NI PCIe-1473R User Guide and Specifications

The NI PCIe-1473R (NI 1473R) is a PCI Express (PCIe) image acquisition device that supports Base, Medium, Full, and Extended Full configuration Camera Link cameras. The NI 1473R supports Power over Camera Link (PoCL) and has a user-reconfigurable FGPA. This document describes how to install and configure the necessary hardware and software components to begin using the NI 1473R.

Required Components

The following items are necessary to set up and use the NI 1473R:

- ❑ NI 1473R image acquisition device
- ❑ Camera Link camera
- ❑ MDR to MDR Camera Link cable (part number 199744A-05)
  - One 26-pin MDR Camera Link cable for Base configuration cameras
  - Two 26-pin MDR Camera Link cables of the same length for Medium, Full, or Extended Full configuration cameras
- ❑ Computer running Microsoft Windows 7 (32-bit and 64-bit versions)/Vista (32-bit and 64-bit versions)/XP (32-bit)/Server 2008 R2/Server 2003 R2 (32-bit) with at least one available x4 or larger PCIe slot
- ❑ The following software packages:
  - LabVIEW 2010 or later
  - LabVIEW FPGA Module 2010 or later
  - NI-RIO 4.0 or later driver software
  - NI-IMAQ 4.6.1 or later driver software
  - (Optional) NI Vision Development Module 2010 or later

Optional Equipment

National Instruments offers a variety of products for use with the NI 1473R, including the following:

- NI Camera Link I/O Extension Board (PCIe) for additional triggering, timing, and I/O (part number 780869-01)
- SMB to BNC cable, used for front panel trigger I/O (part number 763389-01)

Safety Information

Caution The following paragraphs contain important safety information you *must* follow when installing and operating the device.

Do *not* operate the device in a manner not specified in the documentation. Misuse of the device may result in a hazard and may compromise the safety protection built into the device. If the device is damaged, turn it off and do *not* use it until service-trained personnel can check its safety. If necessary, return the device to National Instruments for repair.

NATIONAL INSTRUMENTS

Keep away from live circuits. Do *not* remove equipment covers or shields unless you are trained to do so. If signal wires are connected to the device, hazardous voltages can exist even when the equipment is turned off. To avoid a shock hazard, do *not* perform procedures involving cover or shield removal unless you are qualified to do so. Disconnect all field power prior to removing covers or shields.

If the device is rated for use with hazardous voltages (>30 V_{rms}, 42.4 V_{pk}, or 60 V_{dc}), it may require a safety earth-ground connection wire. Refer to the device specifications for maximum voltage ratings.

Because of the danger of introducing additional hazards, do *not* install unauthorized parts or modify the device. Use the device only with the chassis, modules, accessories, and cables specified in the installation instructions. All covers and filler panels *must* be installed while operating the device.

Do *not* operate the device in an explosive atmosphere or where flammable gases or fumes may be present. Operate the device only at or below the pollution degree stated in the specifications. Pollution consists of any foreign matter—solid, liquid, or gas—that may reduce dielectric strength or surface resistivity. The following is a description of pollution degrees.

- Pollution Degree 1—No pollution or only dry, nonconductive pollution occurs. The pollution has no effect.
- Pollution Degree 2—Normally only nonconductive pollution occurs. Occasionally, nonconductive pollution becomes conductive because of condensation.
- Pollution Degree 3—Conductive pollution or dry, nonconductive pollution occurs. Nonconductive pollution becomes conductive because of condensation.

Clean the device and accessories by brushing off light dust with a soft, nonmetallic brush. Remove other contaminants with a stiff, nonmetallic brush. The unit *must* be completely dry and free from contaminants before returning it to service.

You *must* insulate signal connections for the maximum voltage for which the device is rated. Do *not* exceed the maximum ratings for the device. Remove power from signal lines before connection to or disconnection from the device.

Caution National Instruments measurement products may be classified as either Measurement Category I or II. Operate products at or below the Measurement Category level specified in the hardware specifications.

Measurement Category[1]: Measurement circuits are subjected to working voltages[2] and transient stresses (overvoltage) from the circuit to which they are connected during measurement or test. Measurement Category establishes standardized impulse withstand voltage levels that commonly occur in electrical distribution systems. The following is a description of Measurement (Installation[3]) Categories:

- Measurement Category I is for measurements performed on circuits *not* directly connected to the electrical distribution system referred to as MAINS[4] voltage. 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.

[1] Measurement Categories as defined in electrical safety standard IEC 61010-1.

[2] Working voltage is the highest rms value of an AC or DC voltage that can occur across any particular insulation.

[3] Measurement Category is also referred to as Installation Category.

[4] MAINS is defined as the (hazardous live) electrical supply system to which equipment is designed to be connected for the purpose of powering the equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

- 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 (e.g., 115 V for U.S. or 230 V for Europe). Examples of Measurement Category II are measurements performed on household appliances, portable tools, and similar products.
- Measurement Category III is for measurements performed in the building installation at the distribution level. This category refers to measurements on hard-wired equipment such as equipment in fixed installations, distribution boards, and circuit breakers. Other examples are wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and stationary motors with permanent connections to fixed installations.

Install Application Software and Driver

Before installing the NI 1473R, you must install the application software and device driver. Install the software in the following order:

1. **LabVIEW**—Refer to the *LabVIEW Release Notes* for installation instructions for LabVIEW and system requirements for the LabVIEW software. Refer to the *LabVIEW Upgrade Notes* for additional information about upgrading to the most recent version of LabVIEW.

   Documentation for LabVIEW is available by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals**.
2. **LabVIEW FPGA Module**—Refer to the *LabVIEW FPGA Module Release and Upgrade Notes* for installation instructions and information about getting started with the LabVIEW FPGA Module.

   Documentation for the LabVIEW FPGA Module is available by selecting **Start»All Programs» National Instruments»LabVIEW»LabVIEW Manuals**.
3. **NI-RIO**—Refer to the *NI-RIO Readme* on the NI-RIO installation media for system requirements and installation instructions for the NI-RIO driver.

   Documentation for the NI-RIO driver software is available by selecting **Start»All Programs» National Instruments»NI-RIO**.
4. **NI-IMAQ**—Refer to the *NI Vision Acquisition Software Release Notes* on the NI Vision Acquisition Software installation media for system requirements and installation instructions for the NI-IMAQ driver.

   Documentation for the NI-IMAQ driver software is available by selecting **Start»All Programs» National Instruments»Vision»Documentation»NI-IMAQ**.
5. **(Optional) NI Vision Development Module**—Refer to the *NI Vision Development Module Readme* on the NI Vision Development Module installation media for system requirements and installation instructions.

   Documentation for the NI Vision Development Module is available by selecting **Start» All Programs»National Instruments»Vision»Documentation»NI Vision**.

Install the Device, Accessories, and Cables

This section describes how to unpack and install the NI 1473R. You must install the software before installing the hardware.

Unpacking

The NI 1473R ships in an antistatic package to prevent electrostatic discharge from damaging device components. To avoid such damage in handling your device, take the following precautions:

- Ground yourself using a grounding strap or by touching a grounded object, such as the computer chassis.
- Touch the antistatic package to a metal part of the computer chassis before removing the device from the package.

Caution *Never* touch the exposed pins of connectors.

Remove the device from the package and inspect it for loose components or any other signs of damage. Notify National Instruments if the device appears damaged in any way. Do *not* install a damaged device in the computer.

Store the NI 1473R in the antistatic package when not in use.

Installing

The following instructions are for general installation. Refer to the documentation provided by your computer manufacturer for specific instructions and warnings.

Note You must install the software before installing the hardware.

1. Power off and unplug the computer.

Caution To protect yourself and the computer from electrical hazards, the computer *must* remain unplugged until the installation is complete.

2. Remove the computer cover to expose the expansion slots.

Caution Installing a PCIe device into any non-PCIe slot can damage both the computer motherboard and the device. If you are unsure of the difference between connector types, do *not* install the device. Refer to the documentation provided by your computer manufacturer to determine the correct slot in which to install the NI 1473R.

3. Touch a metal part of the computer to discharge any static electricity that might be on your clothes or body. Static electricity can damage the device.
4. Choose an unused x4 or larger PCIe slot, and remove the corresponding expansion slot cover on the back panel of the computer.

Note The NI 1473R is intended for a x4 PCIe slot. The NI 1473R will not fit properly into a x1 PCIe slot. The NI 1473R will fit into, and can be used in, a x8 or x16 PCIe slot. Using a smaller width device in a larger width slot is called up-plugging. When up-plugging, some motherboards only support plug-in devices at the x1 data rate. If you plan to use the NI 1473R in an up-plugging configuration with PCIe requirements faster than 200 MB/s, verify with the computer manufacturer that the motherboard will support a x4 plug-in device at a x4 data rate in the PC expansion slot you plan to use.

5. Remove your device from the antistatic package and gently rock the device into the slot. The connection may be tight, but do *not* force the device into place.

Note Check that the bracket of your device aligns up with the hole in the back panel rail of the computer chassis.

6. Secure the device mounting bracket to the back panel rail of the computer.

Note If you will be using the NI Camera Link I/O Extension Board (PCIe), refer to the *NI Camera Link I/O Extension Board (PCIe) User Guide* for installation instructions.

7. Replace the computer cover.
8. Connect the 26-pin MDR Camera Link cable(s) to the Camera Link camera. Refer to the camera manufacturer documentation for specific instructions about how to connect the cable to your camera.
9. Connect the Camera Link cable to the Camera Link connector on the NI 1473R front panel.
10. Plug in and power on the computer.

The NI 1473R is now installed and the camera is now connected.

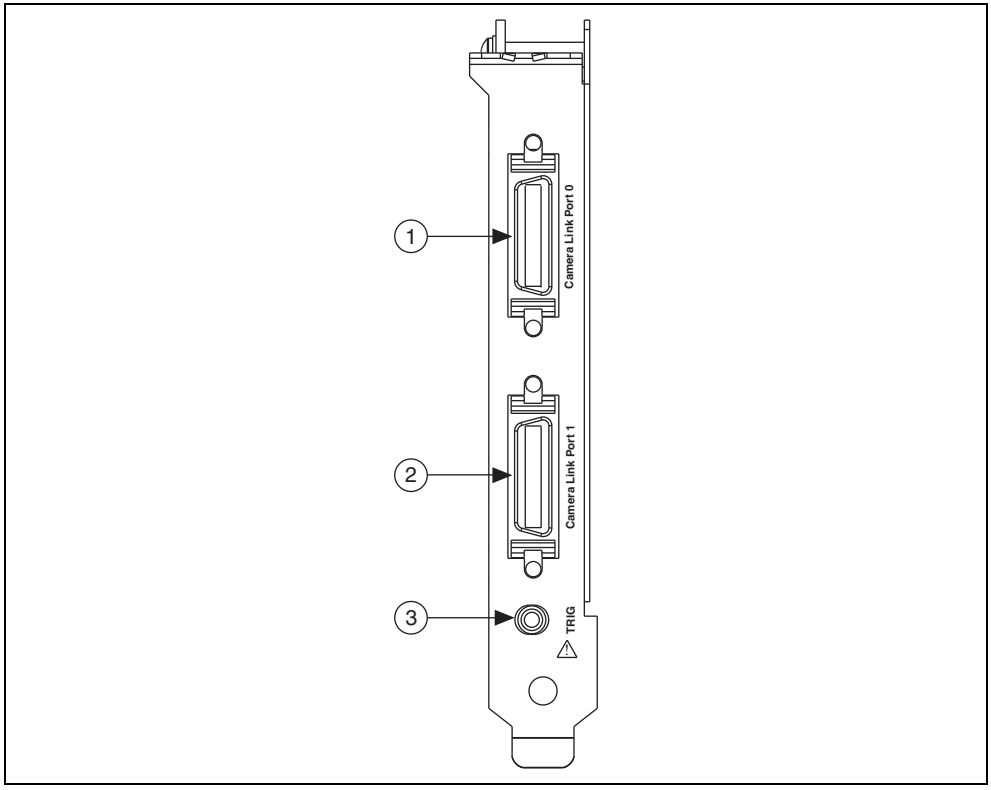
Confirming the Device is Recognized

To confirm that the device is recognized, complete the following steps:

1. Select **Start»All Programs»National Instruments»Measurement & Automation** to open Measurement & Automation Explorer (MAX).
2. Expand **Devices and Interfaces**.
3. Verify that the device appears under **Devices and Interfaces»RIO Devices**.

Signal Connections

The following figure shows the connectors on the NI 1473R.



1	Port 0—Base Camera Link MDR Connector	3	SMB Trigger Connector
2	Port 1—Medium/Full Camera Link MDR Connector		

Figure 1. NI 1473R Connectors

MDR Connectors

Port 0 and Port 1 are 26-pin MDR connectors that provide reliable high-frequency transfer rates between the camera and the NI 1473R.

- For Base configuration cameras, connect one 26-pin MDR Camera Link cable to Port 0 on the NI 1473R.
- For Medium, Full, or Extended Full configuration cameras, connect one 26-pin MDR Camera Link cable to Port 0 and one 26-pin MDR cable to Port 1 on the NI 1473R.

Figure 2 shows the Base configuration 26-pin MDR connector, which is labeled Port 0 on the NI 1473R. Refer to Table 1 for a description of the signals.

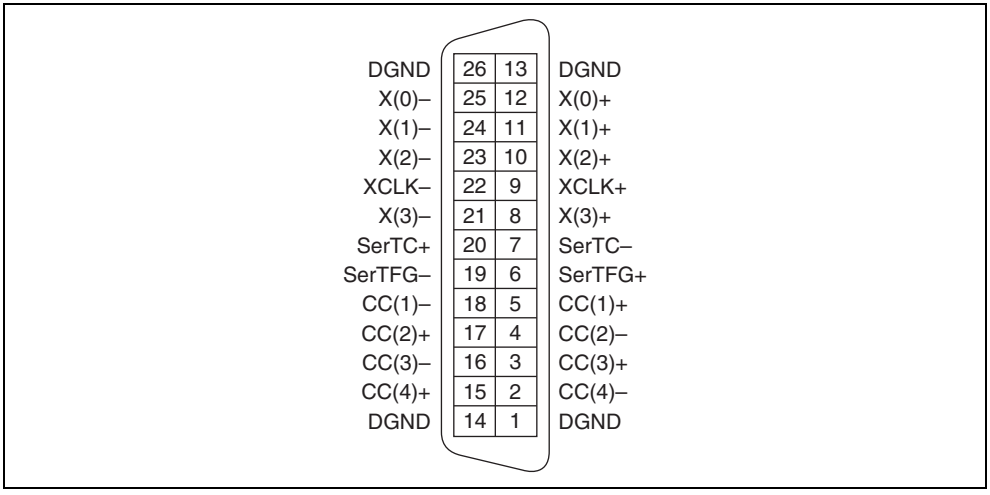


Figure 2. NI 1473R Base Configuration MDR Connector Pin Assignments

Table 1. NI 1473R Base Configuration MDR Signal Descriptions

Signal Name	Description
X<3..0>±	Base configuration data and enable signals from the camera to the NI 1473R.
XCLK±	Transmission clock on the Base configuration chip for Camera Link communication between the NI 1473R and the camera.
SerTC±	Serial transmission to the camera from the NI 1473R.
SerTFG±	Serial transmission to the NI 1473R from the camera.
CC<4..1>±	Four LVDS pairs, defined as camera inputs and NI 1473R outputs, reserved for camera control. On some cameras, the camera controls allow the NI 1473R to control exposure time and frame rate.

Figure 3 shows the Medium/Full configuration 26-pin MDR connector, which is labeled Port 1 on the NI 1473R. Refer to Table 2 for a description of the signals.

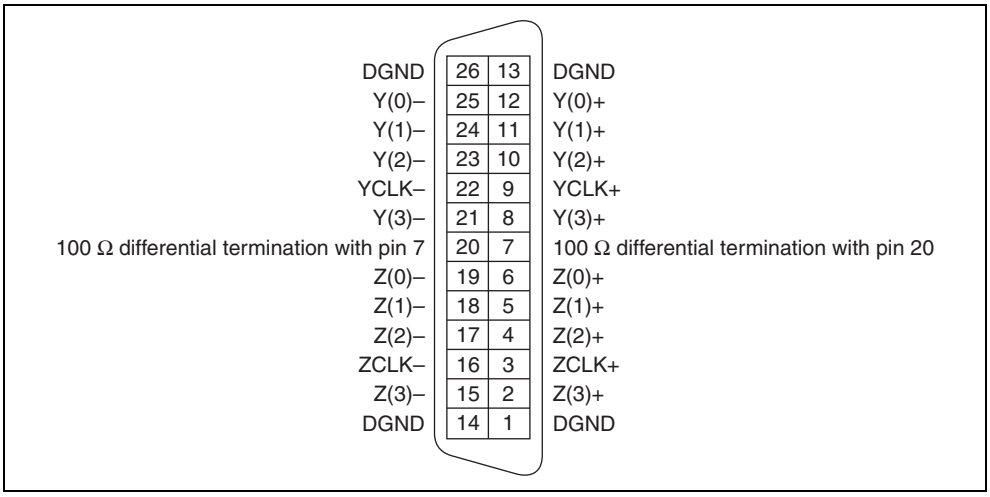


Figure 3. NI 1473R Medium/Full Configuration MDR Connector Pin Assignments

Table 2. NI 1473R Medium/Full Configuration MDR Signal Descriptions

Signal Name	Description
Y<3..0>±	Medium configuration data and enable signals from the camera to the NI 1473R.
YCLK±	Transmission clock on the Medium configuration chip for Camera Link communication between the NI 1473R and the camera.
Z<3..0>±	Full configuration data and enable signals from the camera to the NI 1473R.
ZCLK±	Transmission clock on the Full configuration chip for Camera Link communication between the NI 1473R and the camera.

SMB Connector

The SMB connector can be used for front panel trigger connectivity. It can be used as a 5 V input to trigger acquisitions or as a 5 V output to provide status information to your system. For further triggering and DIO needs, use the NI Camera Link I/O Extension Board (PCIe). The I/O Extension Board provides three differential isolated inputs, three isolated outputs, eight TTL inputs/outputs, and quadrature encoder inputs.

Hardware Block Diagram

The following block diagram illustrates the key functional components of the NI 1473R.

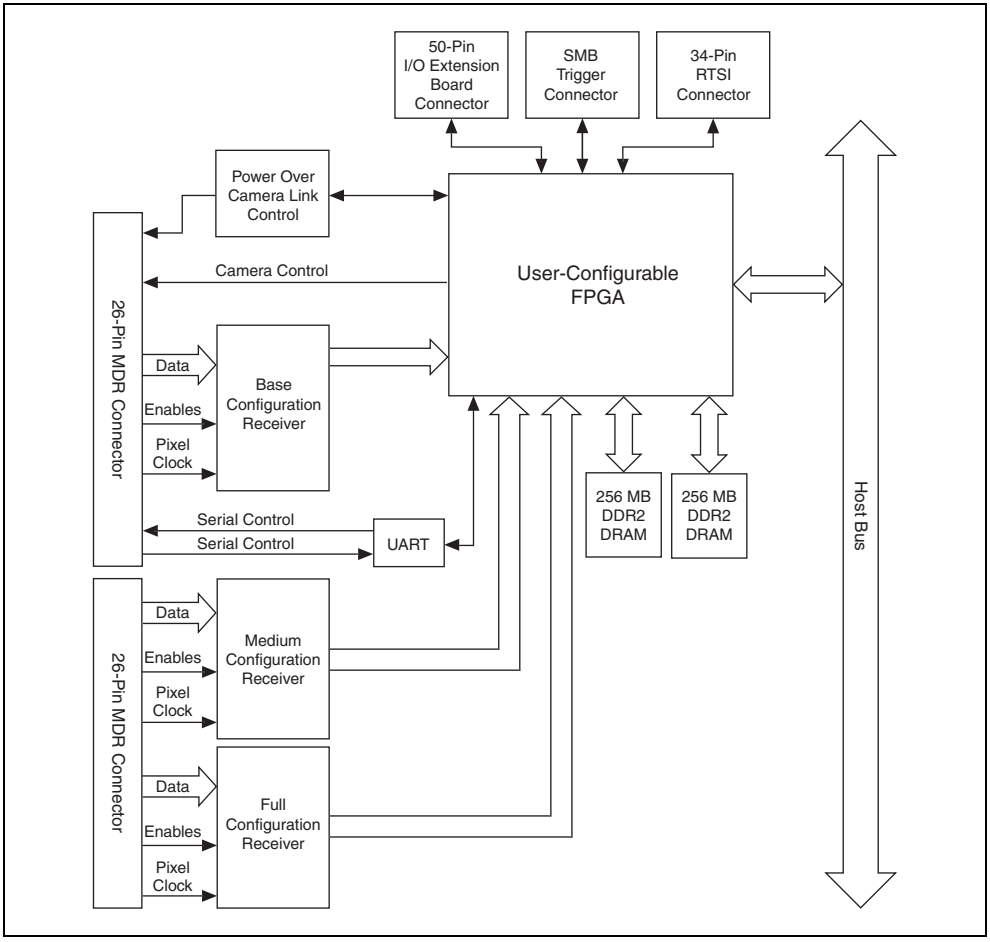


Figure 4. NI 1473R Block Diagram

Specifications

This section lists specifications for the NI PCIe-1473R. These specifications are typical at 25 °C, unless otherwise stated.

Features

Supported camera standard.....Camera Link 1.2

Supported configurations.....Base, Medium, Full, Extended Full

Camera connectors.....Two 26-pin MDR

PCI Express Interface

PCI Express compliance 1.1

Native link width.....x4

Up-plugging availability x8, x16

Note Some system devices limit data transfer rates for plug-in devices in an up-plugging configuration. Refer to the documentation provided by the computer manufacturer to determine if your computer will support a x4 plug-in device at a x4 data rate in a larger slot.

Reconfigurable FPGA

FPGA type Virtex-5 LX50

Number of flip-flops 19,200

Number of 6-input LUTs 19,200

Number of DSP48 slices.....48
(25 × 18 multipliers)

Embedded block RAM .....1,728 kbits

Trigger Characteristics

Number of external trigger I/O lines.....1

Trigger input

Voltage range .....0 to 5 V (TTL)

Input high voltage .....2.0 V

Input low voltage .....0.8 V

Trigger output

Voltage range .....0 to 5 V (TTL)

Output high voltage.....3.06 V at 3 mA source

Output low voltage.....0.55 V at 3 mA sink

Maximum pulse rate .....2 MHz

Clocks

Pixel clock frequency range.....20 MHz to 85 MHz[1]

Note The Camera Link specification requires cameras to transmit at a minimum of 20 MHz.

Serial Interface

Baud rates supported.....9.6, 19.2, 38.4, 57.6, 115.2, 230.4, 460.8, or 921.6 kbps

Power Requirements

Voltage .....+3.3 V (1.5 A)
+12 V (1.25 A)

[1] This value corresponds to the serialized Camera Link cable transmission rate of 140 to 595 MHz.

Power Over Camera Link (PoCL)

Voltage ..... 12 V nominal

Average power output ..... 4 W maximum

SafePower ..... Supported

Physical Characteristics

Dimensions ..... 10.7 cm × 17.5 cm
(4.2 in. × 6.9 in.)

Weight ..... 205 g (7.23 oz)

Environment

The NI 1473R is intended for indoor use only.

Operating Environment

Operating temperature ..... 0 °C to 45 °C
Tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

Relative humidity range ..... 10% to 90%, noncondensing
Tested in accordance with IEC-60068-2-56.

Altitude ..... 2,000 m at 25 °C ambient temperature

Pollution Degree 2

Storage Environment

Ambient temperature range ..... –20 °C to 70 °C
Tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

Relative humidity range ..... 5% to 95%, noncondensing
Tested in accordance with IEC-60068-2-56.

Note Clean the device with a soft, non-metallic brush. Make sure the device is completely dry and free from contaminants before returning it to service.

Safety

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 (IEC 61326): 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-001: Class A emissions

Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

Note For EMC compliance, operate this device with shielded cables and according to the documentation.

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

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.

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 *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 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 from Here

The following documents and resources contain information you may find helpful as you set up and use the NI 1473R in an application.

- LabVIEW FPGA documentation:
  - *FPGA Module* book in the *LabVIEW Help*—Select **Help»LabVIEW Help** in LabVIEW to view the *LabVIEW Help*. Browse the **FPGA Module** book in the **Contents** tab for information about how to use the FPGA Module to create VIs that run on FPGA targets.
  - *LabVIEW FPGA Module Release and Upgrade Notes*—Contains information about installing the LabVIEW FPGA Module, describes new features, and provides upgrade information. To access this document, refer to `ni.com/manuals`. You can also view the LabVIEW Manuals directory that contains this document by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals**.
- *National Instruments Example Finder*—LabVIEW contains an extensive library of VIs and example programs for use with FPGA targets. To access the NI Example Finder, open LabVIEW and select **Help»Find Examples**.

  You can also access device-specific examples by selecting **Add device** from the **Hardware** pull-down menu in the NI Example Finder window.
- *LabVIEW FPGA IPNet*—Offers resources for browsing, understanding, and downloading LabVIEW FPGA functions or IP (intellectual property). Use this resource to acquire IP that you need for your application, download examples to help learn programming techniques, and explore the depth of IP offered by the LabVIEW FPGA platform. To access the LabVIEW FPGA IPNet, visit `ni.com/ipnet`.

Visit the NI Developer Zone at `ni.com/zone` for the latest example programs, tutorials, technical presentations, and a community area where you can share ideas, questions, and source code with developers around the world.

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.

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`.

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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