 W
+12 V	30 W

Current Limits

Caution Exceeding the current limits may cause unpredictable behavior by the device and/or PC/chassis.

+5 V terminal (connector 0)	1 A max[2]
P0/PFI/P1/P2 and +5 V terminals combined	1.7 A max

Physical Characteristics

Printed circuit board dimensions	Standard 3U PXI
Weight	294 g (10.4 oz)
I/O connectors	
Module connector	68-Pos Right Angle PCB-Mount VHDCI (Receptacle)
Cable connector	68-Pos Offset IDC Cable Connector (Plug) (SHC68-*)

Note For more information about the connectors used for DAQ devices, refer to the document, *NI DAQ Device Custom Cables, Replacement Connectors, and Screws*, by going to *ni.com/info* and entering the Info Code `rdspmb`.

Calibration

Recommended warm-up time	15 minutes
Calibration interval	2 years

[2] Has a self-resetting fuse that opens when current exceeds this specification.

Maximum Working Voltage

Maximum working voltage refers to the signal voltage plus the common-mode voltage.

Channel to earth	11 V, Measurement Category I

Caution Do not use for measurements within Categories II, III, or IV.

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.

Environmental Guidelines

Notice This model is intended for use in indoor applications only.

Environmental Characteristics

Temperature and Humidity

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

Shock and Vibration

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

Environmental Standards

This product meets the requirements of the following environmental standards for electrical equipment.

- IEC 60068-2-1 Cold
- IEC 60068-2-2 Dry heat
- IEC 60068-2-78 Damp heat (steady state)
- IEC 60068-2-64 Random operating vibration
- IEC 60068-2-27 Operating shock
- MIL-PRF-28800F
  - Low temperature limits for operation Class 3, for storage Class 3
  - High temperature limits for operation Class 2, for storage Class 3
  - Random vibration for non-operating Class 3
  - Shock for operating Class 2

Note To verify marine approval certification for a product, refer to the product label or visit *ni.com/certification* and search for the certificate.

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 Standards

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
- FCC 47 CFR Part 15B: Class A emissions
- ICES-003: Class A emissions

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 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.

Notice For EMC declarations and certifications, and additional information, refer to the *Product Certifications and Declarations* 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)
- 2011/65/EU; Restriction of Hazardous Substances (RoHS)

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.

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）

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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