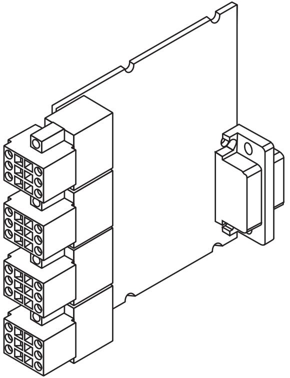
OPERATING INSTRUCTIONS AND SPECIFICATIONS

NI 9219E

4-Channel, 24-Bit, Universal Analog Input Module



NATIONAL INSTRUMENTS™

This document describes how to use the National Instruments 9219E and includes dimensions, terminal assignments, and specifications for the NI 9219E. Visit `ni.com/info` and enter `rdsoftwareversion` to determine which software you need for the modules you are using. For information about installing, configuring, and programming the system, refer to the system documentation. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.

Caution National Instruments makes no electromagnetic compatibility (EMC) or CE marking compliance claims for the NI 9219E. The end-product supplier is responsible for conformity to any and all compliance requirements.

Caution The NI 9219E must be installed inside a suitable enclosure prior to use. Hazardous voltages may be present.

NI 9219E Dimensions

The following figure shows the dimensions of the NI 9219E.

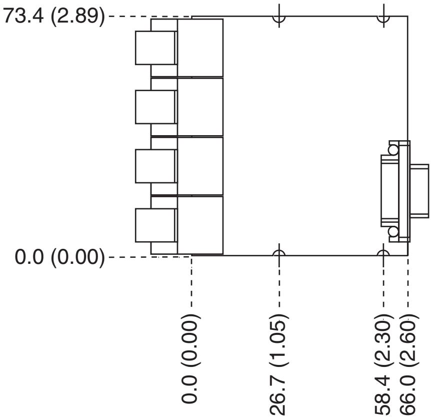


Figure 1. NI 9219E Dimensions in Millimeters (Inches)

Connecting the NI 9219E

The NI 9219E has four 6-terminal spring-terminal connectors that provide connections for four analog input channels.

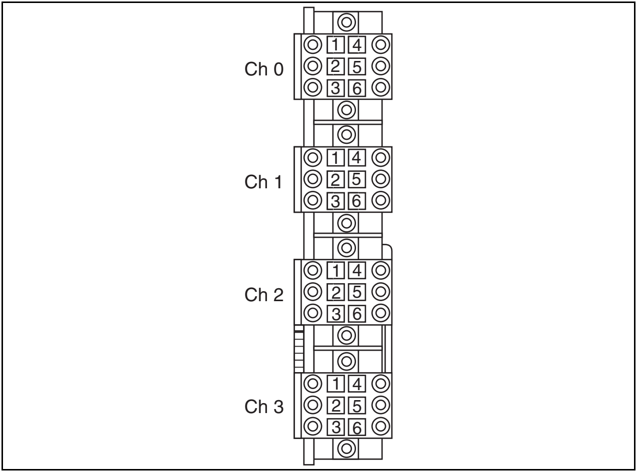


Figure 2. NI 9219E Channel and Terminal Assignments

Table 1. NI 9219E Signal Names

Terminal	Signal Name	Signal Description
1	T+	TEDS Data
2	T–	TEDS COM
3	EX+/HI*	Positive excitation or input signal
4	HI	Positive input signal
5	EX–/LO*	Negative excitation or input signal
6	LO	Negative input signal

* Depending on the mode, terminals 3 and 5 are either the excitation signals or the input signals.

Table 2. NI 9219E Terminal Assignments by Mode

Mode	Terminal 1	Terminal 2	Terminal 3	Terminal 4	Terminal 5	Terminal 6
Voltage	T+	T–	—	HI	LO	—
Current	T+	T–	HI	—	LO	—
4-Wire Resistance	T+	T–	EX+	HI	EX–	LO
2-Wire Resistance	T+	T–	HI	—	LO	—
Thermocouple	T+	T–	—	HI	LO	—
4-Wire RTD	T+	T–	EX+	HI	EX–	LO
3-Wire RTD	T+	T–	EX+	—	EX–	LO
Quarter-Bridge	T+	T–	HI	—	LO	—
Half-Bridge	T+	T–	EX+	HI	EX–	—
Full-Bridge	T+	T–	EX+	HI	EX–	LO
Digital In	T+	T–	—	HI	LO	—
Open Contact	T+	T–	HI	—	LO	—

Connecting the NI 9219E

Connect the positive signal of the signal source to the positive input signal terminal (HI) and the negative signal of the signal source to the negative input signal terminal (LO). Use the excitation terminals if the sensor requires a separate excitation connection. Refer to the *NI 9219E Circuitry* section for information about connections in each mode.

Connecting Wires to the Spring-Terminal Connectors

Use a flathead screwdriver with a blade smaller than 2.3 × 1.0 mm (0.09 × 0.04 in.) to connect wires to the detachable spring-terminal connectors. Insert the screwdriver into a spring clamp activation slot and press a wire into the corresponding connector terminal, then remove the screwdriver to clamp the wire into the terminal. Refer to the *Specifications* section for more information about spring-terminal wiring. Refer to Figure 3 for an illustration of connecting wires to the NI 9219E.

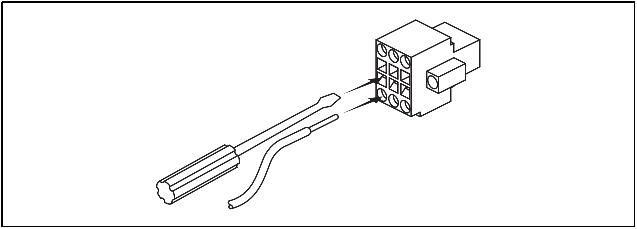


Figure 3. Connecting Wires to the NI 9219E Spring-Terminal Connectors

Connecting TEDS Channels

The NI 9219E supports only Class II TEDS sensors. Connect the two TEDS lines to TEDS Data (T+) and TEDS COM (T–) and ensure that neither T+ nor T– is tied in common to any of the signal inputs (terminals 3 through 6) on the NI 9219E. Visit `ni.com/info` and enter the info code `rdteds` for information about TEDS sensors.

Connecting Signal Sources to the NI 9219E

You can connect ground-referenced or floating signal sources to the NI 9219E. If you make a floating connection between the signal source and the NI 9219E, make sure the voltages on the positive and negative connections are within the channel-to-earth working voltage range to ensure proper operation of the NI 9219E. Refer to the *Specifications* section for more information about operating voltages and overvoltage protection.

Note For best signal quality, National Instruments recommends using shielded cables and twisted pair wiring whenever possible.

Figures 4 and 5 illustrate connecting grounded and floating signal sources to the NI 9219E in Voltage mode.

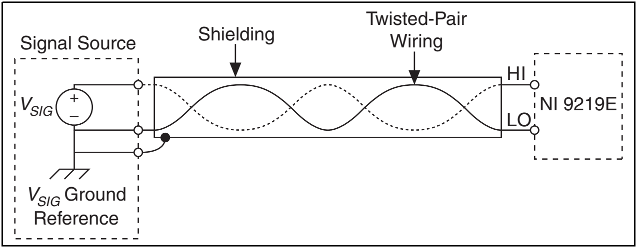


Figure 4. Connecting a Grounded Signal Source to the NI 9219E

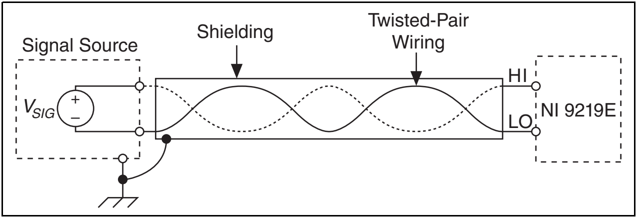


Figure 5. Connecting a Floating Signal Source to the NI 9219E

NI 9219E Circuitry

The NI 9219E is channel-to-channel isolated. Four 24-bit analog-to-digital converters (ADCs) simultaneously sample all four analog input channels. The NI 9219E enables an excitation circuit for all input modes that require excitation, and reconfigures the ADC and excitation circuits in each mode to accommodate each type of sensor.

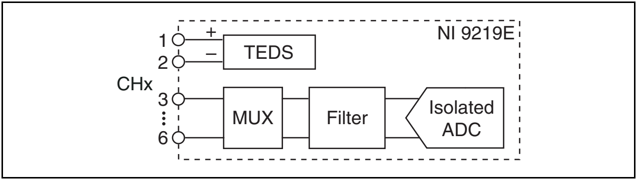


Figure 6. Input Circuitry for One Channel on the NI 9219E

Voltage and Current Modes

In Voltage mode, the ADC measures voltage across the HI and LO terminals. In Current mode, the NI 9219E computes current from the voltage that the ADC measures across an internal shunt resistor.

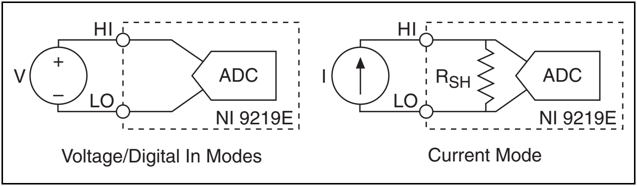


Figure 7. Connections in Voltage, Current, and Digital In Modes

4-Wire Resistance and 4-Wire RTD Modes

In 4-Wire Resistance and 4-Wire RTD modes, the NI 9219E sources a current, which varies based on the resistance of the load, between the EX+ and EX– terminals. The NI 9219E computes measured resistance from the resulting voltage reading. Lead wire resistance does not affect these modes because a negligible amount of current flows across the HI and LO terminals due to the high input impedance of the ADC.

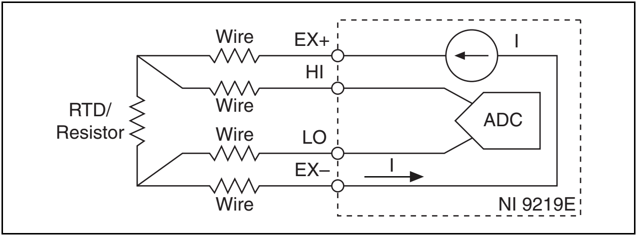


Figure 8. Connections in 4-Wire Resistance and 4-Wire RTD Modes

3-Wire RTD Mode

In 3-Wire RTD mode, the NI 9219E sources a current, which varies based on the resistance of the load, between the EX+ and EX– terminals. This mode compensates for lead wire resistance in hardware if all the lead wires have the same resistance. The NI 9219E applies a gain of 2x to the voltage across the negative lead wire and the ADC uses this voltage as the negative reference to cancel the resistance error across the positive lead wire.

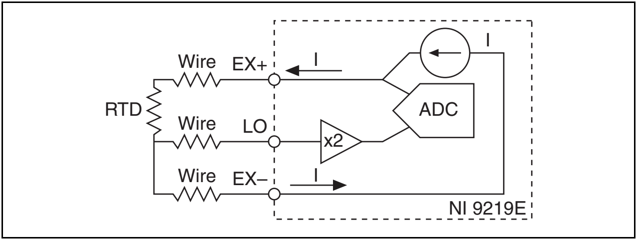


Figure 9. Connections in 3-Wire RTD Mode

2-Wire Resistance and Quarter-Bridge Modes

In 2-Wire Resistance and Quarter-Bridge modes, the NI 9219E sources a current, which varies based on the resistance of the load, between the HI and LO terminals. The NI 9219E computes measured resistance from the resulting voltage reading. 2-Wire Resistance and Quarter-Bridge modes do not compensate for lead wire resistance.

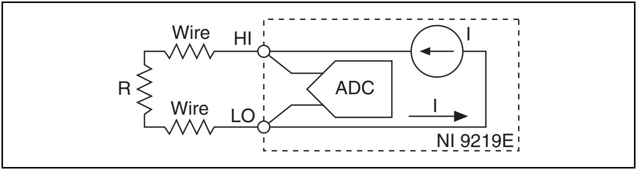
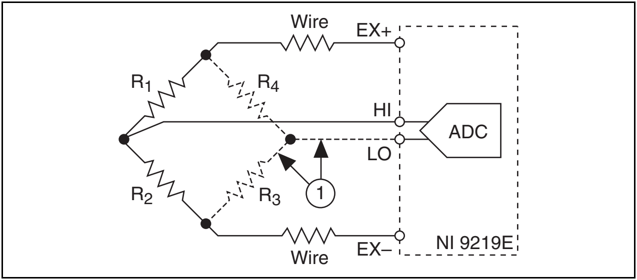


Figure 10. Connections in 2-Wire Resistance and Quarter-Bridge Modes

Half-Bridge and Full-Bridge Modes

In Half-Bridge mode, the HI input is referenced to EX–. In Full-Bridge mode, the ADC reads the HI and LO inputs differentially. Both modes use the internal voltage excitation to set the input range of the ADC and return voltage readings that are proportional to the excitation level. The internal excitation voltage varies based on the resistance of the sensor. Refer to the *Specifications* section for more information about excitation levels.



1 The dotted line represents the portion of the circuit that is connected only in Full-Bridge mode.

Figure 11. Connections in Half-Bridge and Full-Bridge Modes

Thermocouple Mode

In Thermocouple mode, the NI 9219E uses the ±125 mV range of the ADC to return a voltage reading. Use shielded cables and twisted pair wiring and ground the shielded cables. Each channel has a built-in thermistor for cold-junction compensation (CJC) calculations. For improved CJC sensor accuracy, operate the NI 9219E in a stable temperature environment and avoid placing heat sources near the module or its connectors. Visit `ni.com/info` and enter `cjcdatascaling` for more information about isothermal errors and scaling CJC data. Refer to the *Specifications* section for more information about accuracy. The NI 9219E does not support open thermocouple detection.

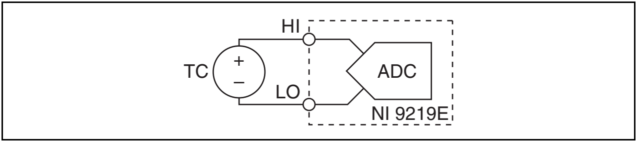


Figure 12. Connections in Thermocouple Mode

Digital In Mode

Digital In mode has a 60 V unipolar threshold that you can set in software. Refer to the software help for information about configuring the Digital In threshold. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation. Digital In mode is supported only in CompactRIO systems. Refer to Figure 7 for an illustration of the connections.

Open Contact Mode

In Open Contact mode, the NI 9219E sources a current between the HI and LO terminals and determines if the two terminals are open or closed based on the measured current through the terminals. When the circuit is open, make sure no more than ±60 V is sourced across the switch. Open Contact mode is supported only in CompactRIO systems.

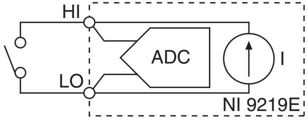


Figure 13. Connections in Open Contact Mode

NI 9219E Timing Options

The NI 9219E supports four different timing options that are optimized for different types of applications by using different ADC conversion times. High Speed is optimized for high speed at the expense of noise rejection, Best 60 Hz Rejection is optimized for rejection of 60 Hz noise, Best 50 Hz Rejection is optimized for rejection of 50 Hz noise, and High Resolution is optimized for maximum overall noise rejection and provides rejection of 50 Hz and 60 Hz noise. Refer to the *Specifications* section for more information.

Excitation Protection

The NI 9219E protects the excitation circuit from overcurrent and overvoltage fault conditions. The module automatically disables the circuit in the event of a fault condition. Whenever possible, channels automatically recover after the fault is removed. Refer to the software help for information on how the software displays and handles overcurrent and overvoltage faults. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.

Sleep Mode

This module supports a low-power sleep mode. Support for sleep mode at the system level depends on the chassis that the module is plugged into. Refer to the chassis manual for information about support for sleep mode. If the chassis supports sleep mode, refer to the software help for information about enabling sleep mode. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.

Typically, when a system is in sleep mode, you cannot communicate with the modules. In sleep mode, the system consumes minimal power and may dissipate less heat than it does in normal mode. Refer to the *Specifications* section for more information about power consumption and thermal dissipation.

Specifications

The following specifications are typical for the range –40 to 85 °C internal to any enclosures unless otherwise noted.

Input Characteristics

Number of channels..........................4 analog input channels

ADC resolution.................................24 bits

Type of ADC....................................Delta-sigma (with analog prefiltering)

Sampling mode ....Simultaneous

Type of TEDS supported ....IEEE 1451.4 TEDS Class II (Interface)

Mode input ranges

Mode	Nominal Range(s)	Actual Range(s)
Voltage	±60 V, ±15 V, ±4 V, ±1 V, ±125 mV	±60 V, ±15 V, ±4 V, ±1 V, ±125 mV
Current	±25 mA	±25 mA
4-Wire and 2-Wire Resistance	10 kΩ, 1 kΩ	10.5 kΩ, 1.05 kΩ
Thermocouple	±125 mV	±125 mV
4-Wire and 3-Wire RTD	Pt 1000, Pt 100	5.05 kΩ, 505 Ω
Quarter-Bridge	350 Ω, 120 Ω	390 Ω, 150 Ω
Half-Bridge	±500 mV/V	±500 mV/V
Full-Bridge	±62.5 mV/V, ±7.8 mV/V	±62.5 mV/V, ±7.8125 mV/V

Mode	Nominal Range(s)	Actual Range(s)
Digital In	—	0–60 V
Open Contact	—	1.05 kΩ

Conversion time, no channels in TC mode

High speed .... 10 ms for all channels

Best 60 Hz rejection .... 110 ms for all channels

Best 50 Hz rejection .... 130 ms for all channels

High resolution .... 500 ms for all channels

Conversion time, one or more channels in TC mode

High speed .... 20 ms for all channels

Best 60 Hz rejection .... 120 ms for all channels

Best 50 Hz rejection .... 140 ms for all channels

High resolution .... 510 ms for all channels

Overvoltage protection

Terminals 1 and 2 .... ±30 V

Terminals 3 through 6, across any combination .... ±60 V

Input impedance

Voltage and Digital In modes (±60 V, ±15 V, ±4 V) .... 1 MΩ

Current mode .... < 40 Ω

All other modes .... >1 GΩ

Accuracy

Mode, Range	Gain Error (Percent of Reading)	Offset Error (ppm of Range)
	Typ (25 °C, ±5 °C), Max (–40 to 85 °C)	
Voltage, ±60 V	±0.3, ±0.4	±20, ±50
Voltage, ±15 V	±0.3, ±0.4	±60, ±180
Voltage, ±4 V	±0.3, ±0.4	±240, ±720
Voltage, ±1 V	±0.1, ±0.18	±15, ±45
Voltage/Thermocouple, ±125 mV	±0.1, ±0.18	±120, ±360
Current, ±25 mA	±0.1, ±0.6	±30, ±100
4-Wire and 2-Wire* Resistance, 10 kΩ	±0.1, ±0.5	±120, ±320
4-Wire and 2-Wire* Resistance, 1 kΩ	±0.1, ±0.5	±1200, ±3200

Mode, Range	Gain Error (Percent of Reading)	Offset Error (ppm of Range)
	Typ (25 °C, ±5 °C), Max (–40 to 85 °C)	
4-Wire and 3-Wire RTD, Pt 1000	±0.1, ±0.5	±240, ±640
4-Wire and 3-Wire RTD, Pt 100	±0.1, ±0.5	±2400, ±6400
Quarter-Bridge, 350 Ω	±0.1, ±0.5	±2400, ±6400
Quarter-Bridge, 120 Ω	±0.1, ±0.5	±2400, ±6400
Half-Bridge, ±500 mV/V	±0.03, ±0.07	±300, ±450
Full-Bridge, ±62.5 mV/V	±0.03, ±0.08	±300, ±1000
Full-Bridge, ±7.8 mV/V	±0.03, ±0.08	±2200, ±8000

* 2-Wire Resistance mode accuracy depends on the lead wire resistance. This table assumes 0 Ω of lead wire resistance.

Cold-junction compensation
sensor accuracy .... ±1°C typ

Stability

Mode, Range	Gain Drift (ppm of Reading/°C)	Offset Drift (ppm of Range/°C)
Voltage, ±60 V	±20	±0.2
Voltage, ±15 V	±20	±0.8
Voltage, ±4 V	±20	±3.2
Voltage, ±1 V	±10	±0.2
Voltage/Thermocouple, ±125 mV	±10	±1.6
Current, ±25 mA	±15	±0.4
4-Wire and 2-Wire Resistance, 10 kΩ	±15	±3
4-Wire and 2-Wire Resistance, 1 kΩ	±15	±30
4-Wire and 3-Wire RTD, Pt 1000	±15	±6
4-Wire and 3-Wire RTD, Pt 100	±15	±60
Quarter-Bridge, 350 Ω	±15	±120
Quarter-Bridge, 120 Ω	±15	±240
Half-Bridge, ±500 mV/V	±3	±20

Mode, Range	Gain Drift (ppm of Reading/°C)	Offset Drift (ppm of Range/°C)
Full-Bridge, ±62.5 mV/V	±3	±20
Full-Bridge, ±7.8 mV/V	±3	±20

Input noise in ppm of Range_{rms}

Mode, Range	Conversion Time			
	High speed	Best 60 Hz rejection	Best 50 Hz rejection	High reso-lution
Voltage, ±60 V	7.6	1.3	1.3	0.5
Voltage, ±15 V	10.8	1.9	1.9	0.7
Voltage, ±4 V	10.8	2.7	2.7	1.3
Voltage, ±1 V	7.6	1.3	1.3	0.5
Voltage/Thermocouple, ±125 mV	10.8	1.9	1.9	1.0
Current, ±25 mA	10.8	1.9	1.9	1.0
4-Wire and 2-Wire Resistance, 10 kΩ	4.1	1.3	0.8	0.3

Mode, Range	Conversion Time			
	High speed	Best 60 Hz rejection	Best 50 Hz rejection	High reso-lution
4-Wire and 2-Wire Resistance, 1 kΩ	7.1	1.8	1.2	0.7
4-Wire and 3-Wire RTD, Pt 1000	7.6	1.7	1.1	0.4
4-Wire and 3-Wire RTD, Pt 100	10.8	1.9	1.9	0.9
Quarter-Bridge, 350 Ω	5.4	1.0	1.0	0.7
Quarter-Bridge, 120 Ω	5.4	1.0	1.0	0.7
Half-Bridge, ±500 mV/V	3.8	0.5	0.5	0.2
Full-Bridge, ±62.5 mV/V	5.4	1.0	1.0	0.8
Full-Bridge, ±7.8 mV/V	30	4.7	4.7	2.3

Input bias current .... <1 nA

INL.. ±15 ppm

CMRR (f_{in} = 60 Hz) .... >100 dB

NMRR

Best 60 Hz rejection .... 90 dB at 60 Hz
Best 50 Hz rejection .... 80 dB at 50 Hz
High resolution .... 65 dB at 50 Hz and 60 Hz

Excitation level for Half-Bridge and Full-Bridge modes

Mode	Load Resistance (Ω)	Excitation (V)
Half-Bridge	700	2.5
	240	2.0
Full-Bridge	350	2.7
	120	2.2

Excitation level for Resistance, RTD, and Quarter-Bridge modes

Load Resistance (Ω)	Excitation (mV)
120	50
350	150
1 k	430
10 k	2200

MTBF .... 384,716 hours at 25 °C; Bellcore Issue 2, Method 1, Case 3, Limited Part Stress Method

Note Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

Power Requirements

Power consumption from chassis

- Active mode .... 750 mW max
- Sleep mode .... 25 μW max

Thermal dissipation (at 85 °C)

- Active mode .... 625 mW max
- Sleep mode .... 25 μW max

Physical Characteristics

Use a dry, low-velocity stream of air to clean the module. If needed, use a soft-bristle brush for cleaning around components.

Note For two-dimensional drawings and three-dimensional models of the C Series module and connectors, visit `ni.com/dimensions` and search by module number.

Spring-terminal wiring	18 to 28 AWG copper conductor wire with 7 mm (0.28 in.) of insulation stripped from the end
Weight	60 g (2.1 oz)

Safety

Safety Voltages

Connect only voltages that are within the following limits.

Channel-to-channel

Continuous .... 250 VAC, Measurement Category II, (Basic insulation)

Withstand.................................. 1,390 VAC, verified by a 5 s dielectric withstand test

Channel-to-earth ground

Continuous .... 250 VAC, Measurement Category II, (Double insulation)

Withstand.................................. 2,300 VAC, verified by a 5 s dielectric withstand test

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.

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

Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet, for example, 115 V for U.S. or 230 V for Europe.

Caution Do *not* connect to signals or use for measurements within Measurement Categories III or IV.

Safety Standards

This product meets the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1

Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit `ni.com/certification`, search by module number or product line, and click the appropriate link in the Certification column.

Environmental

National Instruments C Series modules are intended for indoor use only but may be used outdoors if installed in a suitable enclosure. Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature
(IEC 60068-2-1, IEC 60068-2-2) ..... –40 to 85 °C

Storage temperature
(IEC 60068-2-1, IEC 60068-2-2) ..... –40 to 85 °C

Operating humidity
(IEC 60068-2-56).............................. 10 to 90% RH, noncondensing

Storage humidity
(IEC 60068-2-56).............................. 5 to 95% RH, noncondensing

Maximum altitude............................. 2,000 m

Pollution Degree 2

Environmental Management

National Instruments 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 *NI and 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 their life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit `ni.com/environment/weee.htm`.

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`.)

Calibration

You can obtain the calibration certificate and information about calibration services for the NI 9219E at `ni.com/calibration`.

Calibration interval .... 1 year

Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At `ni.com/support` you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at `ni.com/support` and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 1800 300 800, Austria 43 662 457990-0, Belgium 32 (0) 2 757 0020, Brazil 55 11 3262 3599, Canada 800 433 3488, China 86 21 5050 9800, Czech Republic 420 224 235 774, Denmark 45 45 76 26 00, Finland 358 (0) 9 725 72511, France 01 57 66 24 24, Germany 49 89 7413130, India 91 80 41190000, Israel 972 3 6393737, Italy 39 02 41309277, Japan 0120-527196,

Korea 82 02 3451 3400, Lebanon 961 (0) 1 33 28 28,
Malaysia 1800 887710, Mexico 01 800 010 0793,
Netherlands 31 (0) 348 433 466, New Zealand 0800 553 322,
Norway 47 (0) 66 90 76 60, Poland 48 22 328 90 10,
Portugal 351 210 311 210, Russia 7 495 783 6851,
Singapore 1800 226 5886, Slovenia 386 3 425 42 00,
South Africa 27 0 11 805 8197, Spain 34 91 640 0085,
Sweden 46 (0) 8 587 895 00, Switzerland 41 56 2005151,
Taiwan 886 02 2377 2222, Thailand 662 278 6777,
Turkey 90 212 279 3031, United Kingdom 44 (0) 1635 523545

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