USER MANUAL AND SPECIFICATIONS

# NI cRIO-9002/9004

Intelligent Real-Time Embedded Controller for CompactRIO

**Figure 1.** CompactRIO cRIO-9002/9004
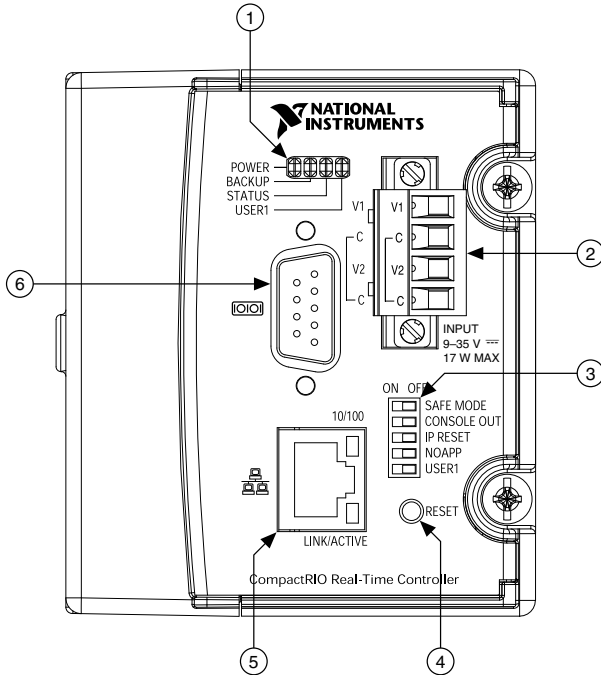


| | | | |
|---|---|---|---|
| 1. | LEDs | 4. | Reset Button |
| 2. | Power Connector | 5. | RJ-45 Ethernet Port |
| 3. | DIP Switches | 6. | RS-232 Serial Port |

This document describes how to connect the cRIO-9002/9004 to a network and how to use the features of the cRIO-9002/9004. This document also contains specifications for the controllers.

# Safety Guidelines

⚠ **Caution** Do not operate the cRIO-9002/9004 in a manner not specified in this document. 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 NI for repair.

## Safety Guidelines for Hazardous Locations

The cRIO-9002/9004 is suitable for use in Class I, Division 2, Groups A, B, C, D, T4 hazardous locations; Class I, Zone 2, AEx nA IIC T4 and Ex nA IIC T4 hazardous locations; and nonhazardous locations only. Follow these guidelines if you are installing the cRIO-9002/9004 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 IP54 as defined by IEC/EN 60079-15.

## Special Conditions for Hazardous Locations Use in Europe and Internationally

The cRIO-9002/9004 has been evaluated as Ex nA IIC T4 Gc equipment under DEMKO Certificate No. 03 ATEX 0324020X and is IECEx UL 14.0089X certified. Each device is marked ⟨Ex⟩ II 3G and is suitable for use in Zone 2 hazardous locations, in ambient temperatures of -40 °C ≤ Ta ≤ 70 °C.

⚠ **Caution** You must make sure that transient disturbances do not exceed 140% of the rated voltage.

⚠ **Caution** The system shall only be used in an area of not more than Pollution Degree 2, as defined in IEC 60664-1.

⚠ **Caution** The system shall be mounted in an ATEX/IECEx-certified enclosure with a minimum ingress protection rating of at least IP54 as defined in IEC/EN 60079-15.

⚠ **Caution** The enclosure must have a door or cover accessible only by the use of a tool.

# Electromagnetic Compatibility Guidelines

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

This product is intended for use in industrial locations. However, harmful interference may occur in some installations, when the product is connected to a peripheral device or test object, or if the product is used in residential or commercial areas. To minimize interference with radio and television reception and prevent 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.

## Special Conditions for Marine Applications

Some products are Lloyd's Register (LR) Type Approved for marine (shipboard) applications. To verify Lloyd's Register certification for a product, visit *ni.com/certification* and search for the LR certificate, or look for the Lloyd's Register mark on the product.

⚠ **Caution** In order to meet the EMC requirements for marine applications, install the product in a shielded enclosure with shielded and/or filtered power and input/output ports. In addition, take precautions when designing, selecting, and installing measurement probes and cables to ensure that the desired EMC performance is attained.

# Installing the Controller on the Chassis

The following figure shows the dimensions of the cRIO-9002/9004.

**Figure 2.** cRIO-9002/9004, Front and Bottom View with Dimensions



90.2 mm
(3.55 in.)

44.2 mm
(1.74 in.)

77.3 mm
(3.04 in.)
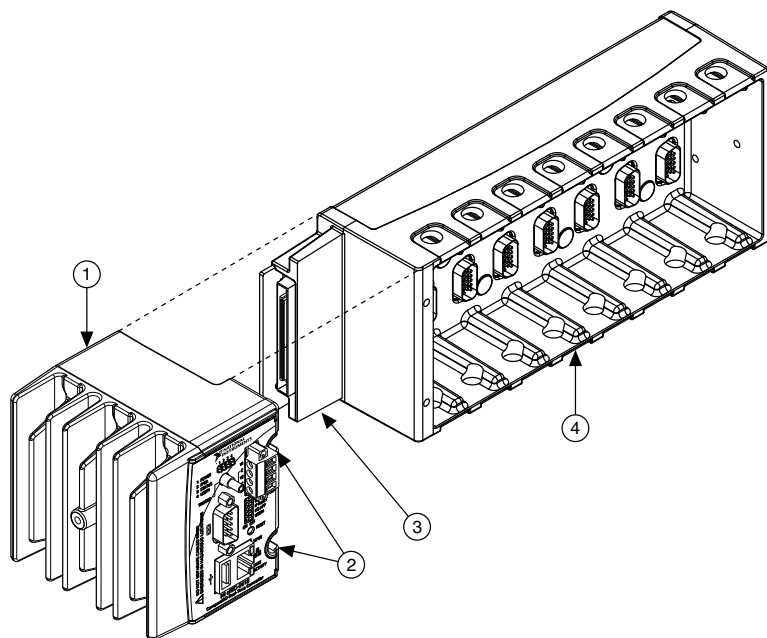
88.1 mm
(3.47 in.)

44.2 mm
(1.74 in.)
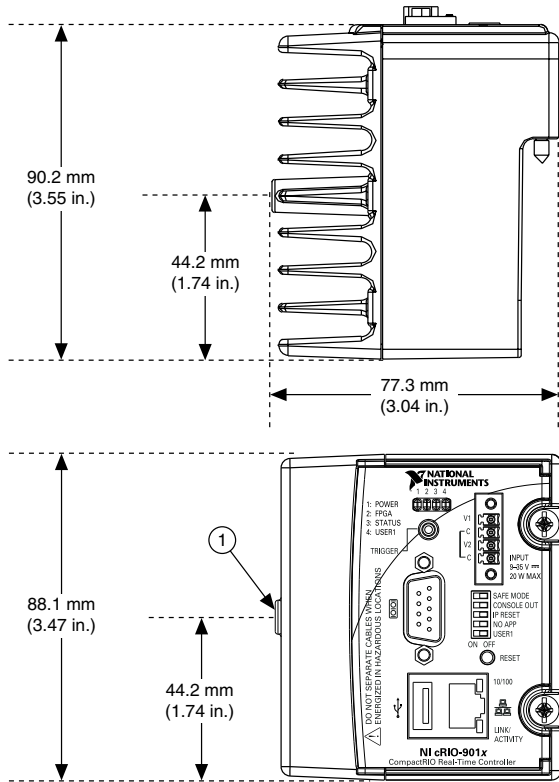
1. M4 Thread

Complete the following steps to install the controller on the chassis.

1.  Make sure that no power is connected to the controller or the chassis.
2.  Align the controller with the chassis as shown in the following figure.

**Figure 3.** Installing the cRIO-9002/9004 in the Chassis

| | | | |
|---|---|---|---|
| 1. | Controller | 3. | Controller Slot |
| 2. | Captive Screws | 4. | Reconfigurable Embedded Chassis |

3. Slide the controller onto the controller slot on the chassis. Press firmly to ensure the chassis connector and the controller connector are mated.

4. Using a number 2 Phillips screwdriver, tighten the two captive screws on the front of the controller to 1.3 N · m (11.5 lb · in.) of torque.

# Connecting the Controller to a Network

Connect the controller to an Ethernet network using the RJ-45 Ethernet port on the controller front panel. Use a standard Category 5 (CAT-5) or better shielded, twisted-pair Ethernet cable to connect the chassis to an Ethernet hub, or use an Ethernet crossover cable to connect the chassis directly to a computer.

⚠ **Caution** To prevent data loss and to maintain the integrity of your Ethernet installation, do not use a cable longer than 100 m. If you are using 100 Mbps Ethernet, National Instruments recommends using a CAT-5 or better shielded twisted-pair Ethernet cable.

If you need to build your own cable, refer to the *Cabling* section for more information about Ethernet cable wiring connections.

The host computer communicates with the controller over a standard Ethernet connection. If the host computer is on a network, you must configure the controller on the same subnet as the

host computer. If neither the host computer nor the CompactRIO controller is connected to a network, you can connect the two directly using a crossover cable.

If you want to use the controller on a subnet other than the one the host computer is on, first connect the controller on the same subnet as the host computer. Use DHCP to assign an IP address or reassign a static IP address for the subnet where you want it to be and physically move it to the other subnet. The first time you configure the controller, you must also install software on it. Refer to the *Measurement & Automation Explorer Help* for more information about configuring the controller in Measurement & Automation Explorer (MAX). Contact your network administrator if you need assistance configuring the host computer and controller on the same subnet.

# Wiring Power to the Controller

⚠ **Caution** You must install the controller on a CompactRIO chassis and tighten the captive screws before you apply power to the controller. Installing the controller while power is applied to it can cause damage to the chassis.

The cRIO-9002/9004 requires an external power supply that meets the specifications in the *Power Requirements* section. The cRIO-9002/9004 filters and regulates the supplied power and provides power for all of the I/O modules in the chassis. You can connect two power sources to the cRIO-9002/9004. The cRIO-9002/9004 draws power from the power source with the higher voltage. The cRIO-9002/9004 has one layer of reversed-voltage protection. The power source you connect to the cRIO-9002/9004 must provide an additional layer of reversed-current flow protection. Complete the following steps to connect power sources to the cRIO-9002/9004.

1.  Install a ferrite across the negative and positive wires for both the V1 and V2 terminals.

**Figure 4.** Wiring Power to the cRIO-9002/9004
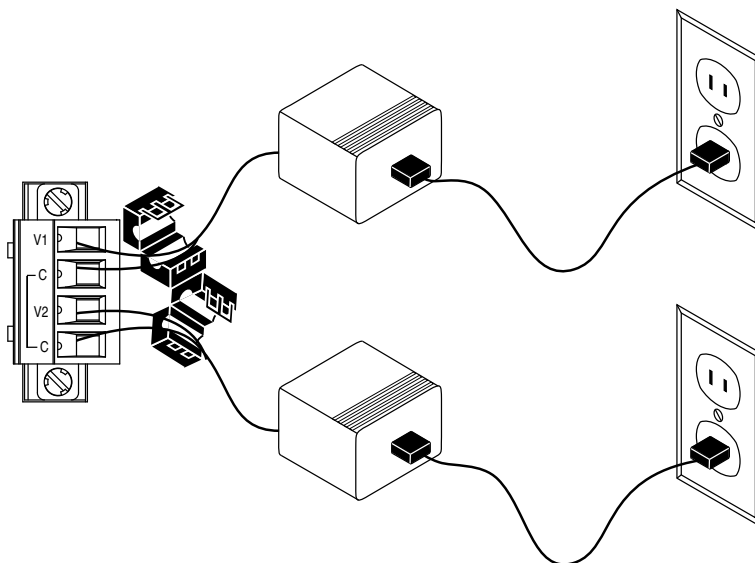


2. Connect the positive lead of one of the power sources to the V1 terminal and the negative lead to one of the C terminals.

3. Connect the positive lead of the other power source to the V2 terminal and the negative lead to one of the C terminals.

> **Note** The controller draws power from either V1 or V2 depending on which terminal has a higher voltage. It does not draw power from both terminals.

> **Caution** The C terminals are internally connected to each other. Make sure to use two power sources that have a common ground.

## Powering On the cRIO-9002/9004

Plug in each power supply to the CompactRIO system. The controller runs a power-on self test (POST). During the POST, the Power, Status, and User1 LEDs turn on. The User1 and Status LEDs turn off, indicating that the POST is complete.

## Boot Options

You can configure the controller to launch an embedded stand-alone application each time you boot the controller. Refer to the *LabVIEW Help* for more information.

The following table lists the reset options available on CompactRIO backplanes, such as the cRIO-910x devices. Use these options to determine how the CompactRIO controllers, such as the cRIO-9002/9004 controllers, are reset in various conditions.

**Table 1.** CompactRIO Reset Options

| Backplane Reset Option | Controller Behavior |
|---|---|
| Do Not Autoload on Reset | Does not load the FPGA bit stream from flash memory |
| Autoload on Power-On Reset | Loads the FPGA bit stream from flash memory to the FPGA when the controller powers on. |
| Autoload on Any Device Reset | Loads the FPGA bit stream from flash to the FPGA when you reboot the controller either with or without cycling power. |

# Connecting Serial Devices to the cRIO-9002/9004

The cRIO-9002/9004 has an RS-232 serial port to which you can connect devices such as displays or input devices. Use the Serial VIs to read from and write to the serial port from a LabVIEW Real-Time application. For more information about the Serial VIs, refer to the *LabVIEW Help*.

**Figure 5.** Controller Serial Port
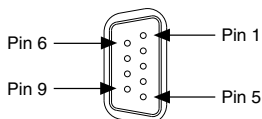


**Table 2.** DB-9 Pin Descriptions

| Pin | Signal |
|---|---|
| 1 | DCD |
| 2 | RXD |
| 3 | TXD |
| 4 | DTR |
| 5 | GND |
| 6 | DSR |
| 7 | RTS |
| 8 | CTS |
| 9 | RI |

# Configuring DIP Switches

**Figure 6.** DIP Switches

ON  OFF
- SAFE MODE
- CONSOLE OUT
- IP RESET
- NO APP
- USER1
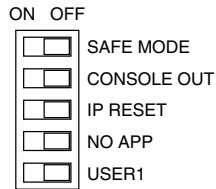
All of the DIP switches are in the OFF position when the chassis is shipped from National Instruments.

## SAFE MODE Switch

The position of the SAFE MODE switch determines whether the embedded LabVIEW Real-Time engine launches at startup. If the switch is in the OFF position, the LabVIEW Real-Time engine launches. Keep this switch in the OFF position during normal operation. If the switch is in the ON position at startup, the cRIO-9002/9004 launches only the essential services required for updating its configuration and installing software. The LabVIEW Real-Time engine does not launch.

If the software on the controller is corrupted, you must put the controller into safe mode and reformat the controller drive. You can put the controller into safe mode by powering it up either with the SAFE MODE switch in the ON position or with no software installed on the drive. Refer to the *Measurement & Automation Explorer Help* for more information about installing software on a controller and reformatting the drive on the controller.

## CONSOLE OUT Switch

With a serial-port terminal program, you can use the CONSOLE OUT switch to read the IP address and firmware version of the controller. Use a null-modem cable to connect the serial port on the chassis to a computer. Push the switch to the ON position. Make sure that the serial-port terminal program is configured to the following settings:
- 9,600 bits per second
- Eight data bits
- No parity
- One stop bit

The serial-port terminal program displays the IP address and firmware version. Keep this switch in the OFF position during normal operation.

## IP RESET Switch

Push the IP RESET switch to the ON position and reboot the controller to reset the IP address and other TCP/IP settings of the controller to the factory defaults. Refer to the *Troubleshooting Network Communication* section for more information about resetting the IP address. You also

can push this switch to the ON position to unlock a chassis that was previously locked in MAX.

## NO APP Switch

Push the NO APP switch to the ON position to prevent a LabVIEW Real-Time startup application from running at startup. If you want to permanently disable a LabVIEW Real-Time application from running at startup, you must disable it in LabVIEW. To run an application at startup, push the NO APP switch to the OFF position, create an application using the LabVIEW Application Builder, and configure the application in LabVIEW to launch at startup. If you already have an application configured to launch at startup and you push the NO APP switch from ON to OFF, the startup application is automatically enabled. For more information about automatically launching VIs at startup and disabling VIs from launching at startup, refer to the *LabVIEW Help*.

## USER1 Switch

You can define the USER1 switch for your application. To define the purpose of this switch in your embedded application, use the RT Read Switch VI in your LabVIEW Real-Time embedded VI. For more information about the RT Read Switch VI, refer to the *LabVIEW Help*.

# Understanding LED Indications

**Figure 7.** cRIO-9002/9004 LEDs
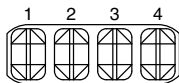


| 1. POWER | 3. STATUS |
| 2. BACKUP | 4. USER1 |

## POWER LED

The POWER LED is lit while the cRIO-9002/9004 is powered on. This LED indicates that the power supply connected to the chassis is adequate.

## BACKUP LED

The Backup LED is lit when the controller is drawing power from the V2 terminal.

## STATUS LED

The STATUS LED is off during normal operation. The cRIO-9002/9004 indicates specific error conditions by flashing the STATUS LED a certain number of times every few seconds, as shown in the following table

| Number of Flashes Every Few Seconds | Indication |
|---|---|
| Slow, continuous flashing (one flash every couple seconds) | The controller is unconfigured. Use MAX to configure the controller. Refer to the *Measurement & Automation Explorer Help* for information about configuring the controller. |
| 2 | The controller has detected an error in its software. This usually occurs when an attempt to upgrade the software is interrupted. Reinstall software on the controller. Refer to the *Measurement & Automation Explorer Help* for information about installing software on the controller. |
| 3 | The controller is in safe mode because the SAFE MODE DIP switch is in the ON position or there is no software installed on the controller. |
| 4 | The software has crashed twice without rebooting or cycling power between crashes. This usually occurs when the controller runs out of memory. Review your RT VI and check the memory usage. Modify the VI as necessary to solve the memory usage issue. |
| Continuously blinking | The controller has detected an unrecoverable error. Contact National Instruments. |
| Solid | The flash memory card on the controller is corrupt. Reformat the hard drive on the controller. Refer to *Measurement & Automation Explorer Help* for more information about reformatting the hard drive. |

## USER1 LED

You can define the USER1 LED to meet the needs of your application. To define the LED, use the RT LEDs VI in LabVIEW. For more information about the RT LEDs VI, refer to the *LabVIEW Help*.

# Resetting the Network Configuration of the Controller

If the controller is not able to communicate with the network, you can manually restore the unit to the factory network settings. When you reset the controller, the IP address, subnet mask, DNS address, gateway, and Time Server IP are set to 0.0.0.0. Resetting does not affect power-on defaults, watchdog settings, or VIs.

Complete the following steps to reset the controller.
1. Move the IP Reset DIP switch to the ON position.
2. Push the Reset button to cycle power to the controller. The Status LED flashes once, indicating that the controller IP address is unconfigured.

3. Move the IP Reset switch to the OFF position.

The network settings are restored. You can reconfigure the settings in MAX from a computer on the same subnet. Refer to the *Measurement & Automation Explorer Help* for more information about configuring the controller.

# cRIO-9002/9004 Specifications

The following specifications are typical for the range -40 °C to 70 °C unless otherwise noted.

⚠ **Caution** Do not operate the cRIO-9002/9004 in a manner not specified in this document. 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 NI for repair.

## Network

| | |
|---|---|
| Network interface | 10Base-T and 100Base-TX Ethernet |
| Compatibility | IEEE 802.3 |
| Communication rates | 10 Mbps, 100 Mbps, auto-negotiated |
| Maximum cabling distance | 100 m/segment |

## RS-232 Serial Port

| | |
|---|---|
| Maximum baud rate | 115,200 bps |
| Data bits | 5, 6, 7, 8 |
| Stop bits | 1, 2 |
| Parity | Odd, Even, Mark, Space |
| Flow control | RTS/CTS, XON/XOFF, DTR/DSR |

## Memory

| | |
|---|---|
| cRIO-9002 | |
| Nonvolatile | 64 MB |
| DRAM | 32 MB |
| cRIO-9004 | |
| Nonvolatile | 512 MB |
| DRAM | 64 MB |

# MTBF

The following MTBF specifications apply to the cRIO-9002/9004.

| | |
|---|---|
| MTBF | 1,253,788 hours at 25 °C; Bellcore Issue 6, Method 1, Case 3, Parts Count Method |

# Power Requirements

You must use a National Electric Code (NEC) Class 2 power source with the cRIO-9002/9004.

| | |
|---|---|
| Recommended power supply | 48 W secondary, 18 VDC to 24 VDC |
| Power consumption | |
| Controller only | 7 W maximum |
| Controller supplying power to eight CompactRIO modules | 17 W |
| Power supply | |
| On powerup | 9 V to 35 V |
| After powerup | 6 V to 35 V |

**Note** The cRIO-9002/9004 powers up only at 9 V or higher, but when these devices are powered on, they can run on as little as 6 V.

# Physical Characteristics

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

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

| | |
|---|---|
| Screw-terminal wiring | |
| Gauge | 0.5 mm $^2$ to 2.1 mm$^2$ (20 AWG to 14 AWG) copper conductor wire |
| Wire strip length | 7 mm (0.28 in.) of insulation stripped from the end |
| Temperature rating | 85 °C |
| Torque for screw terminals | 0.5 N · m to 0.6 N · m (4.4 lb · in. to 5.3 lb · in.) |
| Wires per screw terminal | One wire per screw terminal |
| Ferrules | 0.25 mm$^2$ to 1.5 mm$^2$ |

Connector securement

| | |
|---|---|
| Securement type | Screw flanges provided |
| Torque for screw flanges | 0.3 N · m to 0.4 N · m (2.7 lb · in. to 3.5 lb · in.) |

| | |
|---|---|
| Dimensions | 90.2 mm × 77.3 mm × 88.1 mm (3.6 in. × 3.0 in. × 3.5 in.) |
| Weight | 488 g (17.2 oz) |

# Safety Voltages

Connect only voltages that are within the following limits:

| | |
|---|---|
| V terminal to C terminal | 35 V maximum, Measurement Category I |

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 not intended for direct connection to the MAINS building installations of Measurement Categories CAT II, CAT III, or CAT IV.

**Caution** Do not connect the cRIO-9002/9004 to signals or use for measurements within Measurement Categories II, III, or IV.

# Safety and Hazardous Locations 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 61010-1
- EN 60079-0:2012, EN 60079-15:2010
- IEC 60079-0: Ed 6, IEC 60079-15; Ed 4
- UL 60079-0; Ed 5, UL 60079-15; Ed 3
- CSA 60079-0:2011, CSA 60079-15:2012

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

# Hazardous Locations

| | |
|---|---|
| U.S. (UL) | Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nA IIC T4 |
| Canada (C-UL) | Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nA IIC T4 |
| Europe (ATEX) and International (IECEx) | Ex nA IIC T4 Gc |

# Electromagnetic Compatibility

- EN 55011 Class A at 10 m FCC Part 15A above 1 GHz
- Industrial levels per EN 61326:1997 + A2:2001, Table A.1
- CE, C-Tick, and FCC Part 15 (Class A) Compliant

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

# CE Compliance $C \in$

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)
- 94/9/EC; Potentially Explosive Atmospheres (ATEX)

# 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 model 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 Hz to 500 Hz |
|     Sinusoidal (IEC 60068-2-6) | 5 g, 10 Hz 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 | IP40 |
| Operating humidity (IEC 60068-2-78) | 10% RH to 90% RH, noncondensing |
| Storage humidity (IEC 60068-2-78) | 5% RH 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 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.）

## Cabling

The following table shows the standard Ethernet cable wiring connections for both normal and crossover cables.

**Table 3.** Ethernet Cable Wiring Connections

| Pin | Connector 1 | Connector 2 (Normal) | Connector 2 (Crossover) |
|-----|-------------|----------------------|-------------------------|
| 1 | white/orange | white/orange | white/green |
| 2 | orange | orange | green |
| 3 | white/green | white/green | white/orange |
| 4 | blue | blue | blue |
| 5 | white/blue | white/blue | white/blue |
| 6 | green | green | orange |
| 7 | white/brown | white/brown | white/brown |
| 8 | brown | brown | brown |

**Figure 8.** Ethernet Connector Pinout
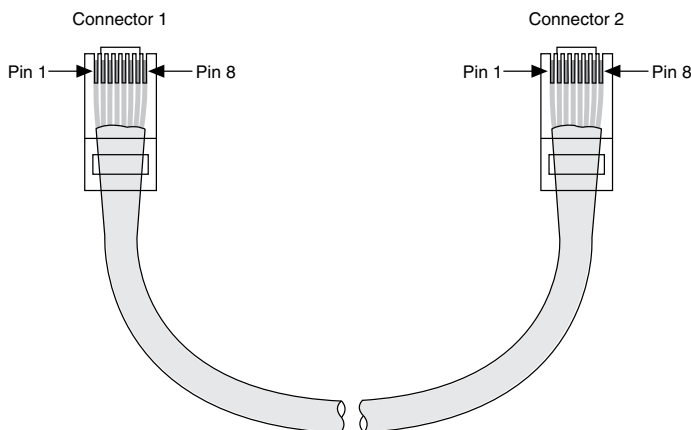


# Worldwide Support and Services

The NI website 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.

Visit *ni.com/services* for NI Factory Installation Services, repairs, extended warranty, and other services.

Visit *ni.com/register* to register your NI product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

A Declaration of Conformity (DoC) is our claim of compliance with the Council of the European Communities using the manufacturer's declaration of conformity. This system affords the user protection for electromagnetic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting *ni.com/certification*. If your product supports calibration, you can obtain the calibration certificate for your product at *ni.com/calibration*.

NI corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. NI also has offices located around the world. For telephone support in the United States, create your service request at *ni.com/support* or dial 1 866 ASK MYNI (275 6964). For telephone support outside the United States, visit the *Worldwide Offices* section of *ni.com/niglobal* to access the branch office websites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.