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# NI Vision

## NI PCIe-1427 User Manual

*Base Configuration Camera Link Image Acquisition Device*

September 2006
371816A-01

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Depending on where it is operated, this Class A product could be subject to restrictions in the FCC rules. (In Canada, the Department of Communications (DOC), of Industry Canada, regulates wireless interference in much the same way.) Digital electronics emit weak signals during normal operation that can affect radio, television, or other wireless products.

All Class A products display a simple warning statement of one paragraph in length regarding interference and undesired operation. The FCC rules have restrictions regarding the locations where FCC Class A products can be operated.

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

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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>. |
|  | This icon denotes a note, which alerts you to important information. |
|  | This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash. |
| **bold** | Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. |
| *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 1427 | NI 1427 refers to the NI PCIe-1427 image acquisition device. |

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# 1 Introduction

This chapter provides an overview of the NI PCIe-1427 (NI 1427) image acquisition device, the Camera Link standard, and software choices for programming the NI 1427.

## About the NI 1427

The NI 1427 is a highly flexible image acquisition device that supports Base configuration Camera Link-compatible cameras. The NI 1427 acquires digital images in real time and transfers them directly to system memory. Featuring a high-speed data path, the NI 1427 is ideal for both industrial and scientific environments.

The NI 1427 is easy to install and configure. The NI 1427 ships with NI Vision Acquisition Software, which includes NI-IMAQ, the National Instruments driver software. NI-IMAQ is used to directly control the NI 1427 and other National Instruments image acquisition devices. With NI-IMAQ, you can quickly and easily start your applications without having to program the device at the register level. Refer to *Getting Started with the NI PCIe-1427* for information about installing the NI 1427.

Camera files configure the NI 1427 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 at `ni.com/camera`.

The MDR 26-pin connector on the NI 1427 provides connection to Camera Link-compatible cameras. For further configuration information, refer to the *Camera Link and the NI 1427* section of Chapter 2, *Hardware Overview*.

The 15-pin D-SUB connector has four external TTL input/output (I/O) lines you can use as triggers or as high-speed digital I/O lines. Should you choose not to use the TTL I/O lines, the 15-pin D-SUB connector also provides access to two optically isolated inputs and two RS-422 inputs.The RS-422 inputs can be used as either single-ended or differential lines, or together as a quadrature encoder input. Additional I/O lines for advanced



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triggering, pulse-train outputs, and isolated digital I/O are available with the NI Camera Link I/O Extension Board. Refer to the *NI Camera Link I/O Extension Board User Guide* for information about the NI Camera Link I/O Extension Board.

For more advanced digital or analog system triggering or digital I/O lines, you can use the NI 1427 and NI-IMAQ with National Instruments Data Acquisition (DAQ) or Motion Control products.

Synchronizing several functions to a common trigger or timing event can be a challenge with image acquisition devices. The NI 1427 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 1427 and up to four National Instruments Vision, DAQ, or Motion Control devices. The RTSI bus can also synchronize multiple image acquisition devices to perform simultaneous captures.

Refer to the *Specifications* section of *Getting Started with the NI PCIe-1427* for detailed specifications of the NI 1427.

# 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



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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 1427 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.

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 1427 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 1427 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



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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 1427.

### 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 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.



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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 VI diagrams 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.



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# 2

# Hardware Overview

This chapter provides an overview of NI 1427 hardware functionality and explains the operations of the functional units on the device.

## Functional Overview

The NI 1427 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 1427.

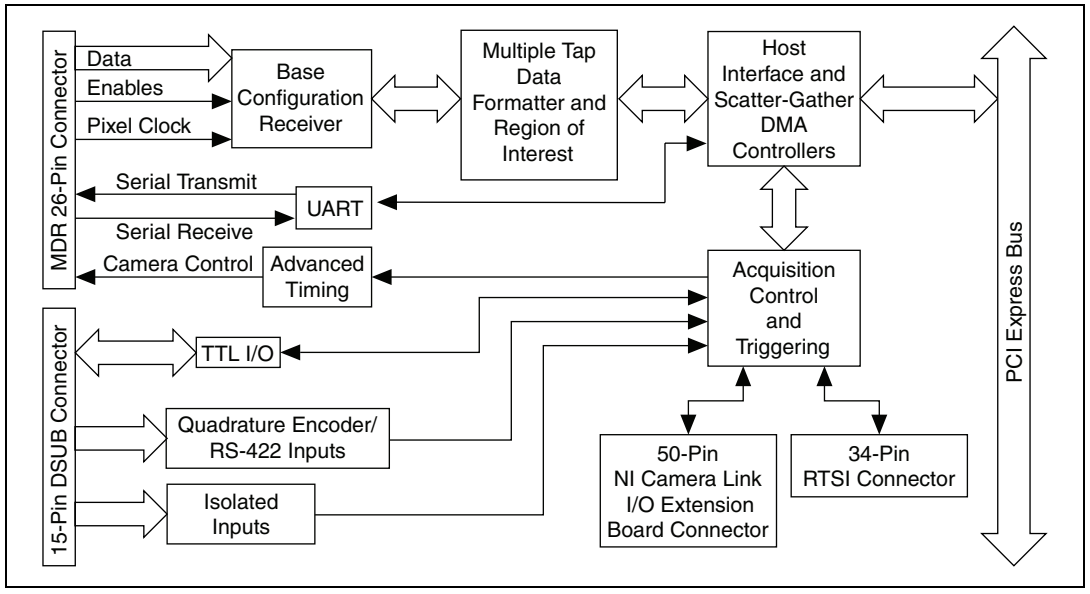



**Figure 2-1.** NI 1427 Block Diagram



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# Camera Link and the NI 1427

The NI 1427 supports the Camera Link Base 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

# Data Transmission

A 28-to-4 serializing Channel Link chip drives the data and camera enable signals across the Camera Link cable, and the pixel clock on the camera controls the Channel Link chip data transmission. The four LVDS pairs are then deserialized by another Channel Link chip on the NI 1427.

**Note** Exact timing of camera and image acquisition device communication is camera dependent. Refer to the *Specifications of the Camera Link Interface Standard for Digital Cameras and Frame Grabbers* manual for more information about Camera Link timing requirements.



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## Hardware Binarization

The NI 1427 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, while all pixels outside the threshold interval, or the background region, are set to the image white value.

Figure 2-2 illustrates binarization and inverse binarization.

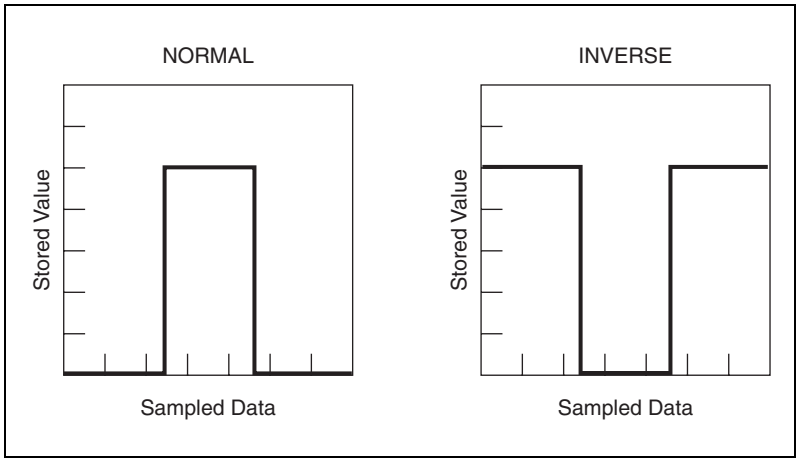



**Figure 2-2.** Binarization and Inverse Binarization



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## 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 1427 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** For your convenience, data reformatting instructions for these 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 1427 status signals to these trigger lines. Seven RTSI bus triggers and four external triggers—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. Refer to the *Using the NI 1427 with the NI Camera Link I/O Extension Board* section of Chapter 3, *Signal Connections*, for information about the I/O functionality of the NI 1427 when used with the NI Camera Link I/O Extension Board.

Individually configure the four external triggers in MAX as single-ended I/O lines or, alternatively, as isolated or RS-422 input only lines. You can configure the four external triggers in any combination of single-ended I/O or input only lines. Table 2-1 lists the configuration options available for each trigger source.



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**Table 2-1.** Trigger Configuration Options for the NI 1427

| Trigger Number | Single-ended Input/Output | Alternative Input Only |
|---|---|---|
| 0 | TTL_TRIG(0) | ISO_IN(0) |
| 1 | TTL_TRIG(1) | ISO_IN(1) |
| 2 | TTL_TRIG(2) | RS422_IN(0) |
| 3 | TTL_TRIG(3) | RS422_IN(1) |

**Note** If not configured as single-ended I/O lines, triggers have input only capability.

## Wiring an Isolated Input to Output Devices

You can wire an isolated input to both sourcing and sinking output devices. Refer to Figures 2-3 and 2-4 for wiring examples by output type. Refer to *Getting Started with the NI PCIe-1427* for information about switching thresholds and current requirements.

**Caution** Do *not* apply a voltage greater than 30 VDC to the isolated inputs. Voltage greater than 30 VDC may damage the NI 1427.

**Note** Isolated inputs are compatible with 5 V logic if the external circuit meets the voltage and current requirements listed in *Getting Started with the NI PCIe-1427*.



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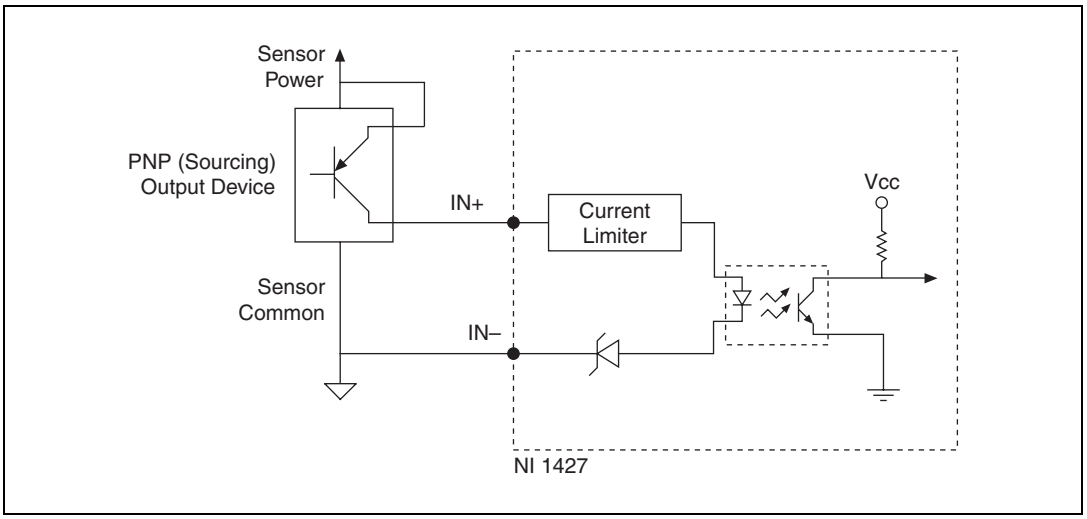



**Figure 2-3.** Example of Connecting an Isolated Input to a Sourcing Output Device

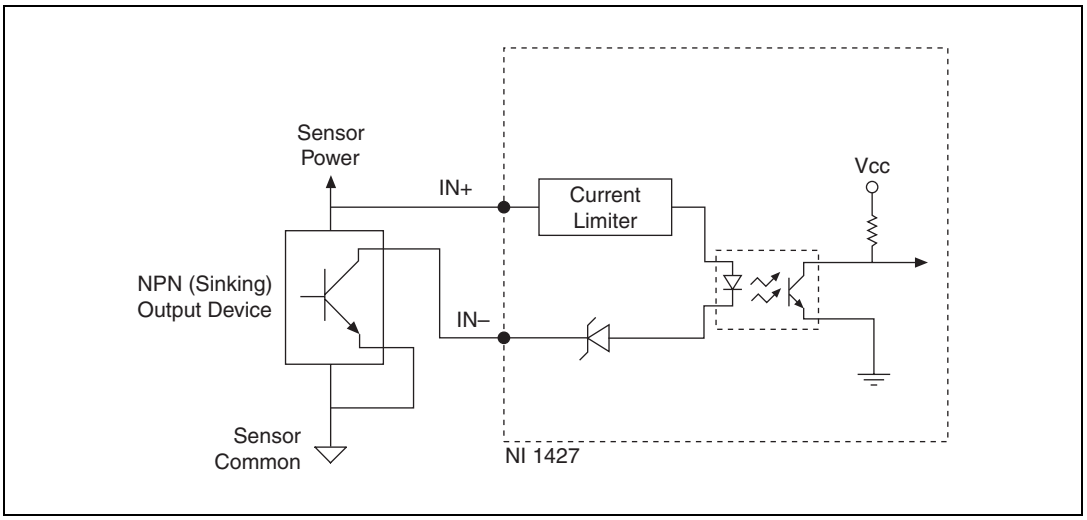



**Figure 2-4.** Example of Connecting an Isolated Input to a Sinking Output Device

## Connecting to a Quadrature Encoder

The NI 1427 accepts single-ended or differential (RS-422) line driver inputs. Shielded encoder cables are recommended for all applications. Unshielded cables are more susceptible to noise and can corrupt the encoder signals. Figure 2-5 shows the quadrature encoder/RS-422 inputs circuit.



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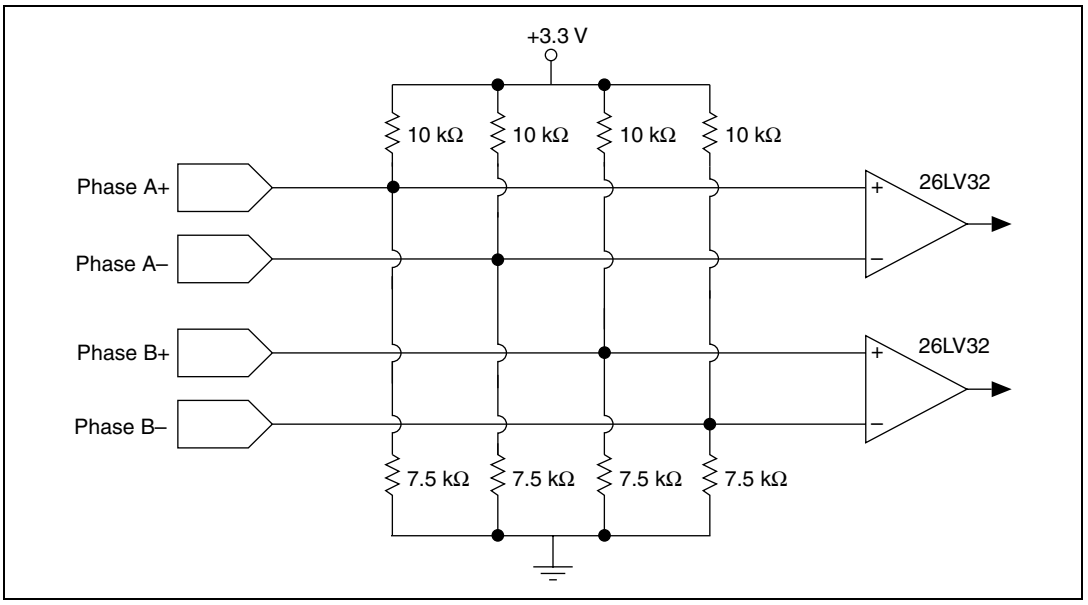



**Figure 2-5.** NI 1427 Quadrature Encoder/RS-422 Inputs Circuit

Figure 2-6 shows an example of connecting differential line drivers.

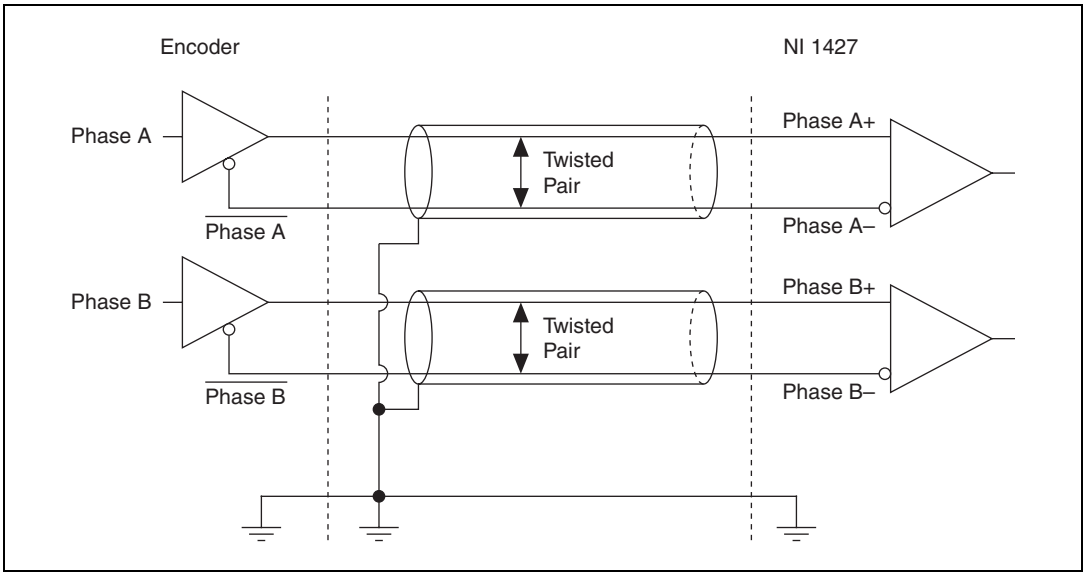



**Figure 2-6.** Example of Connecting Differential Line Drivers



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Figure 2-7 shows an example of connecting single-ended drivers.

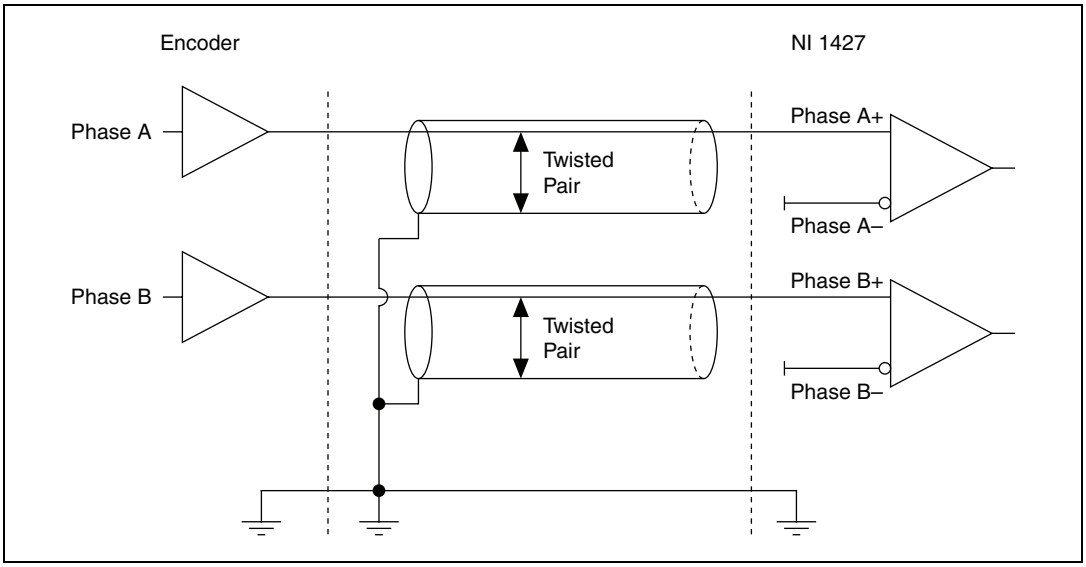



**Figure 2-7.** Example of Connecting Single-Ended Drivers

## High-Speed Timing

Built from high-speed counters, the timing circuitry on the NI 1427 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 1427 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.

The NI 1427 also allows you to route the external trigger inputs 0–3 onto the camera control lines 1–4. Use MAX to select the source for the camera control lines. You have the option to choose either the default control signal that is specified in the camera file or the external trigger input as the source for the camera control lines.



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## 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 1427 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, select an ROI to speed up the transfer and processing times for the image.

**Note** You can use MAX to set the acquisition window on the NI 1427.

## Acquisition Window Control

You can configure the following parameters on the NI 1427 to control the video acquisition window:

- **Acquisition window**—The NI 1427 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 1427 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 1427 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 run time. The NI 1427 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 1427 is compliant with the PCI Express 1.1 specification. The NI 1427 is intended for a x1 PCIe slot. The NI 1427 fits into, and can also be used in, a x4, x8, or x16 PCIe slot. Using a smaller width device in a larger width slot is called up-plugging.



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## Start Conditions

The NI 1427 can start acquisitions in the following ways:

- **Software control**—The NI 1427 supports software control of acquisition start. You can configure the NI 1427 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 1427 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 1427 supports the following baud rates: 115200, 56000, 38400, 19200, 9600, 7200, 4800, 3600, 2400, 2000, 1800, 1200, 600, and 300 bps.

You can use the serial interface interactively with MAX, `clsercon.exe`, or a manufacturer supplied camera control utility, 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.
- `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. From the `<NI-IMAQ>\bin` directory, access `clsercon.exe`.
- **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 1427 serial port.



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Programmatically:

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

**Note** `clsercon.exe`, IMAQ Serial Write, IMAQ Serial Read, `imgSessionSerialWrite`, and `imgSessionSerialRead` are used for direct manual access of the NI 1427 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`.



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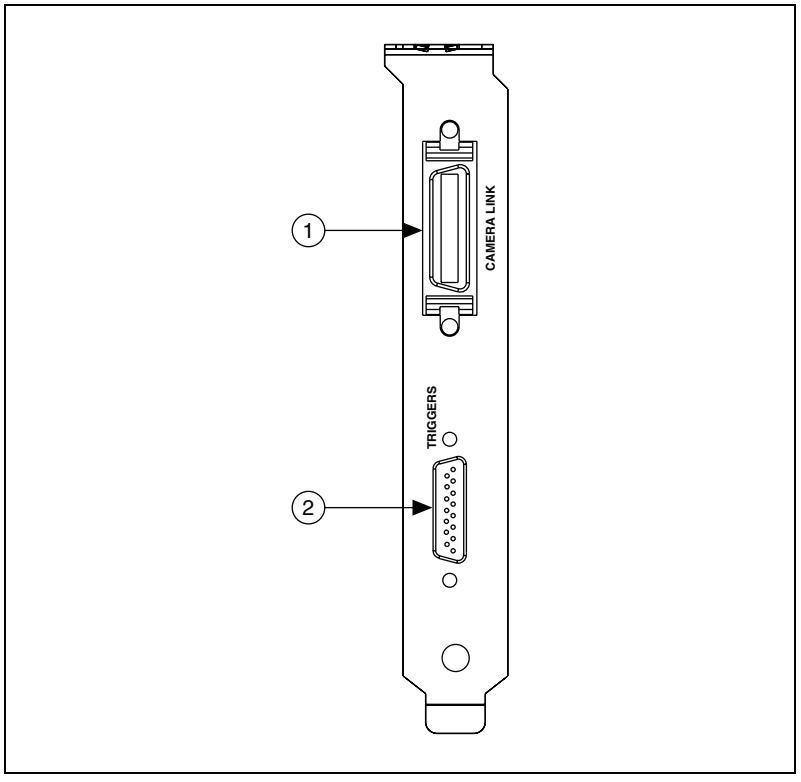
# 3

# Signal Connections

This chapter describes connecting signals to the MDR 26-pin and 15-pin D-SUB connectors on the NI 1427. This chapter also describes considerations for using the NI 1427 with the NI Camera Link I/O Extension Board.

## Connectors

Figure 3-1 shows the connectors on the NI 1427 device.




| | | | |
|---|---|---|---|
| 1 | MDR 26-Pin Connector | 2 | 15-Pin D-SUB Connector |

**Figure 3-1.** NI 1427 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 image acquisition device. To access this connector, use a 3M Camera Link cable. Refer to the *Camera Link Cables* section of Appendix A, *Cabling*, for additional information about Camera Link cables, including available cable lengths and ordering information.

Figure 3-2 shows the NI 1427 MDR 26-pin connector assignments. Refer to Table 3-1 for a description of the MDR 26-pin signal connections.

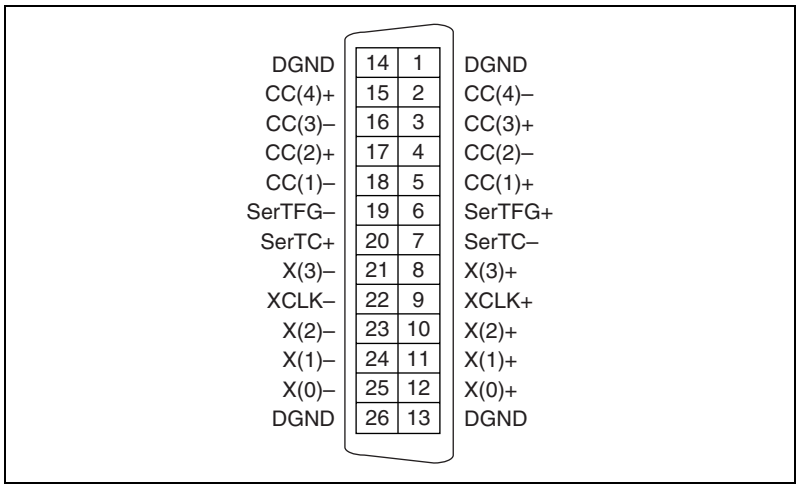



**Figure 3-2.** MDR 26-Pin Connector Pin Assignments

**Table 3-1.** MDR 26-Pin Connector Signals

| Signal Name | Description |
|---|---|
| X<3..0>± | LVDS Base configuration data and enable signals from the camera to the image acquisition device. |
| XCLK± | Transmission clock on the Base configuration chip for Camera Link communication between the image 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 image acquisition device outputs, reserved for camera control.<br>On some cameras, the camera controls allow the image acquisition device to control exposure time and frame rate. |



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## 15-pin D-SUB Connector

The 15-pin D-SUB connector connects to general purpose digital I/O. The general purpose digital I/O available on this connector includes four TTL I/O lines, two optically isolated input lines, and two RS-422 input lines. The RS-422 lines can be used individually as either single-ended or differential lines, or together as a quadrature encoder input.

National Instruments provides a generic 15-pin cable assembly kit (part number 190912-04) that breaks the connector out into 15 color-coded wires for easy connectivity. Refer to the *15-Pin D-SUB Cable Specifications* section of Appendix A, *Cabling*, for information about ordering a cable assembly kit.

If you require twisted pair wiring, you must build a custom cable. Refer to the connector pin assignments in Figure 3-3, the signal descriptions in Table 3-2, and the *15-Pin D-SUB Cable Specifications* section of Appendix A, *Cabling*, to build a custom cable for the 15-pin D-SUB connector.

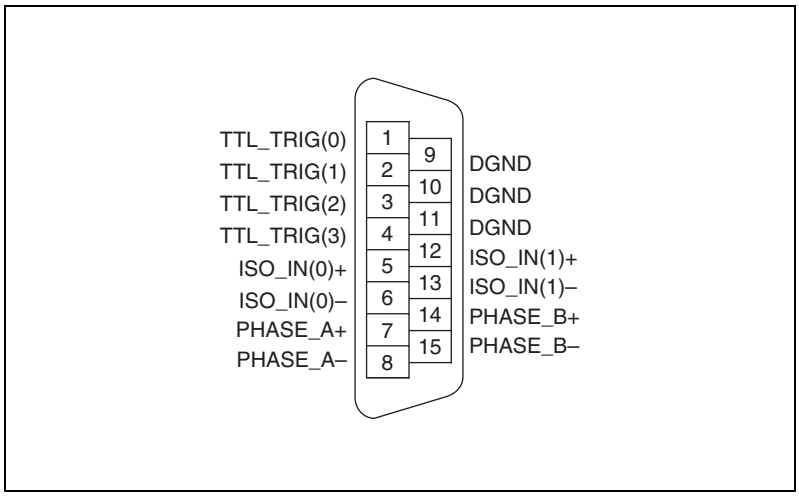



**Figure 3-3.** 15-pin D-SUB Connector Pin Assignments



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**Table 3-2.** 15-Pin D-SUB Connector Signals

| Signal Name | Description |
|---|---|
| TTL_TRIG<3..0> | TTL external triggers/DIO lines (I/O). |
| DGND | Direct connection to digital GND on the NI 1427. |
| ISO_IN<1..0>± | 30 V isolated input only lines.<br>Use these lines instead of, not in addition to, TTL_TRIG<1..0>. |
| PHASE_A±<br>PHASE_B± | The primary use of these single-ended or differential signals is for interfacing to a quadrature encoder.<br>Alternatively, these pairs can be used as independent RS-422 trigger inputs instead of, not in addition to, TTL_TRIG<3..2>. |

## Using the NI 1427 with the NI Camera Link I/O Extension Board

When an NI Camera Link I/O Extension Board is connected to the NI 1427, all of the I/O functionality on the NI 1427 15-pin D-SUB connector is disabled except either the TTL_TRIG(0) or ISO_IN(0) signal.

Refer to the *NI Camera Link I/O Extension Board User Guide* for information about installing, configuring, and connecting to the NI Camera Link I/O Extension Board.



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# A

# Cabling

This appendix contains cabling requirements for the NI 1427, including Camera Link cable ordering information.

## 15-Pin D-SUB Cable Specifications

National Instruments provides a generic 15-pin cable assembly kit (part number 190912-04) that breaks the connector out into 15 color-coded wires for easy connectivity. Visit the National Instruments Web site at `ni.com/catalog` to purchase a cable assembly kit for the NI 1427.

If you decide to build a custom cable, National Instruments recommends that you use twisted pair wiring to help reduce noise pickup from outside sources and crosstalk. TTL I/O lines should be twisted together with a wire connected to DGND. Isolated input and RS-422 input lines should be twisted together in their proper ± pairs.

Refer to the *Connectors* section of Chapter 3, *Signal Connections*, for connector pin assignments.

## Camera Link Cables

Use a standard Camera Link cable to connect your camera to the MDR 26-pin connector on the NI 1427 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.

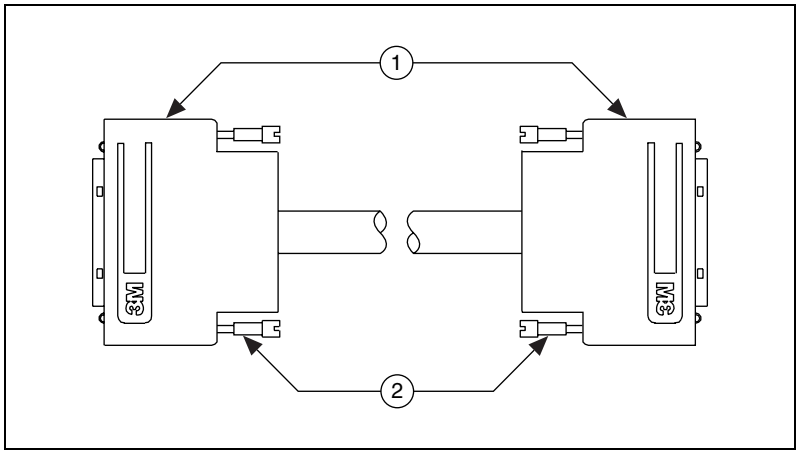
**Note** National Instruments recommends purchasing a Camera Link cable. Building your own cable is not recommended due to the high-speed signaling on the Camera Link interface.

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`.



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Figure A-1 illustrates the 3M Camera Link cable.




| | | | |
|---|---|---|---|
| 1 | MDR 26-Pin Male Plug | 2 | 2X Thumbscrews |

**Figure A-1.** Camera Link Cable

## 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/products`. Camera Link cables are available in 1 to 10 m lengths from the 3M Web site at `www.3m.com`. Refer to Figure A-2 for 3M part number information.

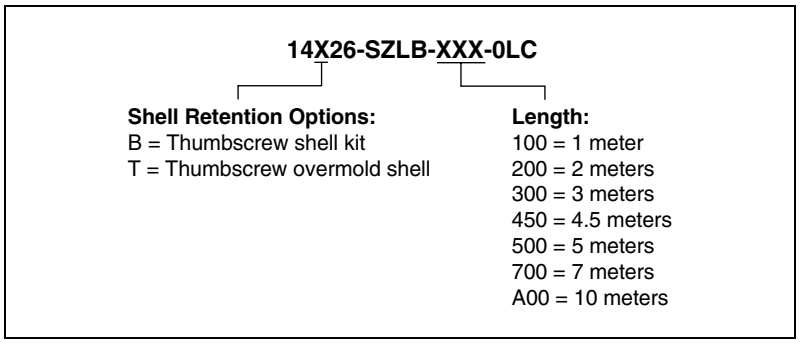



**Figure A-2.** 3M Part Number Ordering Information



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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 Developer Exchange at `ni.com/exchange`. 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. |

## 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. |

## 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 frame grabber or IEEE 1394 (FireWire®) camera. |



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## 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. |



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## 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. |



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| | |
|---|---|
| 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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