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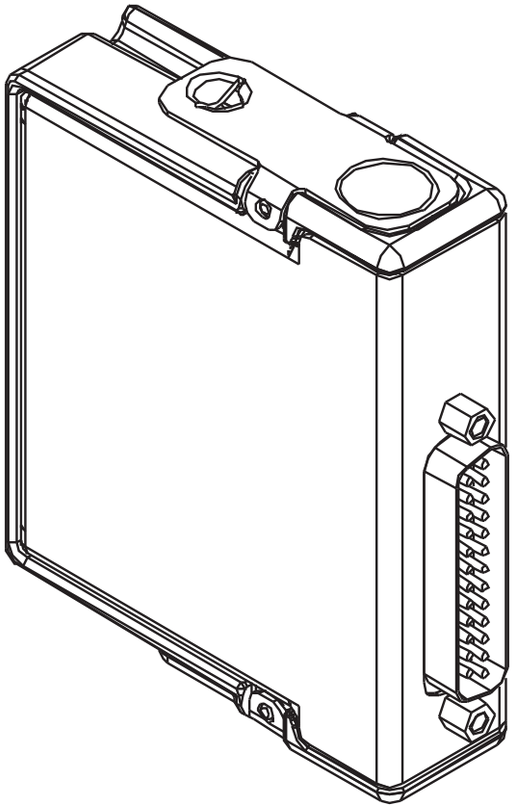
OPERATING INSTRUCTIONS AND SPECIFICATIONS

NI 9401

8-Channel, TTL Digital Input/Output Module

Français Deutsch 日本語 한국어 简体中文

ni.com/manuals



NATIONAL INSTRUMENTS™

This document describes how to use the National Instruments 9401 and includes specifications and terminal assignments for the NI 9401. For information about installing, configuring, and programming the system, refer to the system documentation. Visit `ni.com/info` and enter the following Info Codes:

- `cseriesdoc`—for information about C Series and system documentation.
- `compatibility`—for information about chassis and carrier compatibility for the modules you are using.
- `rdsoftwareversion`—for information about which software you need for the modules you are using.



Note The safety guidelines and specifications in this document are specific to the NI 9401. The other components in the system might not meet the same safety ratings and specifications. Refer to the documentation for each component in the system to determine the safety ratings and specifications for the entire system. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.

Safety Guidelines

Operate the NI 9401 only as described in these operating instructions.



Hot Surface This icon denotes that the component may be hot. Touching this component may result in bodily injury.



Caution Do not operate the NI 9401 in a manner not specified in these operating instructions. Product misuse can result in a hazard. You can compromise the safety protection built into the product if the product is damaged in any way. If the product is damaged, return it to National Instruments for repair.

Safety Guidelines for Hazardous Locations

The NI 9401 is suitable for use in Class I, Division 2, Groups A, B, C, D, T4 hazardous locations; Class I, Zone 2, AEx nC IIC T4, and Ex nC IIC T4 hazardous locations; and nonhazardous locations only. Follow these guidelines if you are installing the NI 9401 in a potentially explosive environment. Not following these guidelines may result in serious injury or death.



Caution Do *not* disconnect I/O-side wires or connectors unless power has been switched off or the area is known to be nonhazardous.



Caution Do *not* remove modules unless power has been switched off or the area is known to be nonhazardous.



Caution Substitution of components may impair suitability for Class I, Division 2.



Caution For Division 2 and Zone 2 applications, install the system in an enclosure rated to at least IP 54 as defined by IEC 60529 and EN 60529.



Caution For Division 2 and Zone 2 applications, connected signals must be within the following limit:

Capacitance.....0.2 µF max

Special Conditions for Hazardous Locations Use in Europe

This equipment has been evaluated as EEx nC IIC T4 equipment under DEMKO Certificate No. 03 ATEX 0324020X. Each module is marked ⟨Ex⟩ II 3G and is suitable for use in Zone 2 hazardous locations. If you are using the NI 9401 in Gas Group IIC hazardous locations or in ambient temperatures of -40 °C ≤ Ta ≤ 70 °C, you must use the device in an NI chassis that has been evaluated as EEx nC IIC T4, Ex nA IIC T4, or Ex nL IIC T4 equipment.

Electromagnetic Compatibility Guidelines

This product was tested and complies with the regulatory requirements and limits for electromagnetic compatibility (EMC) as stated in the product specifications. These requirements and limits are designed to provide reasonable protection against harmful interference when the product is operated in its intended operational electromagnetic environment.

This product is intended for use in industrial locations. There is no guarantee that harmful interference will not occur in a particular installation, when the product is connected to a test object, or if the product is used in residential areas. To minimize the potential for

the product to cause interference to radio and television reception or to experience unacceptable performance degradation, install and use this product in strict accordance with the instructions in the product documentation.

Furthermore, any changes or modifications to the product not expressly approved by National Instruments could void your authority to operate it under your local regulatory rules.



Caution To ensure the specified EMC performance, operate this product only with shielded cables and accessories.



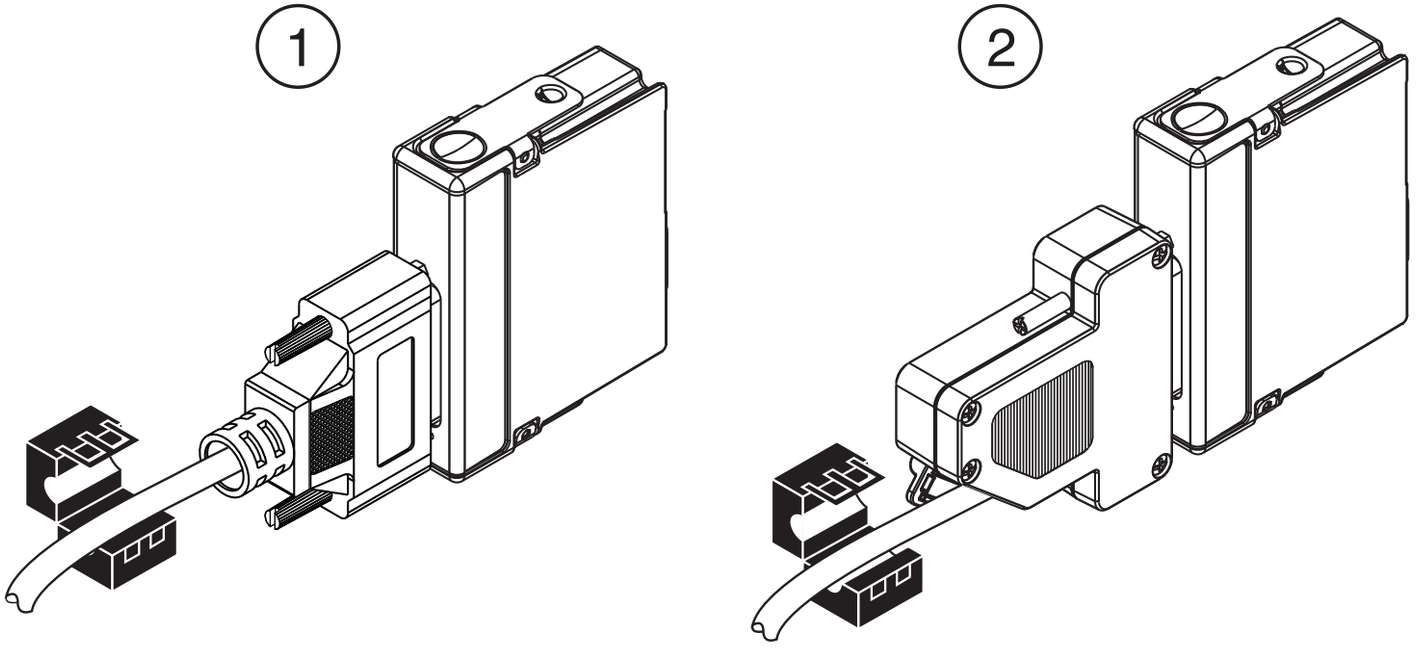
Caution To ensure the specified EMC performance, you must install a clamp-on ferrite bead (National Instruments part number 711627-01) in accordance with the product installation instructions. Refer to the NI 9401 product page on `ni.com` for purchasing information about clamp-on ferrite beads.

Cable Requirements for EMC Compliance

Select and install cables for the NI 9401 in accordance with the following requirements:

- Install a clamp-on ferrite bead (National Instruments part number 711627-01) on cable that you are connecting to NI 9401.
- The clamp-on ferrite bead must be connected to the cable as close to the module as possible. Placing the ferrite elsewhere on the cable noticeably impairs its effectiveness.

Figure 1. Installing a Ferrite Bead



1 Installing a ferrite bead on a 25-pin DSUB cable.
2 Installing a ferrite bead on the cable of the NI 9924 terminal block.

Special Conditions for Marine Applications

Some modules are Lloyd's Register (LR) Type Approved for marine applications. To verify Lloyd's Register certification, visit `ni.com/certification` and search for the LR certificate, or look for the Lloyd's Register mark on the module.

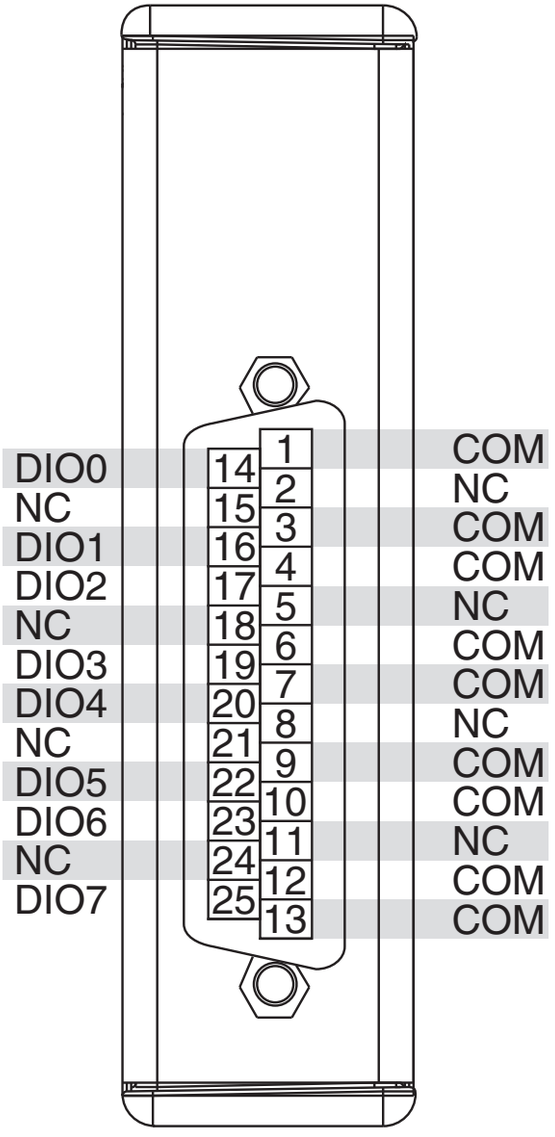


Caution To meet radio frequency emission requirements for marine applications, use shielded cables and install the system in a metal enclosure. Suppression ferrites must be installed on power supply inputs near power entries to modules and controllers. Power supply and module cables must be separated on opposite sides of the enclosure and must enter and exit through opposing enclosure walls.

Connecting the NI 9401

The NI 9401 has a 25-pin DSUB connector that provides connections for eight digital input/output channels.

Figure 2. NI 9401 Pin Assignments



Each channel has a DIO pin to which you can connect a digital input or output device. The eight DIO channels are internally referenced to COM, so you can use any of the nine COM lines as a reference for the external signal.

The DIO channels are grouped in two ports, one containing channels 0, 1, 2, and 3, and one containing channels 4, 5, 6, and 7. You can independently configure each digital port in software for input or output. Note that all four channels in the port must share the same line direction. Refer to the software help for information about configuring ports on the NI 9401.

Each channel also has a pull-down resistor and includes overvoltage, overcurrent, and short-circuit protection. Refer to the *Specifications* section for more information about input thresholds and overvoltage protection. Refer to the *Overcurrent Protection* section for more information about overcurrent protection.

Figure 3 illustrates how to connect an SPI device to the NI 9401. In this example, the three channels assigned to output signals are on one port and the channel assigned to an input signal is on the other port.

Figure 3. Connecting an SPI Device to the NI 9401

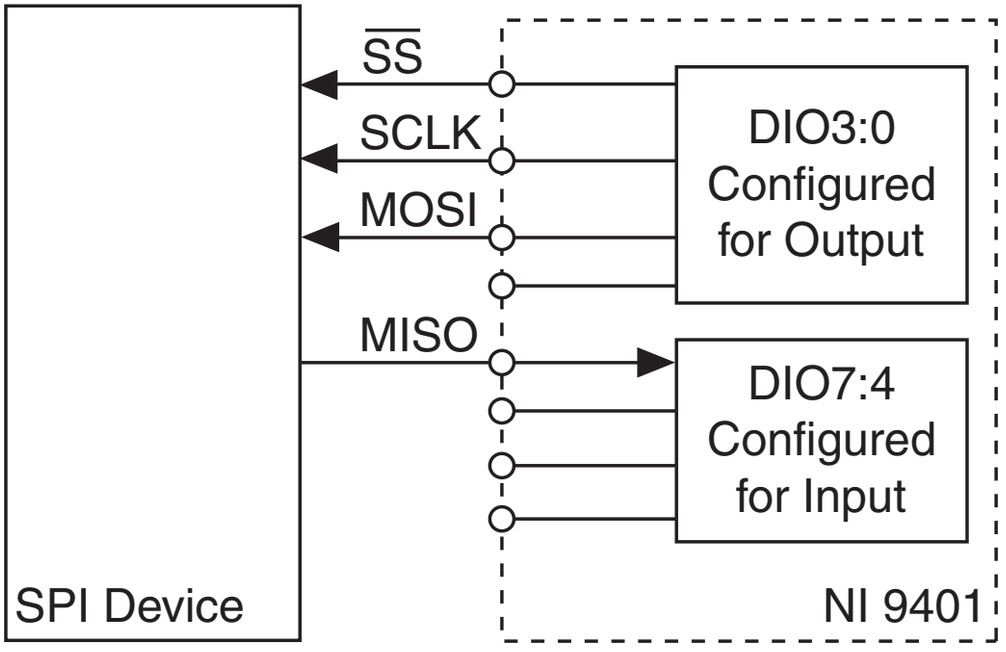
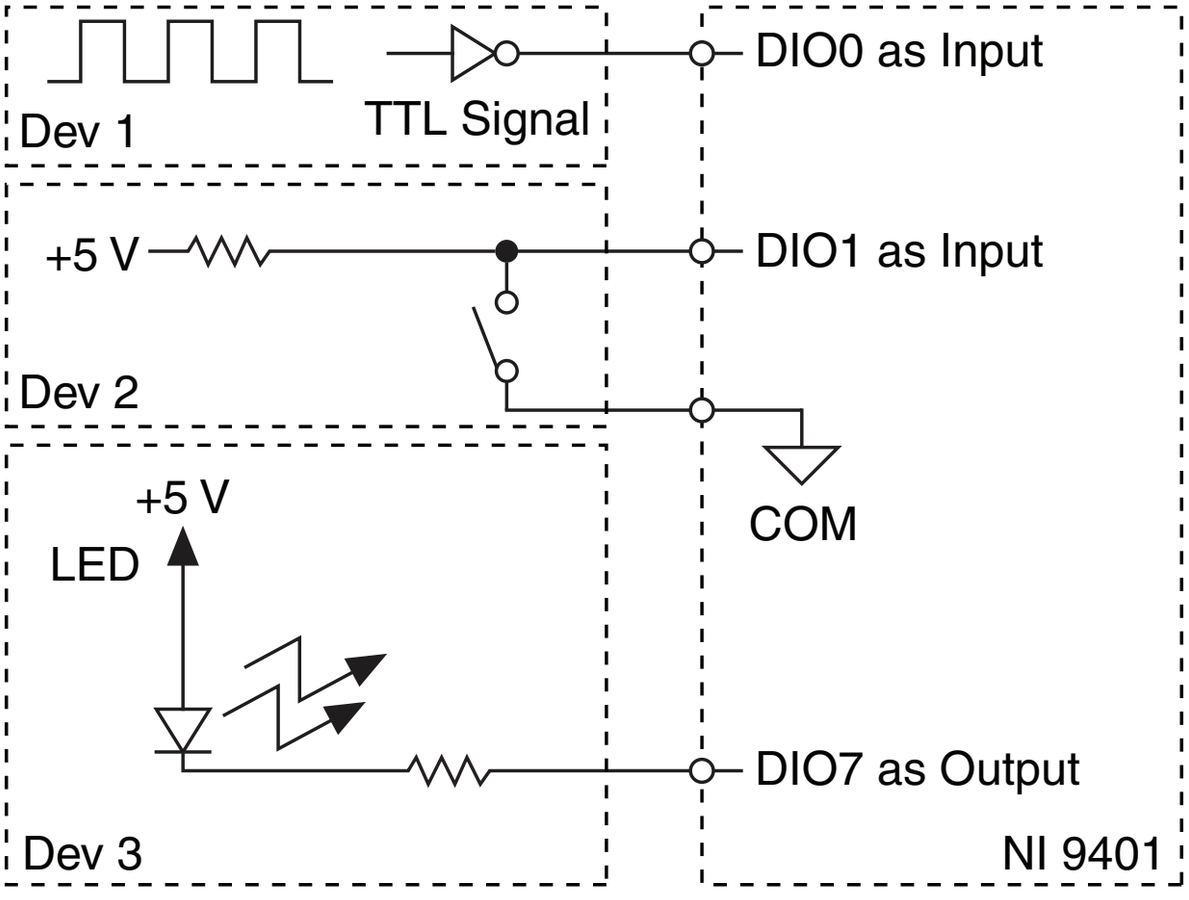


Figure 4 illustrates how to connect several types of digital devices to the NI 9401.

Figure 4. Connecting Digital Devices to the NI 9401



Overcurrent Protection

Overcurrent protection on the NI 9401 allows only a specified amount of current for switching DIO channels or sourcing the output load. If the NI 9401 goes into an overcurrent state, by exceeding the specified maximum switching frequency or the output load, the module power supply begins to drop in voltage until it completely turns off or the overcurrent condition is removed. When the module is in this state, it can accept new line direction configuration and output state data but cannot pass valid input data to the software. Refer to the *Specifications* section for more information about the maximum switching frequency and output load for each channel.

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 70 °C unless otherwise noted. All voltages are relative to COM unless otherwise noted.

Input/Output Characteristics

Number of channels..... 8 DIO channels

Default power-on line direction..... Input

Input/output type..... TTL, single-ended

Digital logic levels

Input

Voltage ..... 5.25 V max

High, V_{IH} ..... 2 V min

Low, V_{IL} ..... 0.8 V max

Output

High, V_{OH} ..... 5.25 V max

Sourcing 100 µA ..... 4.7 V min

Sourcing 2 mA ..... 4.3 V min

Low, V_{OL}

Sinking 100 µA ..... 0.1 V max

Sinking 2 mA ..... 0.4 V max

Maximum input signal switching frequency by number of input channels, per channel

8 input channels ..... 9 MHz

4 input channels ..... 16 MHz

2 input channels ..... 30 MHz

Maximum output signal switching frequency by number of output channels with an output load of 1 mA, 50 pF, per channel

- 8 output channels ..... 5 MHz
- 4 output channels ..... 10 MHz
- 2 output channels ..... 20 MHz

I/O propagation delay ..... 100 ns max

I/O pulse width distortion ..... 10 ns typ

Input current ($0 \text{ V} \leq V_{in} \leq 4.5 \text{ V}$)..... ±250 µA typ

Input capacitance ..... 30 pF typ

Input rise/fall time..... 500 ns max

Overvoltage protection, channel-to-COM ..... ±30 V max on one channel at a time; however, continued use at this level will degrade the life of the module.

MTBF ..... 1,244,763 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 ..... 580 mW max

Sleep mode ..... 1 mW max

Thermal dissipation (at 70 °C)

Active mode ..... 580 mW max

Sleep mode ..... 1 mW max

Physical Characteristics

If you need to clean the module, wipe it with a dry towel.

Weight..... 145 g (5.1 oz)

Safety

Maximum Voltage[1]

Connect only voltages that are within the following limits.

Channel-to-COM ..... ±30 V max on one channel at a time, Measurement Category I

Isolation Voltages

Channel-to-channel..... None

Channel-to-earth ground

Continuous ..... 60 VDC, Measurement Category I

Withstand..... 1,000 V_{rms}, verified by a 5 s dielectric withstand test

[1] The maximum voltage that can be applied or output between any channel and COM without damaging the module or other devices.

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 the NI 9401 to signals or use for measurements within Measurement Categories II, III, or IV.

Hazardous Locations

U.S. (UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nC IIC T4
Canada (C-UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nC IIC T4
Europe (DEMKO)	EEx nC IIC T4

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.

Electromagnetic Compatibility

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

- EN 61326 EMC requirements; Industrial Immunity
- EN 55011 Emissions; Group 1, Class A
- CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A

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 generates radio frequency energy for the treatment of material or inspection/analysis purposes.

Note For EMC declarations and certifications, refer to the *Online Product Certification* section.

CE Compliance CE

This product meets the essential requirements of applicable European Directives as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Online Product Certification

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

Shock and Vibration

To meet these specifications, you must panel mount the system.

Operating vibration

Random (IEC 60068-2-64)..... 5 g_{rms}, 10 to 500 Hz

Sinusoidal (IEC 60068-2-6) ..... 5 g, 10 to 500 Hz

Operating shock

(IEC 60068-2-27) ..... 30 g, 11 ms half sine,
50 g, 3 ms half sine,
18 shocks at 6 orientations

Environmental

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 °C to 70 °C

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

Ingress protection..... IP 40

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

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

Pollution Degree 2

Maximum altitude..... 2,000 m

Indoor use only.

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 products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers, National Instruments WEEE initiatives, and compliance with WEEE Directive 2002/96/EC on Waste and Electronic Equipment, 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`.)

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, visit the Worldwide Offices section of `ni.com/niglobal` to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

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