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NI Vision

NI PCIe-1433 User Manual and Specifications

Base, Medium, and Full Configuration Camera Link Frame Grabber

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While this hardware is compliant with the applicable regulatory EMC requirements, there is no guarantee that interference will not occur in a particular installation. To minimize the potential for the hardware to cause interference to radio and television reception or to experience unacceptable performance degradation, install and use this hardware in strict accordance with the instructions in the hardware documentation and the DoC[1].

If this hardware does cause interference with licensed radio communications services or other nearby electronics, which can be determined by turning the hardware off and on, you are encouraged to try to correct the interference by one or more of the following measures:

- Reorient the antenna of the receiver (the device suffering interference).
- Relocate the transmitter (the device generating interference) with respect to the receiver.
- Plug the transmitter into a different outlet so that the transmitter and the receiver are on different branch circuits.

Some hardware may require the use of a metal, shielded enclosure (windowless version) to meet the EMC requirements for special EMC environments such as, for marine use or in heavy industrial areas. Refer to the hardware's user documentation and the DoC[1] for product installation requirements.

When the hardware is connected to a test object or to test leads, the system may become more sensitive to disturbances or may cause interference in the local electromagnetic environment.

Operation of this hardware in a residential area is likely to cause harmful interference. Users are required to correct the interference at their own expense or cease operation of the hardware.

Changes or modifications not expressly approved by National Instruments could void the user's right to operate the hardware under the local regulatory rules.

[1] The Declaration of Conformity (DoC) contains important EMC compliance information and instructions for the user or installer. To obtain 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.

Conventions

The following conventions are used in this manual:

<>	Angle brackets that contain numbers separated by an ellipsis represent a range of values associated with a bit or signal name—for example, AO <3..0>.
»	The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.
	This icon denotes a note, which alerts you to important information.
bold	Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.
italic	Italic text denotes variables, emphasis, a cross-reference, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.
`monospace`	Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.

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1 Introduction

The NI PCIe-1433 (NI 1433) is an image acquisition device that supports Base, Medium, Full, and Extended Full configuration Camera Link-compatible cameras. The NI 1433 acquires digital images in real time and transfers them directly to system memory. Featuring a high-speed data path, the NI 1433 is ideal for both industrial and scientific environments.

The NI 1433 is easy to install and configure. It ships with NI-IMAQ, the National Instruments driver software that is used to directly control the NI 1433 and other National Instruments image acquisition devices. With NI-IMAQ, you can start your applications without having to program the device at the register level. Refer to *Getting Started with the NI PCIe-1433* for information about installing the NI 1433.

Camera files configure the NI 1433 with information about the output format of your camera. Camera files validated by National Instruments are installed with the NI-IMAQ driver software. Additional camera files are available for download from the National Instruments Industrial Camera Advisor Web site at `ni.com/camera`.

The 26-pin MDR connectors on the NI 1433 provide the connection to Camera Link-compatible cameras. For further configuration information, refer to the *Camera Link and the NI 1433* section of Chapter 2, *Hardware Overview*.

The NI 1433 has one I/O line on its front panel. Additional I/O lines for advanced triggering, pulse-train outputs, and isolated DIO are available with the NI Camera Link I/O Extension Board (PCIe). The I/O Extension Board also can be used for interfacing to a quadrature encoder. Refer to the *NI Camera Link I/O Extension Board (PCIe) User Guide* for information about the I/O Extension Board.

For more advanced digital or analog system triggering or digital I/O lines, you can use the NI 1433 and NI-IMAQ with the National Instruments Data Acquisition (DAQ) or Motion Control product lines.

Synchronizing several functions to a common trigger or timing event can be a challenge with image acquisition devices. The NI 1433 uses the Real-Time System Integration (RTSI) bus to synchronize multiple devices,

such as data acquisition and motion control devices. The RTSI bus uses the National Instrument RTSI bus interface and ribbon cable to route additional timing and trigger signals between the NI 1433 and up to four National Instruments DAQ, Motion Control, or Vision devices. The RTSI bus also can synchronize multiple image acquisition devices to perform simultaneous captures.

Refer to Appendix A, *Specifications* for detailed specifications of the NI 1433.

Camera Link

This section provides a brief overview of the Camera Link standard. Refer to the *Specifications of the Camera Link Interface Standard for Digital Cameras and Frame Grabbers* manual for more detailed information about Camera Link specifications. This manual is available on several Web sites, including the Automated Imaging Association site at `www.machinevisiononline.org`.

Overview

Developed by a consortium of camera and image acquisition device manufacturers, Camera Link is a standard for interfacing digital cameras with image acquisition devices. Camera Link simplifies connectivity between the image acquisition device and the camera by defining a single standard connector for both. This standard ensures physical compatibility of devices bearing the Camera Link logo.

The basis for the Camera Link standard is the National Semiconductor Channel Link chipset, a data transmission method consisting of a general-purpose transmitter/receiver pair. The Channel Link driver takes 28 bits of parallel digital data and a clock and serializes the stream to four LVDS (EIA-644) data streams and an LVDS clock, providing high-speed data transmission across 10 wires and over distances of up to 10 m.

Power Over Camera Link

The NI 1433 supports Power over Camera Link (PoCL). PoCL is an extension to the Camera Link standard that allows frame grabbers to power cameras through the Camera Link cable. PoCL uses standard Camera Link connectors and is backwards compatible with existing Camera Link equipment.

Note Because the power available through Camera Link cables is limited, PoCL is not sufficient for high-performance cameras.

SafePower

The NI 1433 supports PoCL SafePower. SafePower is a protocol that prevents the frame grabber from attempting to supply power to a conventional (non-PoCL) camera or through a conventional cable.

Software Overview

Programming the NI 1433 requires the NI-IMAQ driver software to control the hardware. National Instruments also offers the following application software packages for analyzing and processing your acquired images.

- **NI Vision Builder for Automated Inspection**—Allows you to configure solutions to common inspection tasks.
- **NI Vision Development Module**—Provides customized control over hardware and algorithms.

The following sections provide an overview of the driver and application software. For detailed information about individual software packages, refer to the documentation specific to each software package.

NI-IMAQ Driver Software

The NI 1433 ships with NI Vision Acquisition Software, which includes the NI-IMAQ driver software. NI-IMAQ has an extensive library of functions—such as routines for video configuration, continuous and single shot image acquisition, memory buffer allocation, trigger control, and device configuration—you can call from the application development environment (ADE). NI-IMAQ handles many of the complex issues between the computer and the image acquisition device, such as programming interrupts and camera control.

NI-IMAQ performs all functions required for acquiring and saving images but does not perform image analysis. Refer to the *National Instruments Application Software* section for image analysis functionality.

NI-IMAQ also provides the interface between the NI 1433 and LabVIEW, LabWindows™/CVI™, or a text-based programming environment. The NI-IMAQ software kit includes a series of libraries for image acquisition for LabVIEW, LabWindows/CVI, and Measurement Studio, which contains libraries for .NET.

NI-IMAQ features both high-level and low-level functions. Examples of high-level functions include the sequences to acquire images in multi-buffer, single-shot, or continuous mode. An example of a low-level function is configuring an image sequence, since it requires advanced understanding of image acquisition.

National Instruments Application Software

This section describes the National Instruments application software packages you can use to analyze and process the images you acquire with the NI 1433.

Vision Builder for Automated Inspection

NI Vision Builder for Automated Inspection (Vision Builder AI) is configurable machine vision software that you can use to prototype, benchmark, and deploy applications. Vision Builder AI does not require programming, but is scalable to powerful programming environments.

Vision Builder AI allows you to easily configure and benchmark a sequence of visual inspection steps, as well as deploy the visual inspection system for automated inspection. With Vision Builder AI, you can perform powerful visual inspection tasks and make decisions based on the results of individual tasks. You also can migrate the configured inspection to LabVIEW, extending the capabilities of the applications if necessary.

Vision Development Module

NI Vision Development Module, which consists of NI Vision and NI Vision Assistant, is an image acquisition, processing, and analysis library for the following common machine vision tasks:

- Pattern matching
- Particle analysis
- Gauging
- Taking measurements
- Grayscale, color, and binary image display

You can use the Vision Development Module functions individually or in combination. With the Vision Development Module, you can acquire, display, and store images, as well as perform image analysis and processing. Using the Vision Development Module, imaging novices and experts can program the most basic or complicated image applications without knowledge of particular algorithm implementations.

As a part of the Vision Development Module, NI Vision Assistant is an interactive prototyping tool for machine vision and scientific imaging developers. With Vision Assistant, you can prototype vision applications quickly and test how various image processing functions work.

Vision Assistant generates a Builder file, which is a text description containing a recipe of the machine vision and image processing functions. This Builder file provides a guide you can use for developing applications in any ADE, such as LabWindows/CVI or Visual Basic, using the Vision Assistant machine vision and image processing libraries. Using the LabVIEW VI creation wizard, Vision Assistant can create LabVIEW VIs that perform the prototype you created in Vision Assistant. You can then use LabVIEW to add functionality to the generated VI.

Integration with DAQ and Motion Control

Platforms that support NI-IMAQ also support NI-DAQ and a variety of National Instruments data acquisition (DAQ) devices. This allows for integration between image acquisition and DAQ devices.

Use National Instruments high-performance stepper and servo motion control products with pattern matching software in inspection and guidance applications, such as locating alignment markers on semiconductor wafers, guiding robotic arms, inspecting the quality of manufactured parts, and locating cells.

2

Hardware Overview

This chapter provides an overview of NI 1433 hardware functionality and explains the operations of the functional units on the device.

Functional Overview

The NI 1433 features a flexible, high-speed data path optimized for receiving and formatting video data from Camera Link cameras.

The following block diagram illustrates the key functional components of the NI 1433.

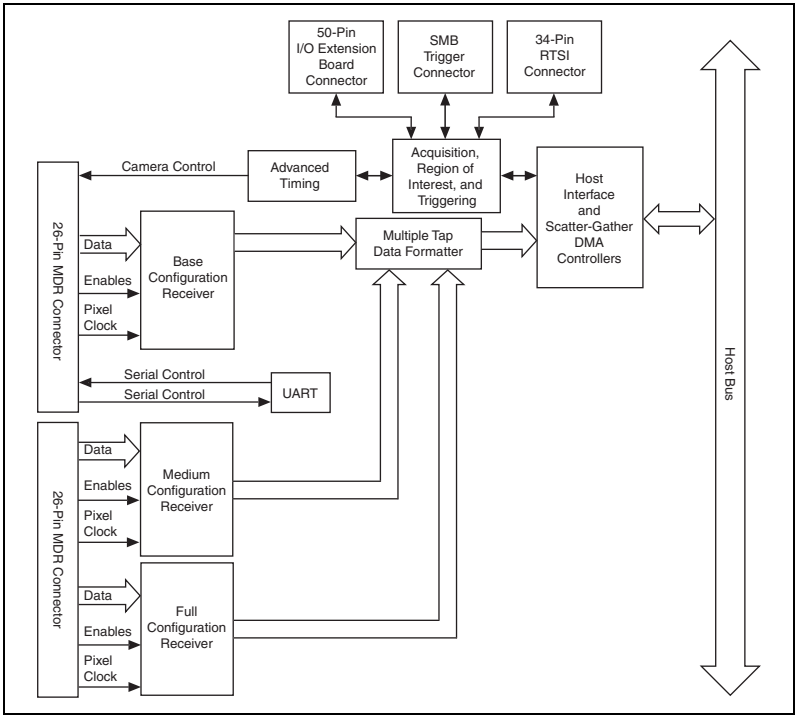


Figure 2-1. NI 1433 Block Diagram

Camera Link and the NI 1433

The NI 1433 supports Camera Link Base, Medium, Full, and Extended Full configurations.

The Camera Link specifications include up to 64 data bits, enable signals, and asynchronous serial transmission, as well as four digital camera control lines for controlling exposure time, frame rates, and other camera control signals. The four control lines are configured in the camera file to generate precise timing signals for controlling digital camera acquisition.

Note Extended Full configurations support up to 80 bits of data.

The Camera Link standard defines physical connections between image acquisition devices and Camera Link cameras, and it allows for flexibility of image format and data transfer protocols. The camera manufacturer defines image parameters, such as image resolution and the number of bits per pixel, and camera control parameters, such as frame-on-demand and exposure control signals.

These variable parameters are defined on a per-camera basis in a camera file (`camera_model.icd`) supplied by National Instruments. NI-IMAQ uses the information in this camera file to program the NI 1433 to acquire images from a specific camera. Without this camera file, the driver does not have the information necessary to configure the NI 1433 to recognize the image format of the particular camera you are using.

The three Camera Link configurations have the following bit allocations and number of taps:

Table 2-1. Camera Link Bit Allocations and Taps

	Base Configuration	Medium Configuration	Full Configuration
Bit Allocation and Taps	8-bit × 1, 2, or 3 taps (pixels) 10-bit × 1 or 2 taps 12-bit × 1 or 2 taps 14-bit × 1 tap 16-bit × 1 tap 24-bit RGB	8-bit × 4 taps 10-bit × 3 or 4 taps 12-bit × 3 or 4 taps 30-bit RGB 36-bit RGB	8-bit × 8 taps

Medium, Full, and Extended Full configurations require using both connectors. These configurations allow for more data throughput by offering multiple synchronized data channels between the camera and the NI 1433.

Hardware Binarization

The NI 1433 supports binarization and inverse binarization. Binarization and inverse binarization segment an image into two regions: a particle region and a background region. Use binarization and inverse binarization to isolate objects of interest in an image.

To separate objects under consideration from the background, select a pixel value range. This pixel value range is known as the gray-level interval, or the threshold interval. Binarization works by setting all image pixels that fall within the threshold interval to the image white value and setting all other image pixels to 0. Pixels inside the threshold interval are considered part of the particle region. Pixels outside the threshold interval are considered part of the background region.

Inverse binarization flips the assigned bit numbers of the particle region and the background region. Thus, all pixels that belong in the threshold interval, or the particle region, are set to 0, and all pixels outside the threshold interval, or the background region, are set to the image white value.

The following figure illustrates binarization and inverse binarization.

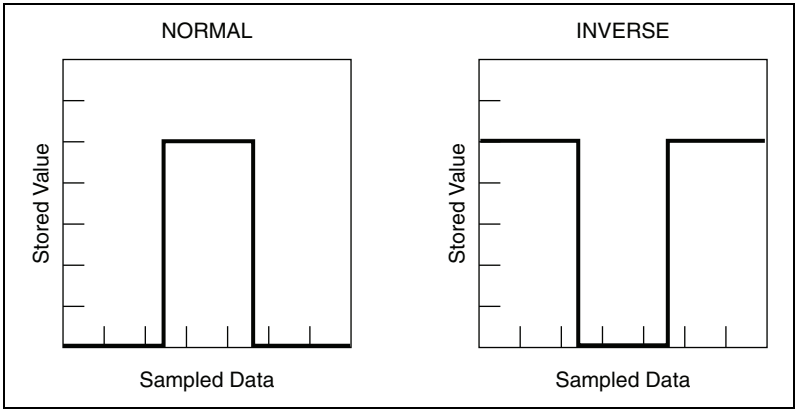


Figure 2-2. Binarization and Inverse Binarization

Multiple-Tap Data Formatter

Many digital cameras transfer multiple taps, or pixels, of data simultaneously to increase the frame rate of the camera. However, the data in each tap may not be transferred in the traditional top-left to bottom-right direction. Also, the taps may not transfer data in the same direction.

The multiple-tap data formatting circuitry on the NI 1433 can reorder the data from multiple taps. The data from each tap can be independently scanned either from left-to-right or right-to-left and top-to-bottom or bottom-to-top.

Note Data reformatting instructions for cameras have been preprogrammed into the camera files.

Trigger Control and Mapping Circuitry

The trigger control and mapping circuitry routes, monitors, and drives the external and RTSI bus trigger lines. You can configure each trigger line to start an acquisition on a rising edge or a falling edge. You also can drive each line asserted or unasserted as a digital I/O line. You can map pulses from the high-speed timing circuitry or the NI 1433 status signals to these trigger lines. Seven RTSI bus triggers and one external trigger—all of which are programmable for polarity and direction—are available for simultaneous use. Additional I/O is available with the NI Camera Link I/O Extension Board (PCIe).

Noise Filtering

Noise filtering is available for all TTL inputs and RTSI inputs. Refer to the *NI-IMAQ VI Reference Help* or the *NI-IMAQ Function Reference Help* for more information about noise filtering.

Quadrature Encoder Support

The NI 1433 supports RS-422 and singled-ended phase signal decoding from a quadrature encoder. The Phase A and Phase B outputs from the quadrature encoder can be interfaced with the NI 1433 through the NI Camera Link I/O Extension Board (PCIe).

Refer to the *Connecting to a Quadrature Encoder* section of the *NI Camera Link I/O Extension Board (PCIe) User Guide* for more information on connecting to and using onboard quadrature counters.

The NI 1433 provides a 64-bit counter to maintain a precise record of an absolute position determined by the encoder inputs. To generate a pulse train that is based on positional ticks, you can set a unique divide down factor. This pulse train is commonly used as a trigger for a line scan camera when performing a web inspection. The NI 1433 also supports querying the absolute position counter value.

Noise Filtering

Noise filtering is available for the Phase A and Phase B encoder inputs. Refer to the *NI-IMAQ VI Reference Help* or the *NI-IMAQ Function Reference Help* for more information about noise filtering.

High-Speed Timing

Built from high-speed counters, the timing circuitry on the NI 1433 can generate precise real-time control signals for your camera. Map the output of this circuitry to a trigger line to provide accurate pulses and pulse trains. Use these control signals to control exposure time and frame rate.

Note The external control for cameras has been preprogrammed into the camera file. You can use Measurement & Automation Explorer (MAX) to specify the frequency and duration of these signals in easy-to-use units.

Acquisition and Region of Interest (ROI)

The acquisition and ROI circuitry monitors incoming video signals and routes the active pixels to the multiple-tap data formatter. The NI 1433 can perform ROI acquisitions on all video lines and frames. In an ROI acquisition, select an area within the acquisition window to transfer across the host bus to system memory. If the area of the image you need is smaller than the camera output that appears in the acquisition window, selecting an ROI speeds up the transfer and processing times for the image.

Note You can use MAX to set the acquisition and ROI parameters.

Acquisition Window Control

You can configure the following parameters on the NI 1433 to control the video acquisition window:

- **Acquisition window**—The NI 1433 allows you to specify a particular region of active pixels and active lines within the incoming video data. The active pixel region selects the starting pixel and number of pixels to be acquired relative to the assertion edge of the horizontal (or line)

enable signal from the camera. The active line region selects the starting line and number of lines to be acquired relative to the assertion edge of the vertical (or frame) enable signal.

- **Region of interest**—The NI 1433 uses a second level of active pixel and active line regions for selecting a region of interest. Using the region-of-interest circuitry, the device acquires only a selected subset of the acquisition window.

DMA Controllers

The NI 1433 uses onboard direct memory access (DMA) controllers to transfer data between the device and host memory. Each of these controllers supports scatter-gather DMA, which allows the DMA controller to reconfigure at runtime. The NI 1433 can perform continuous image transfers directly to either contiguous or fragmented memory buffers. The NI-IMAQ driver software efficiently programs the DMA engines while providing an easy-to-use high-level interface.

PCIe Interface

The NI 1433 is compliant with PCI Express 1.1 specifications. The NI 1433 is intended for a x4 PCIe slot. It does not fit properly into a x1 PCIe slot. However, the NI 1433 does 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 1433 in an up-plugging configuration, with a camera that produces data faster than 200 MB/s, verify with your computer manufacturer that your motherboard supports a x4 plug-in device at a x4 data rate in the PC expansion slot you plan to use.

Start Conditions

The NI 1433 can start acquisitions in the following ways:

- **Software control**—The NI 1433 supports software control of acquisition start. You can configure the NI 1433 to capture a fixed number of frames. Use this configuration for capturing a single frame or a sequence of frames.
- **Trigger control**—You can start an acquisition by enabling external or RTSI bus trigger lines. Each of these inputs can start a video acquisition on a rising edge or a falling edge.

Serial Interface

The NI 1433 provides serial communication to and from the camera through two LVDS pairs in the Camera Link cable. All Camera Link serial communication uses one start bit, one stop bit, no parity, and no hardware handshaking.

The NI 1433 supports all baud rates specified by the Camera Link specification. Refer to the *Serial Interface* section of Appendix A, *Specifications*, for a list of baud rates the NI 1433 supports.

You can use the serial interface interactively with MAX, `clsercon.exe`, or a manufacturer supplied camera control utility, or programmatically with LabVIEW, C, or .NET.

Interactively:

- **MAX**—Use MAX with a camera file containing preprogrammed commands. When an acquisition is initiated, the commands are sent to the camera.
- `clsercon.exe`—Use the National Instruments terminal emulator for Camera Link, `clsercon.exe`, if a camera file with preprogrammed serial commands does not exist for your camera. With `clsercon.exe`, you can still communicate serially with your camera. Access `clsercon.exe` from the `<NI-IMAQ>\bin` directory, where `<NI-IMAQ>` is the location NI-IMAQ is installed.
- **Manufacturer Supplied Camera Control Utility**—Camera manufacturers who are compliant with the Camera Link 1.1 or later specification provide a camera control utility which sends the appropriate serial commands for configuring your camera through the NI 1433 serial port.

Programmatically:

- **LabVIEW**—Use the serial interface programmatically, through calls to the NI-IMAQ driver using the IMAQ Serial Write VI and IMAQ Serial Read VI.
- **C**—Use the serial interface programmatically, through calls to the NI-IMAQ driver using the `imgSessionSerialWrite` and `imgSessionSerialRead` functions.
- **.NET**—Use the serial interface programmatically, through calls to the NI-IMAQ driver using the `ImaqSerialConnection` class.

Note `clsercon.exe` and all programmatic connection methods provide direct manual access of the NI 1433 serial port, and are not required for most users.

National Instruments also fully supports the recommended serial API described in the *Specifications of the Camera Link Interface Standard for Digital Cameras and Frame Grabbers* manual. This manual is available on several Web sites, including the Automated Imaging Association Web site at `www.machinevisiononline.org`.

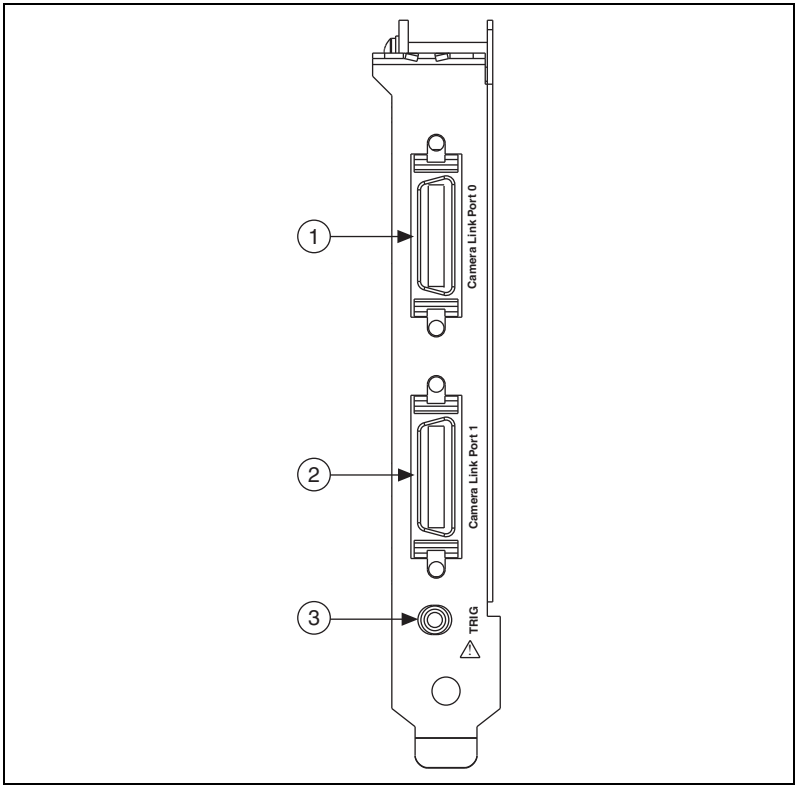
3

Signal Connections

This chapter describes connecting signals to the connectors on the NI 1433 and describes considerations for using the NI 1433 with the NI Camera Link I/O Extension Board (PCIe).

Connectors

The following figure shows the connectors on the NI 1433 device.



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

Figure 3-1. NI 1433 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 1433.

- For Base configuration cameras, connect one 26-pin MDR Camera Link cable to Port 0 on the NI 1433.
- 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 1433.

Refer to the *Cabling* section for additional information about Camera Link cables.

Figure 3-2 shows the Base configuration 26-pin MDR connector, which is labeled Port 0 on the NI 1433. Refer to Table 3-1 for a description of the signals.

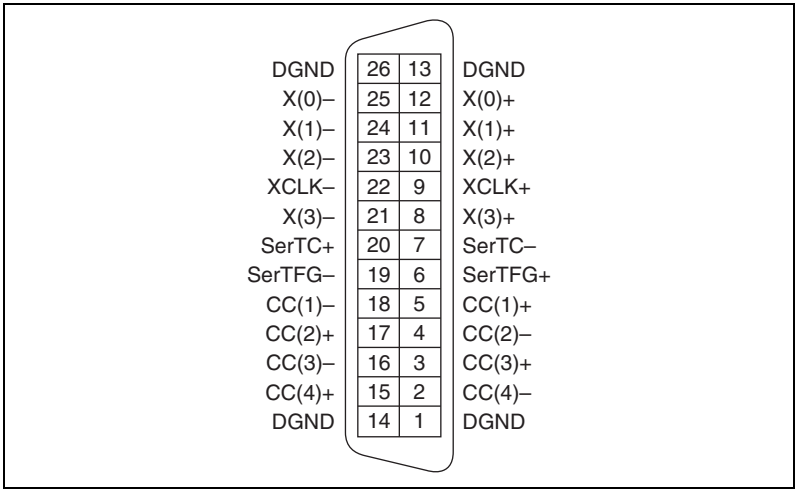


Figure 3-2. NI 1433 Base Configuration MDR Connector Pin Assignments

Table 3-1. NI 1433 Base Configuration MDR Signal Descriptions

Signal Name	Description
X<3..0>±	Base configuration data and enable signals from the camera to the NI 1433.
XCLK±	Transmission clock on the Base configuration chip for Camera Link communication between the NI 1433 and the camera.
SerTC±	Serial transmission to the camera from the NI 1433.

Table 3-1. NI 1433 Base Configuration MDR Signal Descriptions (Continued)

Signal Name	Description
SerTFG±	Serial transmission to the NI 1433 from the camera.
CC<4..1>±	Four LVDS pairs, defined as camera inputs and NI 1433 outputs, reserved for camera control. On some cameras, the camera controls allow the NI 1433 to control exposure time and frame rate.

Figure 3-3 shows the Medium/Full configuration 26-pin MDR connector, which is labeled Port 1 on the NI 1433. Refer to Table 3-2 for a description of the signals.

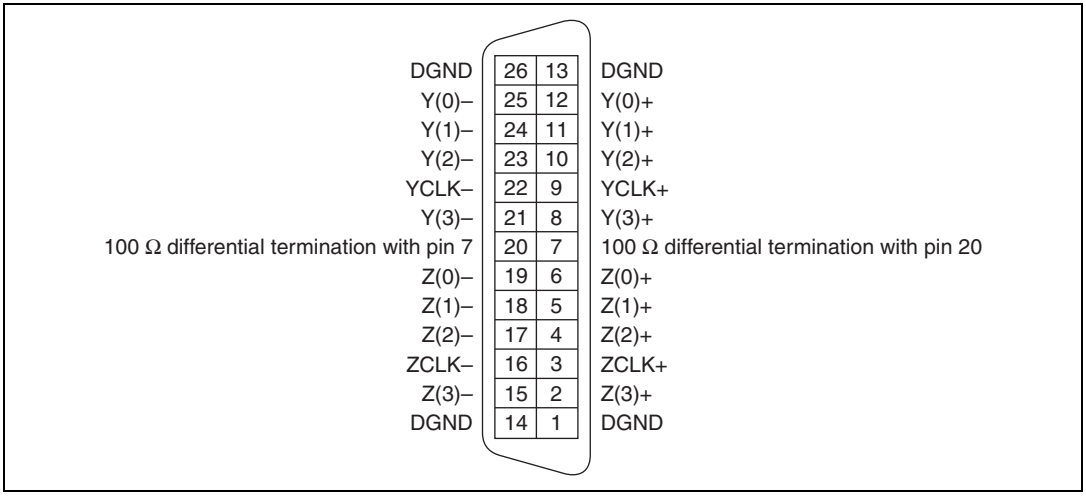


Figure 3-3. NI 1433 Medium/Full Configuration MDR Connector Pin Assignments

Table 3-2. NI 1433 Medium/Full Configuration MDR Signal Descriptions

Signal Name	Description
Y<3..0>±	Medium configuration data and enable signals from the camera to the NI 1433.
YCLK±	Transmission clock on the Medium configuration chip for Camera Link communication between the NI 1433 and the camera.
Z<3..0>±	Full configuration data and enable signals from the camera to the NI 1433.
ZCLK±	Transmission clock on the Full configuration chip for Camera Link communication between the NI 1433 and the camera.

Cabling

Use a standard Camera Link cable to connect your camera to the 26-pin MDR connector on the NI 1433 device. Camera Link cables consist of two MDR-26 male plugs linked with a twin-axial shielded cable and are available in two shell configurations.

National Instruments recommends that you use the following cables to connect your camera to the 26-pin MDR connectors on the NI 1433:

- MDR to MDR Camera Link cable (part number 199744A-05)
- MDR to SDR Camera Link cable (part number 199745A-05)

Note To ensure the high-speed signaling of the Camera Link interface, National Instruments recommends that you purchase a Camera Link cable rather than build a custom cable.

Refer to the *Specifications of the Camera Link Interface Standard for Digital Cameras and Frame Grabbers* manual for more information about Camera Link cables. This manual is available on several Web sites, including the Automated Imaging Association Web site at `www.machinevisiononline.org`.

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.

A

Specifications

This lists specifications for the NI PCIe-1433. 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.

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
- Polarity ..... Programmable, active high or active low

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
- Polarity .....Programmable, active high or active low

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)

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)

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

Environment

The NI 1433 is intended for indoor use only.

Operating Environment

Operating temperature..... 0 °C to 50 °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.

Shock and Vibration

Operational shock ..... 30 g peak, half-sine, 11 ms pulse
Tested in accordance with IEC-60068-2-27. Test profile developed in accordance with MIL-PRF-28800F.

Random vibration

Operating .....5 to 500 Hz, 0.3 grms

Nonoperating .....5 to 500 Hz, 2.4 grms
Tested in accordance with IEC-60068-2-64. Nonoperating test profile exceeds the requirements of MIL-PRF-28800F, Class 3.

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`.)

B

Technical Support and Professional Services

Visit the following sections of the award-winning National Instruments Web site at ni.com for technical support and professional services:

- **Support**—Technical support at ni.com/support includes the following resources:
  - **Self-Help Technical Resources**—For answers and solutions, visit ni.com/support for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on. Registered users also receive access to the NI Discussion Forums at ni.com/forums. NI Applications Engineers make sure every question submitted online receives an answer.
  - **Standard Service Program Membership**—This program entitles members to direct access to NI Applications Engineers via phone and email for one-to-one technical support as well as exclusive access to on demand training modules via the Services Resource Center. NI offers complementary membership for a full year after purchase, after which you may renew to continue your benefits.

    For information about other technical support options in your area, visit ni.com/services, or contact your local office at ni.com/contact.
- **Training and Certification**—Visit ni.com/training for self-paced training, eLearning virtual classrooms, interactive CDs, and Certification program information. You also can register for instructor-led, hands-on courses at locations around the world.
- **System Integration**—If you have time constraints, limited in-house technical resources, or other project challenges, National Instruments Alliance Partner members can help. To learn more, call your local NI office or visit ni.com/alliance.

- **Declaration of Conformity (DoC)**—A 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 electronic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting `ni.com/certification`.
- **Calibration Certificate**—If your product supports calibration, you can obtain the calibration certificate for your product at `ni.com/calibration`.

If you searched `ni.com` and could not find the answers you need, contact your local office or NI corporate headquarters. Phone numbers for our worldwide offices are listed at the front of this manual. You also can 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.

Glossary

A

acquisition window	The image size specific to a video standard or camera resolution.
active line region	The region of lines actively being stored. Defined by a line start (relative to the vertical synchronization signal) and a line count.
active pixel region	The region of pixels actively being stored. Defined by a pixel start (relative to the horizontal synchronization signal) and a pixel count.
API	Application programming interface.
area	A rectangular portion of an acquisition window or frame that is controlled and defined by software.

B

buffer	Temporary storage for acquired data.
bus	A group of conductors that interconnect individual circuitry in a computer, such as the PCI bus; typically the expansion vehicle to which I/O or other devices are connected.

C

Camera Link	Interface standard for digital video data and camera control based on the Channel Link chipset.
Channel Link	National Semiconductor chipset for high-speed data serialization and deserialization for transmission across cables up to 10 m.

D

DAQ	Data acquisition. (1) Collecting and measuring electrical signals from sensors, transducers, and test probes or fixtures and inputting them to a computer for processing. (2) Collecting and measuring the same kinds of electrical signals with A/D or DIO boards plugged into a computer, and possibly generating control signals with D/A and/or DIO boards in the same computer.
DMA	Direct memory access. A method by which data can be transferred to and from computer memory from and to a device or memory on the bus while the processor does something else; DMA is the fastest method of transferring data to/from computer memory.

F

frame grabber	A device that digitizes an image and stores it in a computer's memory.

H

handshaking	A type of protocol that makes it possible for two devices to synchronize operations.

L

LVDS	Low Voltage Differential Signaling (EIA-644).

N

NI-IMAQ	Driver software for National Instruments frame grabbers.
NI Vision Acquisition Software	A collection of driver software and utilities that acquire, display, save, and monitor images from any NI image acquisition device.

P

parity	Method of error checking. Ensures that there is always either an even number or an odd number of asserted bits in a byte, character, or word, according to the logic of the system. If a bit should be lost in data transmission, its loss can be detected by checking the parity
PCI	Peripheral Component Interconnect. A high-performance expansion bus architecture originally developed by Intel to replace ISA and EISA. PCI offers a theoretical maximum transfer rate of 133 Mbytes/s.
PCIe	PCI express. A high-performance expansion bus architecture originally developed by Intel to replace PCI. PCIe offers a theoretical maximum transfer rate that is dependent upon lane width. A x1 link theoretically provides 250 MB/s in each direction to and from the device. Once overhead is accounted for, a x1 link can provide up to 200 MB/s of input capability and 200 MB/s of output capability. Increasing the number of lanes in a link increases maximum throughput by approximately the same factor.
pixel	Picture element. The smallest division that makes up the video scan line; for display on a computer monitor, a pixel's optimum dimension is square (aspect ratio of 1:1, or the width equal to the height).
pixel clock	Divides the incoming horizontal video line into pixels.
protocol	The exact sequence of bits, characters, and control codes used to transfer data between computers and peripherals through a communications channel.

Q

quadrature encoder	A device that converts angular rotation into two pulse trains, A and B. The phase difference between A and B transmits information about the direction of rotation and the number of transitions indicates the amount of rotation.

R

real time	A property of an event or system in which data is processed as it is acquired instead of being accumulated and processed at a later time.

resolution	The smallest signal increment that can be detected by a measurement system. Resolution can be expressed in bits, in proportions, or in percent of full scale. For example, a system has 12-bit resolution, one part in 4,096 resolution, and 0.0244 percent of full scale.
RGB	Color encoding scheme using red, green, and blue (RGB) color information where each pixel in the color image is encoded using 32 bits: eight bits for red, eight bits for green, eight bits for blue, and eight bits for the alpha value (unused).
ROI	Region of interest. A hardware-programmable rectangular portion of the acquisition window.
RS-422	A robust, serial digital data interchange standard utilizing individual differential signal pairs for data transmission in each direction. Depending on data transmission rates, RS-422 can be used at distances to 4,000 ft (1,275 m).
RTSI bus	Real-Time System Integration Bus. The National Instruments timing bus that connects Vision and DAQ devices directly, by means of connectors on the devices, for precise synchronization of functions.

S

scatter-gather DMA	A type of DMA that allows the DMA controller to reconfigure on-the-fly.

T

tap	A stream of pixels from a camera. Some cameras send multiple streams, or taps, of data over a cable simultaneously to increase transfer rate.
transfer rate	The rate, measured in bytes/s, at which data is moved from source to destination after software initialization and set up operations. The maximum rate at which the hardware can operate.
trigger	Any event that causes or starts some form of data capture.

trigger control and mapping circuitry	Circuitry that routes, monitors, and drives external and RTSI bus trigger lines. You can configure each of these lines to start or stop acquisition on a rising or falling edge.
TTL	Transistor-transistor logic.

V

VI	Virtual Instrument. (1) A combination of hardware and/or software elements, typically used with a PC, that has the functionality of a classic stand-alone instrument. (2) A LabVIEW software module (VI), which consists of a front panel user interface and a block diagram program.

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