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NI Vision

NI PXI/PCI-1428 User Manual

High-Quality Camera Link Image Acquisition Device for PXI and PCI

February 2007
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National Instruments Corporate Headquarters

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Worldwide Offices

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Consult the FCC Web site at `www.fcc.gov` for more information.

FCC/DOC Warnings

This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual and the CE marking Declaration of Conformity*, may cause interference to radio and television reception. Classification requirements are the same for the Federal Communications Commission (FCC) and the Canadian Department of Communications (DOC).

Changes or modifications not expressly approved by NI could void the user's authority to operate the equipment under the FCC Rules.

Class A

Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user is required to correct the interference at their own expense.

Canadian Department of Communications

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

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* The CE marking Declaration of Conformity contains important supplementary information and instructions for the user or installer.

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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.
NI 1428	NI 1428 refers to the NI PXI/PCI-1428 interface device.

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1 Introduction

The NI PXI/PCI-1428 (NI 1428) is an image acquisition device that supports a diverse range of Camera Link-compatible cameras. The NI 1428 acquires digital images in real time and stores the images in onboard frame memory or transfers them directly to system memory. Featuring a high-speed data flow path, the NI 1428 is ideal for both industrial and scientific environments.

The NI 1428 is easy to install and configure. It ships with NI-IMAQ, the National Instruments complete image acquisition driver software you can use to directly control the NI 1428 and other National Instruments image acquisition hardware products. With NI-IMAQ, you can quickly and easily start your applications without having to program the device at the register level.

The NI 1428 supports the Camera Link Base configuration. The VHDCI 68-pin connector provides access to the 8-bit × 4 mode of the Camera Link Medium configuration. For further configuration information, refer to the *Camera Link and the NI 1428* section of Chapter 2, *Hardware Overview*.

The VHDCI 68-pin connector has four external input/output (I/O) lines you can use as triggers or as high-speed digital I/O lines.

For more advanced digital or analog system triggering or digital I/O lines, you can use the NI 1428 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 1428 uses the Real-Time System Integration (RTSI) bus to solve this problem.

The RTSI bus uses the National Instruments RTSI bus interface and ribbon cable to route additional timing and trigger signals between the PCI-1428 and up to four National Instruments DAQ, motion control, or image acquisition devices. The RTSI bus can also synchronize multiple image acquisition hardware captures. The RTSI bus is integrated into the PXI system's backplane for the NI PXI-1428.

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For detailed specifications of the NI 1428, refer to *Getting Started with the NI PXI/PCI-1428*.

Camera Link

This section provides a brief overview of the Camera Link standard. For more detailed information about Camera Link specifications, refer to 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 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.

Software Overview

Programming the NI 1428 requires the NI-IMAQ driver software for controlling 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.

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

NI-IMAQ Driver Software

The NI-IMAQ driver software ships with the NI 1428. 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. For image analysis functionality, refer to the *National Instruments Application Software* section.

NI-IMAQ is also the interface path between the NI 1428 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 Microsoft Visual Basic.

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 the image acquisition device and 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 1428.

Vision Builder for Automated Inspection

NI Vision Builder for Automated Inspection (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.

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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 Builder AI is available for LabVIEW, LabWindows/CVI, and Measurement Studio, which includes support for Microsoft Visual Basic.

Vision Development Module

The Vision Development Module is an image acquisition, processing, and analysis library of more than 270 functions 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.

NI Vision Assistant is included with the Vision Development Module. 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 vision 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 VI diagrams that perform the prototype you created in Vision Assistant. You can then use LabVIEW to add functionality to the generated VI.

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Integration with DAQ

Platforms that support NI-IMAQ also support NI-DAQ and a variety of National Instruments DAQ boards. This allows integration between image acquisition devices and National Instruments DAQ products.

Vision and Motion

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.

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2

Hardware Overview

This chapter provides an overview of NI 1428 hardware functionality and explains the operations of the NI 1428 functional units.

Functional Overview

The NI 1428 features a flexible, high-speed data path optimized for receiving and formatting video data from Camera Link cameras.

Figure 2-1 illustrates the key functional components of the NI 1428.

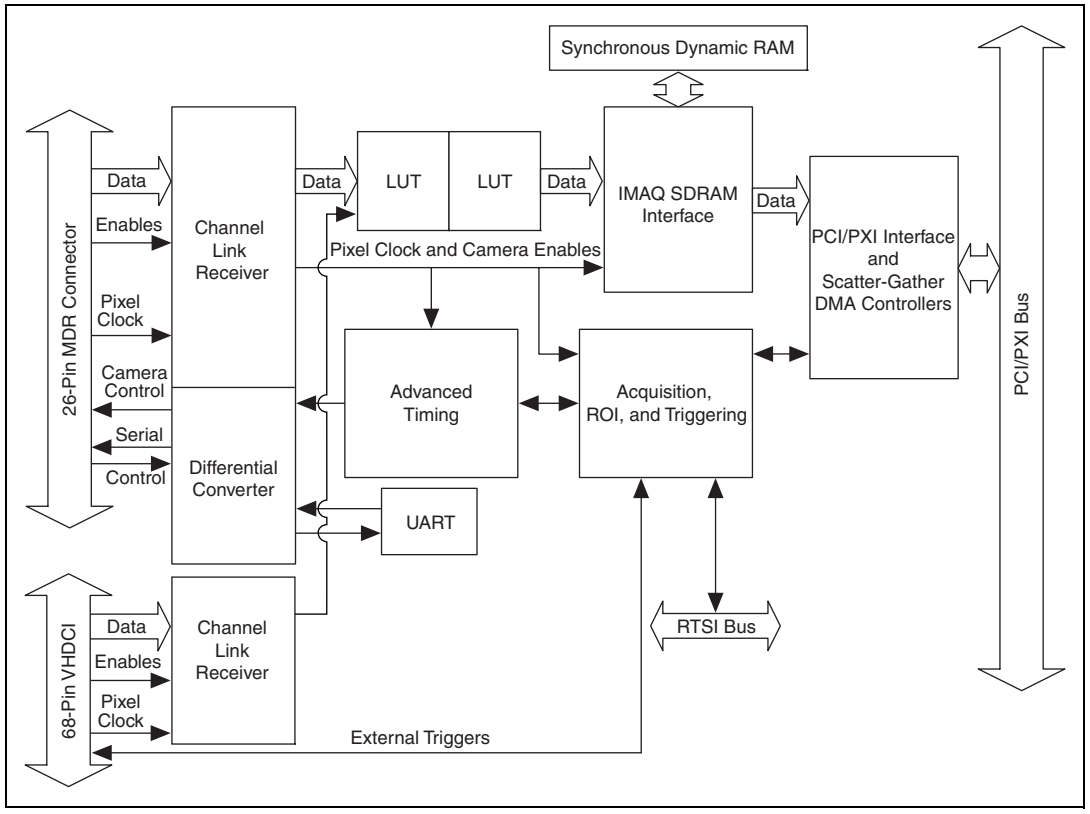


Figure 2-1. NI 1428 Block Diagram

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Camera Link and the NI 1428

The NI 1428 supports the Camera Link Base configuration as well as the 8-bit × 4 mode of the Camera Link Medium configuration.

Base Configuration

The Camera Link Base configuration places 24 data bits and four enable signals (Frame Valid, Line Valid, Data Valid, and a spare) on a single Channel Link part and cable.

The Base configuration includes asynchronous serial transmission as well as four digital camera control lines for controlling exposure time, frame rates, and other camera control signals. These four control lines are configured in the camera file to generate precise timing signals for controlling digital camera acquisition.

Base configuration includes the following bit allocations:

- 8-bit × 1, 2, and 3 taps (channels)
- 10-bit × 1 and 2 taps
- 12-bit × 1 and 2 taps
- 14-bit × 1 tap
- 16-bit × 1 tap
- 24-bit RGB

Medium Configuration

The NI 1428 supports the 8-bit × 4 tap of the Camera Link Medium configuration. The Medium configuration requires using both connectors. This configuration allows for more data throughput by offering two synchronized data streams between the camera and the NI 1428.

Data Transmission

A 28-to-4 serializing Channel Link chip drives the data and camera enable signals across the Camera Link cable, and the camera pixel clock controls the Channel Link data transmission. The four LVDS pairs are then deserialized by another Channel Link chip on the NI 1428.

Note Exact timing of camera and image acquisition device communication is camera dependent. The *Specifications of the Camera Link Interface Standard for Digital Cameras and Frame Grabbers* manual fully explains the Camera Link timing requirements.

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LUTs

The NI 1428 offers lookup tables (LUTs) that can perform operations such as contrast enhancement, data inversion, gamma manipulation, or other nonlinear transfer functions. The LUT fully supports any 8-bit to 16-bit base or medium configuration supported by the NI 1428. Refer to the *Camera Link and the NI 1428* section for more information on supported Camera Link configurations.

Multiple-Tap Data Formatter

Many digital cameras transfer multiple taps, or channels, 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 1428 can reorder the data from up to four 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 For your convenience, data reformatting instructions for these cameras have been preprogrammed into the camera files.

SDRAM

The NI PXI-1428 has 32 MB of onboard high-speed synchronous dynamic RAM (SDRAM). The NI PCI-1428 has 16 MB of SDRAM. The NI 1428 uses the onboard RAM as a FIFO buffer to ensure a complete acquisition. Even when the data rate from the camera exceeds PCI throughput, you can acquire without interruption until the onboard RAM is full.

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 line to start an acquisition on a rising or falling edge and drive each line asserted or unasserted, much like a digital I/O line. You also can map pulses from the high-speed timing circuitry or many of the NI 1428 status signals to these trigger lines. Four external and four RTSI bus triggers (all of which are programmable for polarity and direction) are available for simultaneous use.

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High-Speed Timing

Built from high-speed counters, the high-speed timing circuitry on the NI 1428 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 For your convenience, the external control for cameras that support the NI 1428 has been preprogrammed into the camera file. You can use 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 and SDRAM. The NI 1428 can perform ROI on all video lines and frames. In an ROI acquisition, select an area within the acquisition window to transfer across the PCI bus to system memory.

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

Scatter-Gather DMA Controllers

The NI 1428 uses three independent onboard direct memory access (DMA) controllers. The DMA controllers transfer data between the onboard SDRAM memory buffers and the PCI bus. Each of these controllers supports scatter-gather DMA, which allows the DMA controller to reconfigure on-the-fly. The NI 1428 can perform continuous image transfers directly to either contiguous or fragmented memory buffers.

Bus Master PCI Interface

The NI 1428 implements the PCI interface with a National Instruments custom application-specific integrated circuit (ASIC), the PCI MITE. The PCI interface can transfer data at a theoretical maximum rate of 133 MB/s in bus master mode.

Start Conditions

The NI 1428 can start acquisitions in the following ways:

- **Software control**—The NI 1428 supports software control of acquisition start. You can configure the NI 1428 to capture a fixed number of frames. This configuration is useful for capturing a single frame or a sequence of frames.

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- **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 or falling edge. You can use all four external triggers and up to four RTSI bus triggers simultaneously.
- **Delayed acquisition**—Use either software or triggers to start acquisitions instantaneously or after skipping a specific number of frames. You can use delayed acquisition for post-trigger applications.

Acquisition Window Control

You can configure the following parameters on the NI 1428 to control the video acquisition window:

- **Acquisition window**—The NI 1428 allows the user 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 1428 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.

Serial Interface

The NI 1428 provides serial connections 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 1428 supports the following baud rates: 56000, 38400, 19200, 9600, 7200, 4800, 3600, 2400, 2000, 1800, 1200, 600, and 300.

You can use the serial interface interactively with MAX and `clsercon.exe`, or programmatically with LabVIEW and C.

Interactively:

- **MAX**—Use MAX with a camera file containing preprogrammed commands. When an acquisition is initiated, the commands are sent to the camera.

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- `clsercon.exe`—Use 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. Go to `<NI-IMAQ>\bin` **to access** `clsercon.exe`.

Programmatically:

- **LabVIEW**—Use the serial interface programmatically, through calls to the NI-IMAQ driver using the IMAQ Serial Write and IMAQ Serial Read VIs. Go to `<LabVIEW>\vi.lib\vision\driver\imaqll.llb` to access these files.
- **C**—Use the serial interface programmatically, through calls to the NI-IMAQ driver using `imgSessionSerialWrite` and `imgSessionSerialRead`.

Note `clsercon.exe`, IMAQ Serial Write, IMAQ Serial Read, `imgSessionSerialWrite`, and `imgSessionSerialRead` are used for directly accessing the NI 1428 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.

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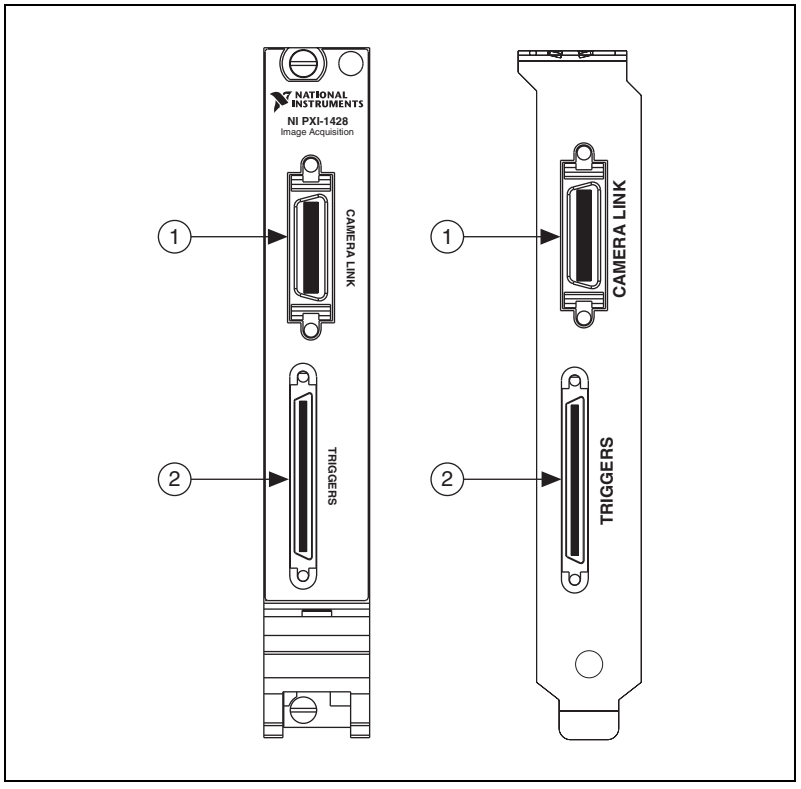
3

Signal Connections

This chapter describes the MDR 26-pin connector and the 68-pin VHDCI connector on the NI 1428 device.

Connectors

Figure 3-1 shows the connectors on the NI 1428 device.



1	MDR 26-Pin Connector	2	68-Pin VHDCI Connector

Figure 3-1. NI 1428 Connectors

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MDR 26-Pin Connector

The MDR 26-pin connector provides reliable high-frequency transfer rates between the camera and the acquisition device. To access this connector, use a 3M Camera Link cable. For additional information on Camera Link cables, including ordering information and cable lengths, refer to the *Camera Link Cables* section of Appendix A, *Cabling*.

Figure 3-2 shows the NI 1428 MDR 26-pin connector assignments. Refer to Table 3-1 for a description of the MDR-26 and 68-pin VHDCI signal connections.

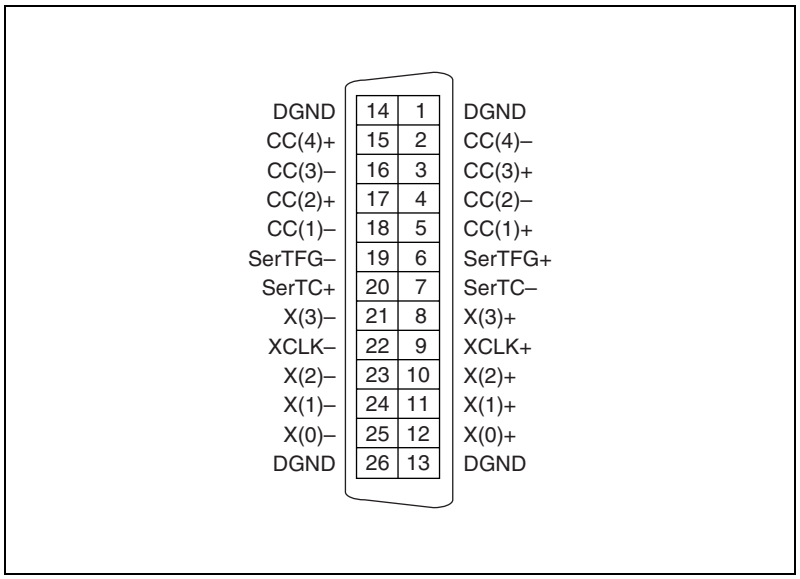


Figure 3-2. MDR 26-Pin Connector Assignments

68-Pin VHDCI Connector

The 68-pin VHDCI connector connects to external digital I/O lines, triggers, and medium configuration 8-bit × 4 mode. To access these connections, build a custom cable or use an optional cable from National Instruments. For information about building a custom cable for the 68-pin VHDCI connector, refer to the *Camera Link Cables* section of Appendix A, *Cabling*.

Figure 3-3 shows the 68-pin VHDCI connector pinout. Refer to Table 3-1 for a description of the MDR-26 and 68-pin VHDCI signal connections.

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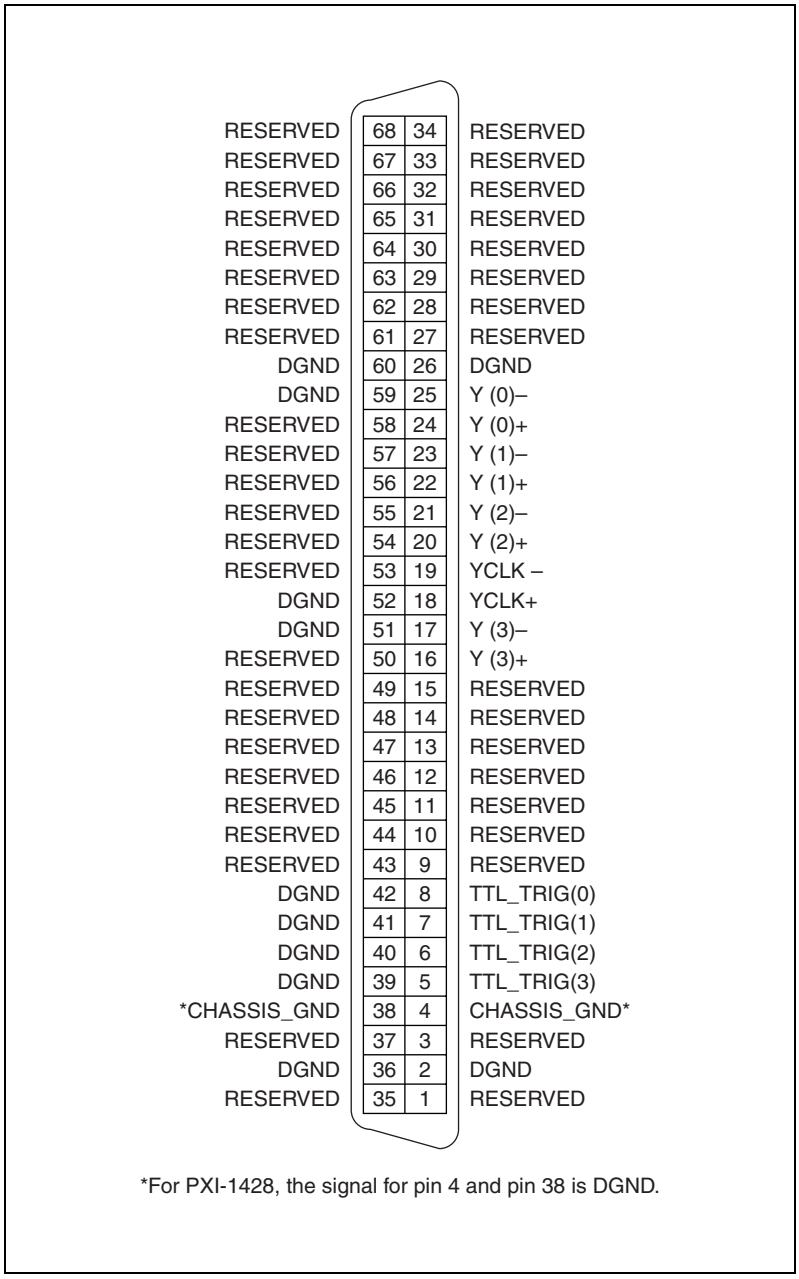


Figure 3-3. NI 1428 68-Pin VHDCI Connector Pin Assignments

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Connector Signal Connection Descriptions

Table 3-1 describes the MDR-26 and 68-pin VHDCI signal connections.

Table 3-1. I/O Connector Signals

Signal Name	Description
TTL_TRIG<3..0>	TTL external triggers/DIO lines (input/output)
DGND	A direct connection to digital GND on the NI 1428
CHASSIS_GND	A direct connection to the computer chassis, which is grounded through the power cord
X<3..0>±	LVDS Base configuration data and enable signals from the camera to the acquisition device
Y<3..0>±	LVDS Medium configuration data and enable signals from the camera to the acquisition device
XCLK±	Transmission clock on the Base configuration chip for Camera Link communication between the acquisition device and the camera
YCLK±	Transmission clock on the Medium configuration chip for Camera Link communication between the acquisition device and the camera
SerTC±	Serial transmission to the camera from the image acquisition device
SerTFG±	Serial transmission to the frame grabber from the camera
CC<4..1>±	Four LVDS pairs, defined as camera inputs and acquisition device outputs, reserved for camera control On some cameras, the camera controls allow the acquisition device to control exposure time and frame rate.

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A

Cabling

This appendix contains cabling requirements for the NI 1428, including Camera Link cable ordering information.

68-Pin VHDCI Cable Specifications

National Instruments offers cables and accessories for connecting to video sources, trigger sources, or synchronization sources. However, if you want to develop your own cable for the 68-pin VHDCI connector, you must use twisted pairs for each signal.

If you are using the Camera Link Medium Configuration/Trigger Cable for NI 1428 (part number 190936-01), refer to Figure B-1 for the MDR 26-pin medium configuration Camera Link connector pinout. Refer to Figure B-2 for the 25-pin D-SUB trigger connector pinout.

Note Refer to the following connector pinouts only if you are using the Camera Link Medium Configuration/Trigger Cable for NI 1428. If you are not using this cable, refer to Chapter 3, *Signal Connections*, for the standard MDR 26-pin connector pinout.

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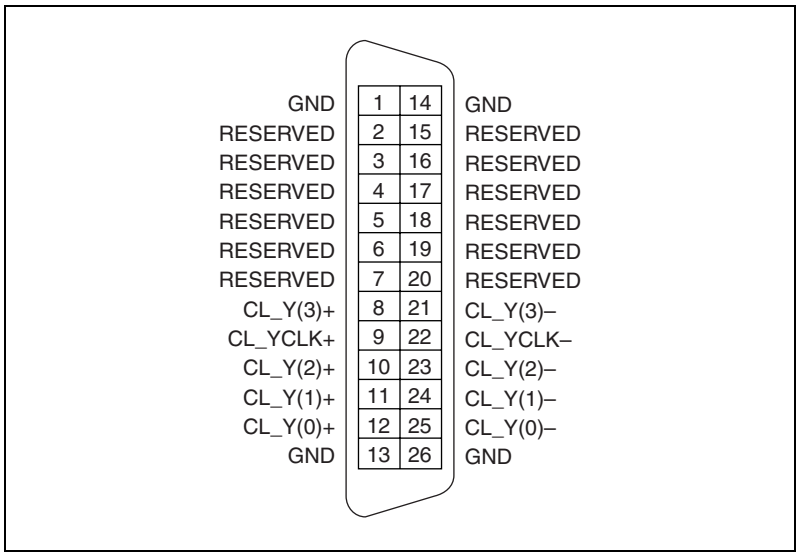


Figure A-1. 26-Pin MDR Medium Configuration Camera Link Connector

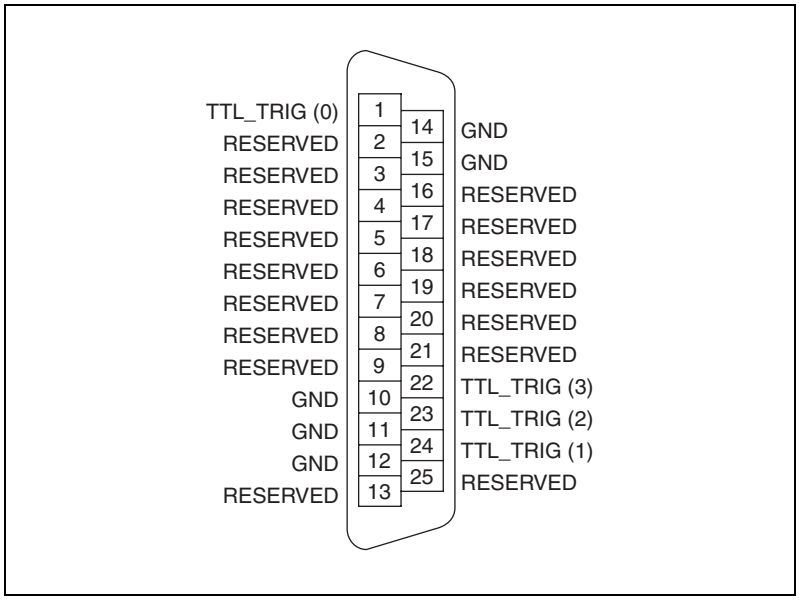


Figure A-2. 25-Pin D-SUB Trigger Connector

For information about additional connector pin assignments, refer to the *Connectors* section of Chapter 3, *Signal Connections*.

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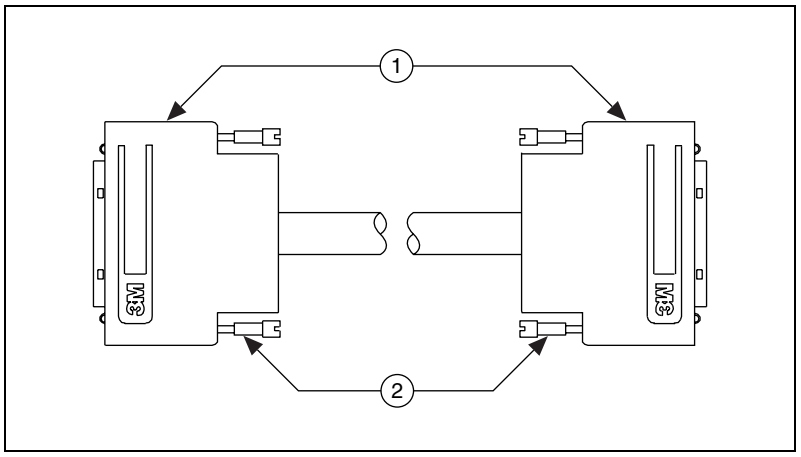
Camera Link Cables

Use a standard Camera Link cable to connect your camera to the MDR 26-pin connector on the NI 1428 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.

Note National Instruments recommends purchasing a Camera Link cable. Building your own cable is not recommended due to the high-speed signaling on the Camera Link interface.

For more information on Camera Link cables, refer to 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 site at `www.machinevisiononline.org`.

Figure A-3 illustrates the Camera Link cable.



1 MDR 26-Pin Male Plug 2 2X Thumbscrews

Figure A-3. Camera Link Cable

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Ordering Information

Camera Link cables are manufactured by 3M corporation and are available from both National Instruments and 3M.

Two-meter Camera Link cables (part number 187676-02) are available from the National Instruments Web site at `ni.com/catalog`. Camera Link cables are available in 1 to 10 m lengths from the 3M Web site at `www.3m.com`. Refer to Figure A-4 for 3M part number information.

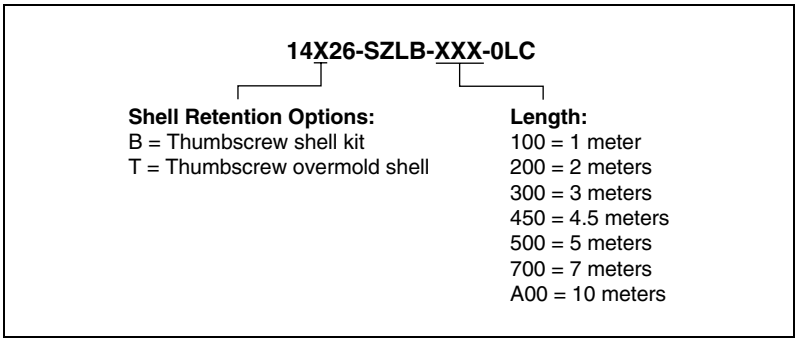


Figure A-4. 3M Part Number Ordering Information

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B

Technical Support and Professional Services

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

- **Support**—Online technical support resources at `ni.com/support` include the following:
  - **Self-Help Resources**—For answers and solutions, visit the award-winning National Instruments Web site 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.
  - **Free Technical Support**—All registered users receive free Basic Service, which includes access to hundreds of Application Engineers worldwide in the NI Discussion Forums at `ni.com/forums`. National Instruments Application Engineers make sure every question receives an answer.

    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`.

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- **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.

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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.
ASIC	Application-Specific Integrated Circuit. A proprietary semiconductor component designed and manufactured to perform a set of specific functions for specific customer needs.

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.

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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.
drivers	Software that controls a specific hardware device, such as an image acquisition board.

F

FIFO	First-in first-out memory buffer. The first data stored is the first data sent to the acceptor; FIFOs are used on image acquisition devices to temporarily store incoming data until that data can be retrieved.

I

I/O	Input/output. The transfer of data to/from a computer system involving communications channels, operator interface devices, and/or data acquisition and control interfaces.

L

LUT	Look-up table. Table containing values used to transform the gray-level values of an image. For each gray-level value in the image, the corresponding new value is obtained from the look-up table.
LVDS	Low Voltage Differential Signaling (EIA-644).

N

NI-IMAQ	Driver software for National Instruments image acquisition hardware.

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P

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.
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.

R

RAM	Random-access memory.
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.
RTSI bus	Real-Time System Integration Bus. The National Instruments timing bus that connects image acquisition 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.
SDRAM	Synchronous dynamic RAM.

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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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