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IMAQ™

IMAQ PCI-1426 User Manual

Base Configuration Camera Link Image Acquisition Device

NATIONAL INSTRUMENTS™

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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

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.

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, DIO<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. Bold text also denotes parameter names.
italic	Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. This font 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

This chapter provides an overview of the IMAQ PCI-1426 image acquisition device, the Camera Link standard, Camera Link and IMAQ 1426 interfacing guidelines, and your software programming choices.

About the IMAQ 1426

The IMAQ 1426 is a highly flexible image acquisition (IMAQ) device that supports a diverse range of Camera Link-compatible cameras from various camera companies. The IMAQ 1426 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 IMAQ 1426 is ideal for both industrial and scientific environments.

The IMAQ 1426 is easy to install and configure. It ships with NI-IMAQ, the National Instruments complete IMAQ driver software you can use to directly control the IMAQ 1426 and other National Instruments IMAQ hardware products. With NI-IMAQ, you can quickly and easily start your applications without having to program the device at the register level.

The IMAQ 1426 supports the Camera Link Base configuration. The MDR 26-pin connector provides access to base configuration cameras. For further configuration information, refer to the *Camera Link and IMAQ 1426* section of Chapter 3, *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. These inputs can be individually selected in software.

For more advanced digital or analog system triggering or digital I/O lines, you can use the IMAQ 1426 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 IMAQ 1426 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 IMAQ 1426 and up to four National Instruments DAQ, motion control, or IMAQ devices. The RTSI bus can also synchronize multiple IMAQ hardware captures.

Refer to the *IMAQ PCI-1426 Specifications* for detailed specifications of the IMAQ 1426.

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.

Software Overview

Programming the IMAQ 1426 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.
- **National Instruments 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-IMAQ driver software ships with the IMAQ 1426. 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 IMAQ 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 is also the interface between the IMAQ 1426 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 IMAQ 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 IMAQ 1426.

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.

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 IMAQ 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.

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

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

Integration with 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.

2

Installation

This chapter contains a list of necessary and optional items to begin acquiring images with the IMAQ PCI-1426 device. This chapter also explains how to unpack, configure, and install the IMAQ 1426.

What You Need to Get Started

You need the following items to set up and use the IMAQ 1426:

❑ *Getting Started with IMAQ for Windows 2000/NT/XP*

❑ NI-IMAQ for Windows 2000/NT/XP and documentation

❑ Pentium-based PCI computer running Windows 2000/NT/XP

❑ Camera Link camera

❑ MDR 26-pin Camera Link cable

❑ Optional software packages and documentation:
   – NI Vision Development Module
   – NI Vision Builder for Automated Inspection
   – LabVIEW
   – LabWindows/CVI
   – Measurement Studio

Optional Equipment

National Instruments offers a variety of products for use with the
IMAQ 1426, including the following:

- 15-pin cable assembly kits for connecting the IMAQ 1426 to general
  purpose digital I/O.

- RTSI bus cables for connecting the IMAQ 1426 to other IMAQ,
  motion control, or DAQ devices.

- Other National Instruments DAQ devices for enhanced triggering,
  timing, or I/O.

Refer to the National Instruments catalog, visit ni.com, or call the
National Instruments office nearest you for more specific information
about these products.

Unpacking

The IMAQ 1426 ships in an antistatic package to prevent electrostatic
discharge from damaging device components. To avoid such damage in
handling the device, take the following precautions:

- Ground yourself using a grounding strap or by holding a grounded
  object, such as the computer chassis.

- Touch the antistatic package to a metal part of the computer chassis
  before removing the device from the package.

⚠ **Caution**   *Never* touch the exposed pins of connectors.

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

Store the IMAQ 1426 in the antistatic envelope when not in use.

Safety Information

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

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

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

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

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

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

- Pollution Degree 1—No pollution or only dry, nonconductive pollution occurs. The pollution has no effect.

- Pollution Degree 2—Normally only nonconductive pollution occurs. Occasionally, nonconductive pollution becomes conductive because of condensation.

- Pollution Degree 3—Conductive pollution or dry, nonconductive pollution occurs. Nonconductive pollution becomes conductive because of condensation.

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

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

Installation

Install the IMAQ 1426 in any open, compatible expansion slot in the PCI system. Refer to the *IMAQ PCI-1426 Specifications* for the typical power requirements for this device.

The following instructions are for general installation. Consult the computer user manual or technical reference manual for specific instructions and warnings.

Caution   The IMAQ 1426 is a sensitive electronic device shipped in an antistatic bag. Open only at an approved workstation and observe precautions for handling electrostatic-sensitive devices.

Note   You must install the NI-IMAQ driver software before installing the IMAQ 1426 device. Refer to the *Getting Started with IMAQ for Windows 2000/NT/XP* for information about how to install NI-IMAQ.

1. Power off and unplug the computer.

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

2. Remove the cover to access the PCI expansion slots.

3. Choose an unused PCI slot, and remove the corresponding expansion slot cover on the back panel of the computer.

4. Touch a metal part on the computer case to discharge any static electricity that might be on your clothes or body before handling the IMAQ 1426. Static electricity can damage the device.

5. Gently rock the IMAQ 1426 into the slot. The connection may be tight, but do not force the device into place.

6. If required, screw the mounting bracket of the device to the back panel rail of the computer.

7. Replace the cover.

8. Plug in and power on the computer.

Configuring the IMAQ 1426

After you have installed the IMAQ 1426 and powered on your computer, Windows will recognize the device and assign resources to it. Use National Instruments Measurement & Automation Explorer (MAX) to configure the IMAQ 1426 for acquisition.

Interfacing with the IMAQ 1426

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. Camera control parameters, such as frame-on-demand and exposure control signals, are also defined by the camera manufacturer.

These variable parameters are defined on a per-camera basis in a camera file (`camera_model.icd`) supplied by National Instruments. The NI-IMAQ driver software uses the information in this camera file to program the IMAQ 1426 to acquire images from a specific camera. Without this camera file, the driver does not have the information necessary to configure the IMAQ 1426 for acquisition.

MAX, the National Instruments configuration utility, provides a simple interface for associating a camera file with the IMAQ 1426. Use the following guidelines to access the camera file in MAX:

1. Launch MAX, and expand the **Devices and Interfaces** branch of the configuration tree.

2. Expand the **NI-IMAQ Devices** branch.

3. Expand the **IMAQ PCI-1426** branch.

4. Right-click **Channel 0** and select **Camera**.

5. Select your camera from the menu. If your camera is not in the menu, verify that the camera file is installed in the `NI-IMAQ\Data` directory.

Many camera files are installed when you install NI-IMAQ, and many more are available for download from the National Instruments Camera Advisor at `ni.com/camera`. When installing new camera files, save them to the `Data` folder located at `Program Files\National Instruments\ NI-IMAQ\Data`.

Contact National Instruments technical support to request camera files not available in the Camera Advisor. Refer to Appendix B, *Technical Support and Professional Services*, for information about National Instruments technical support.

3

Hardware Overview

This chapter provides an overview of IMAQ PCI-1426 hardware functionality and explains the operations of the device's functional units.

Functional Overview

The IMAQ 1426 features a flexible, high-speed data path optimized for receiving and formatting video data from Camera Link cameras.

Figure 3-1 illustrates the key functional components of the IMAQ 1426.
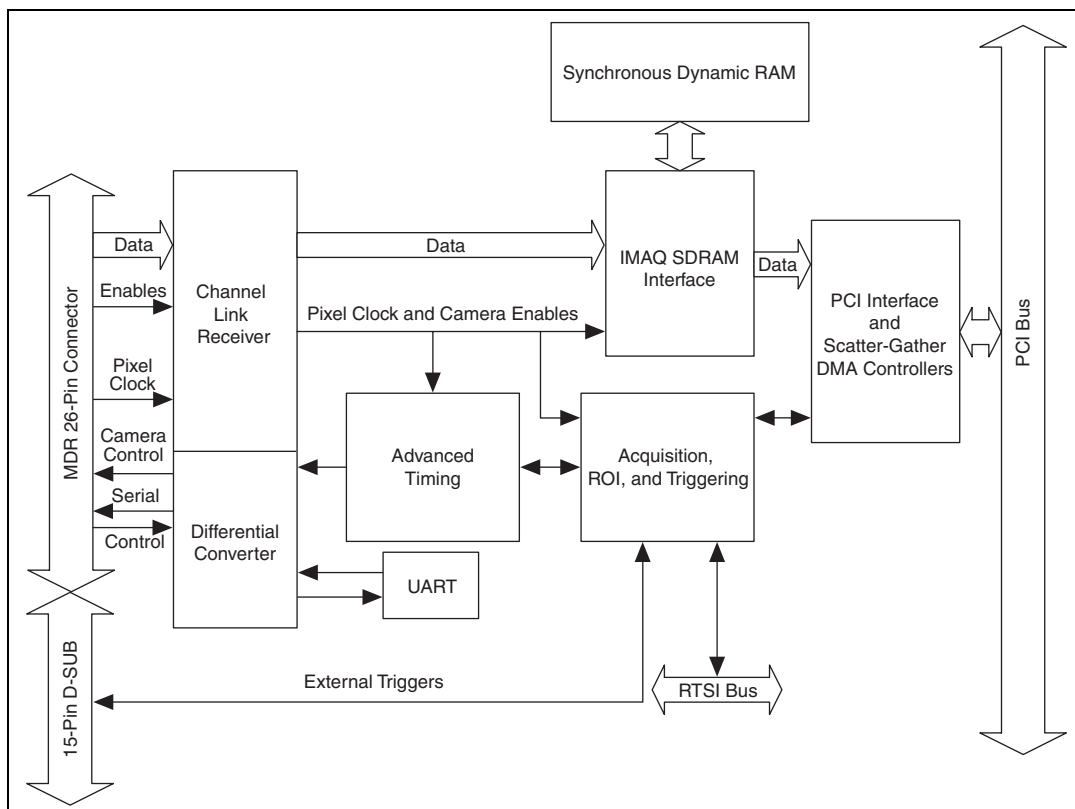

Figure 3-1. IMAQ 1426 Block Diagram

Camera Link and IMAQ 1426

The IMAQ 1426 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 camera's pixel clock controls the Channel Link's data transmission. The four LVDS pairs are then deserialized by another Channel Link chip on the IMAQ 1426.

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.

Hardware Binarization

The IMAQ 1426 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.

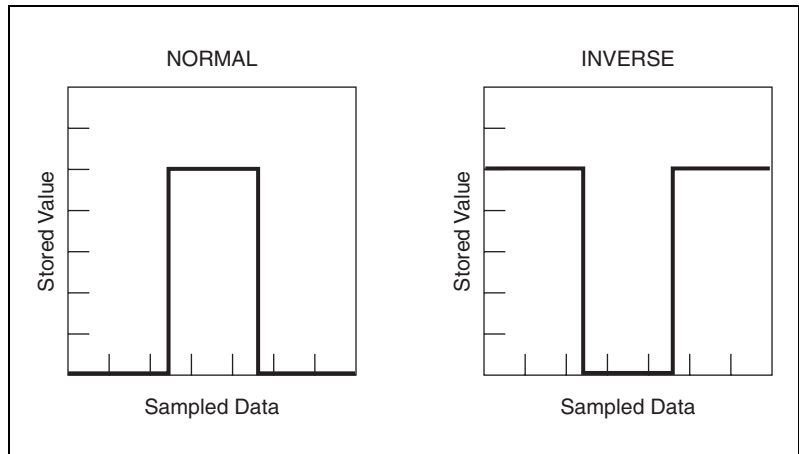Figure 3-2 illustrates binarization and inverse binarization.

Figure 3-2. Binarization and Inverse Binarization

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 IMAQ 1426 can reorder the data from up to three 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 IMAQ 1426 has 16 MB of onboard high-speed synchronous dynamic RAM (SDRAM). The IMAQ 1426 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 IMAQ 1426 status signals to these trigger lines. Four RTSI bus triggers and four external triggers (all of which are programmable for polarity and direction) are available for simultaneous use.

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 3-1 lists the configuration options available for each trigger source.

Table 3-1. Trigger Configuration Options for the IMAQ 1426

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.
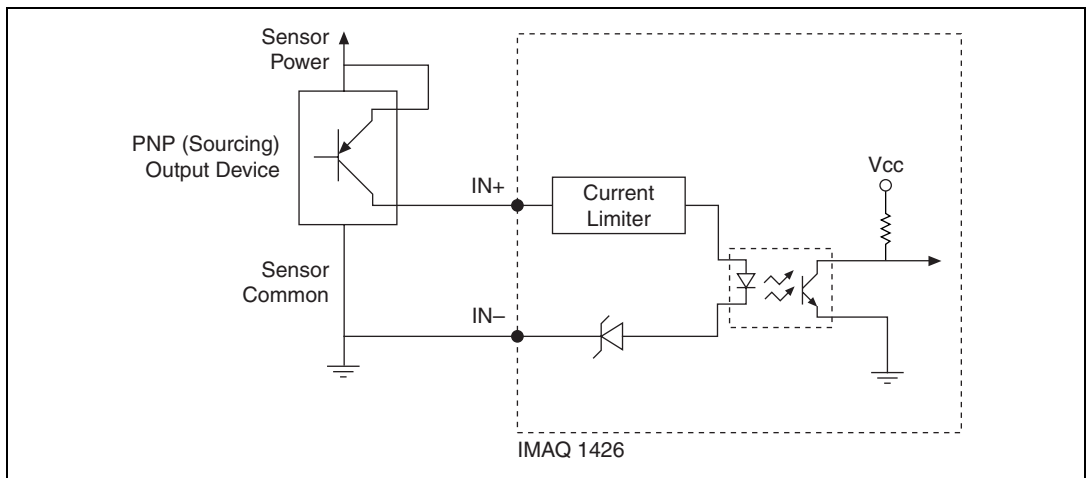
Wiring an Isolated Input to Output Devices

You can wire an isolated input to both sourcing and sinking output devices. Refer to Figures 3-3 and 3-4 for wiring examples by output type. Refer to the *IMAQ PCI-1426 Specifications* 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 IMAQ 1426.

Note   Isolated inputs are compatible with 5 V logic if the external circuit meets the voltage and current requirements listed in the *IMAQ PCI-1426 Specifications*.

Figure 3-3. Example of Connecting an Isolated Input to a Sourcing Output Device
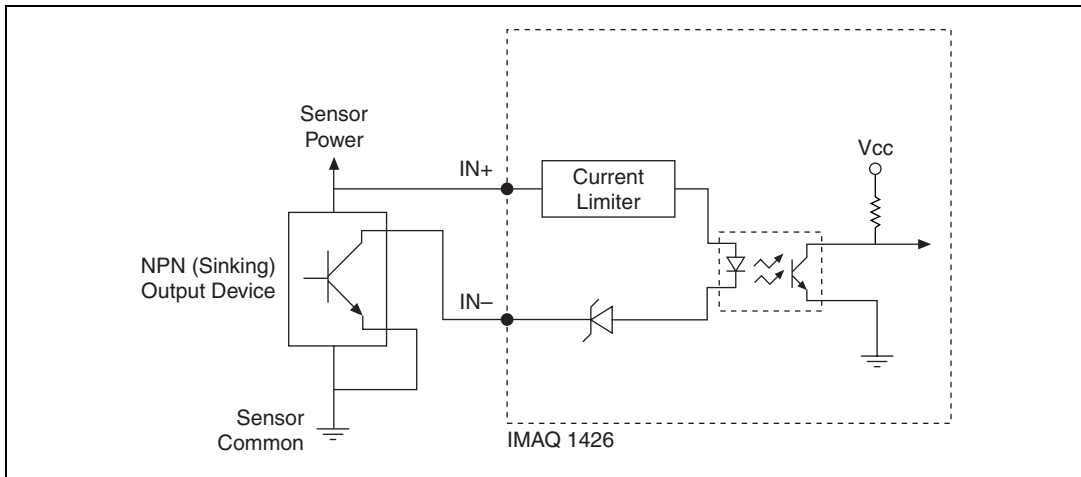
Figure 3-4. Example of Connecting an Isolated Input to a Sinking Output Device

High-Speed Timing

Built from high-speed counters, the high-speed timing circuitry on the IMAQ 1426 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. Map these control signals to the camera control lines to control exposure time and frame rate.

✎ **Note**   For your convenience, the external control for cameras that support the IMAQ 1426 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 IMAQ 1426 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.

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 IMAQ 1426 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 PCI bus to system memory.

Configure the following parameters on the IMAQ 1426 to control the video acquisition window:

- Acquisition window—The IMAQ 1426 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 IMAQ 1426 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.

Note   You can use MAX to set the acquisition window on the IMAQ 1426.

Scatter-Gather DMA Controllers

The IMAQ 1426 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 IMAQ 1426 can perform continuous image transfers directly to either contiguous or fragmented memory buffers.

Bus Master PCI Interface

The IMAQ 1426 implements the PCI interface with a National Instruments custom application-specific integrated circuit (ASIC), the PCI miniMITE. The PCI interface can transfer data at a theoretical maximum rate of 133 MB/s in bus master mode.

Start Conditions

The IMAQ 1426 can start acquisitions in the following ways:

- Software control—The IMAQ 1426 supports software control of a start acquisition. You can configure the IMAQ 1426 to capture a fixed number of frames. This configuration is useful 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 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.

Serial Interface

The IMAQ 1426 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 IMAQ 1426 supports the following baud rates: 56000, 38400, 19200, 9600, 7200, 4800, 3600, 2400 bps, 2000, 1800, 1200, 600, and 300 bps.

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.

- `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. 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** IMAQ Serial Read, IMAQ Serial Write, `clsercon.exe`, `imgSessionSerialRead`, and `imgSessionSerialWrite` are used for directly accessing the IMAQ 1426 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.

Signal Connections

This chapter describes the MDR 26-pin connector and the 15-pin D-SUB connector on the IMAQ PCI-1426 device.

Connectors

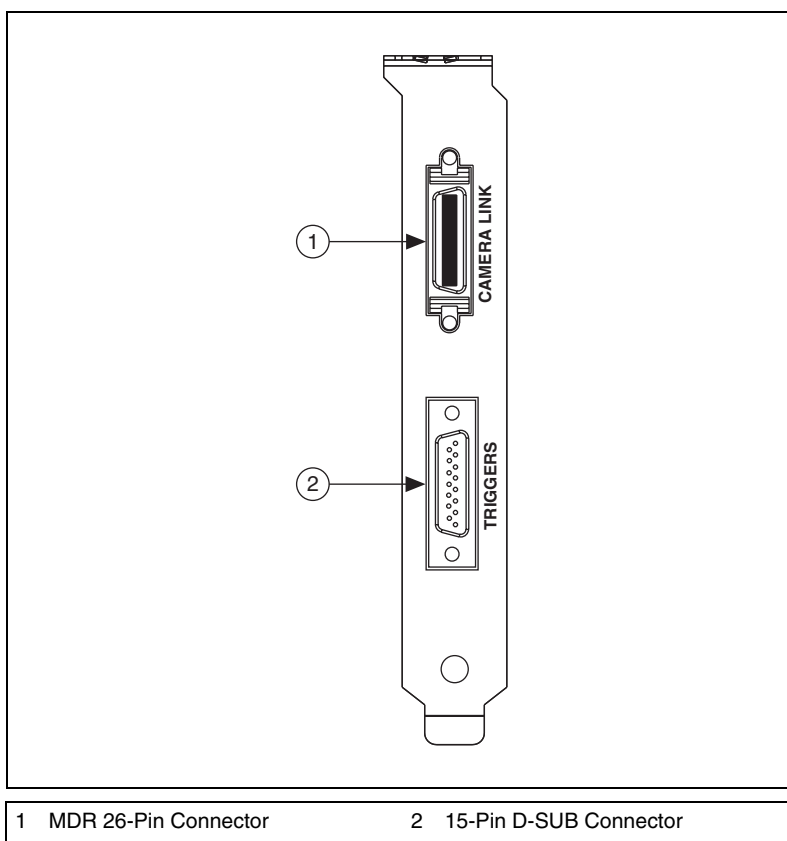Figure 4-1 shows the connectors on the IMAQ 1426 device.

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

Figure 4-1. IMAQ 1426 Connectors

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. 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 4-2 shows the IMAQ 1426 MDR 26-pin connector assignments. Refer to Table 4-1 for a description of the MDR 26-pin and 15-pin D-SUB signal connections.

DGND	14	1	DGND
CC(4)+	15	2	CC(4)–
CC(3)–	16	3	CC(3)+
CC(2)+	17	4	CC(2)–
CC(1)–	18	5	CC(1)+
SerTFG–	19	6	SerTFG+
SerTC+	20	7	SerTC–
X(3)–	21	8	X(3)+
XCLK–	22	9	XCLK+
X(2)–	23	10	X(2)+
X(1)–	24	11	X(1)+
X(0)–	25	12	X(0)+
DGND	26	13	DGND
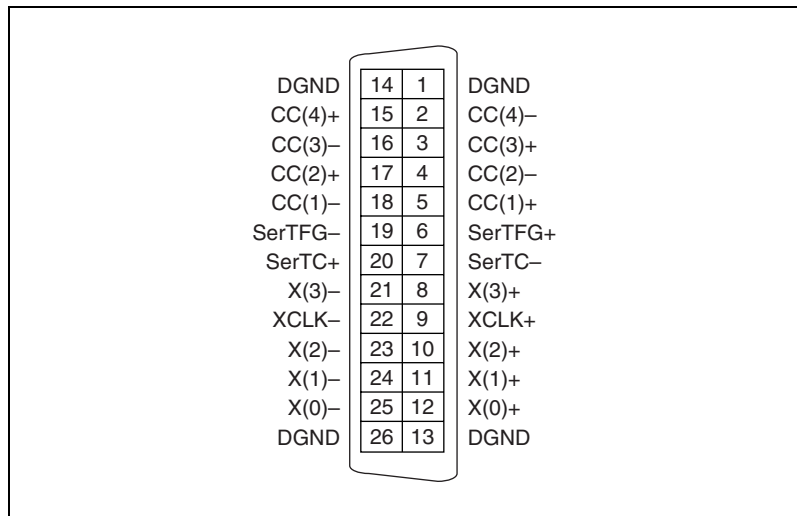
Figure 4-2. MDR 26-Pin Connector Assignments

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.

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 4-3 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.
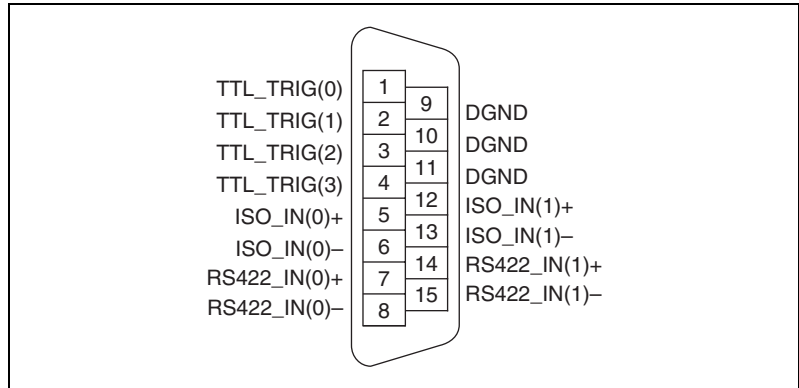

Figure 4-3. 15-pin D-SUB Connector Pin Assignments

Connector Signal Connection Descriptions

Table 4-1 describes the MDR 26-pin and 15-pin D-SUB signal connections.

Table 4-1. I/O Connector Signals

Signal Name	Description
TTL_TRIG<3..0>	TTL external triggers/DIO lines (I/O).
DGND	A direct connection to digital GND on the IMAQ 1426.
ISO_IN<1..0>±	30 V isolated input only lines. Use these lines instead of, not in addition to, TTL_TRIG<1..0>.
RS422_IN<1..0>±	RS-422 signalling standard input only lines. Use these lines instead of, not in addition to, TTL_TRIG<3..2>.
X<3..0>±	LVDS Base 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.
SerTC±	Serial transmission to the camera from the image acquisition device.

Table 4-1. I/O Connector Signals (Continued)

Signal Name	Description
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.

A

Cabling

This appendix contains cabling requirements for the IMAQ PCI-1426 device, 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 IMAQ 1426.

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 4, *Signal Connections*, for connector pin assignments.

Camera Link Cables

Use a 3M Camera Link cable to connect your camera to the MDR 26-pin connector on the IMAQ 1426 device. Camera Link cables consist of two MDR 26-pin 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.

Figure A-1 illustrates the Camera Link cable.

| 1 | MDR 26-Pin Male Plug | 2 | 2X Thumbscrews |
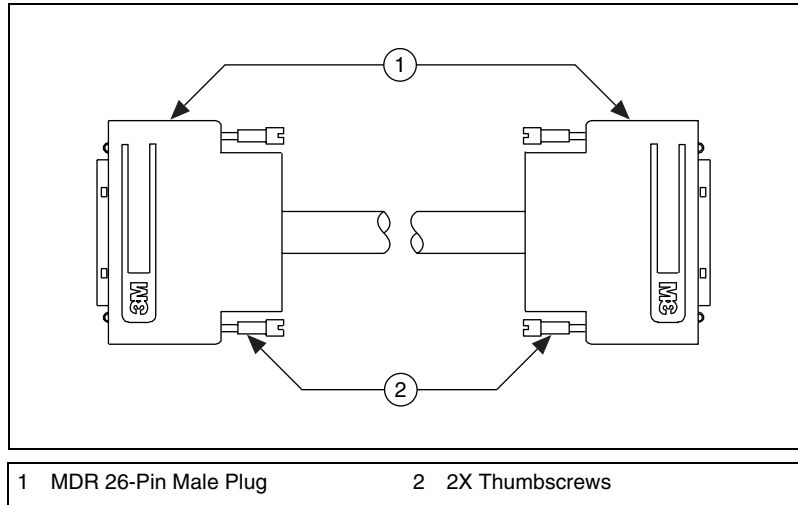
Figure A-1. Camera Link Cable

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/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-2 for 3M part number information.
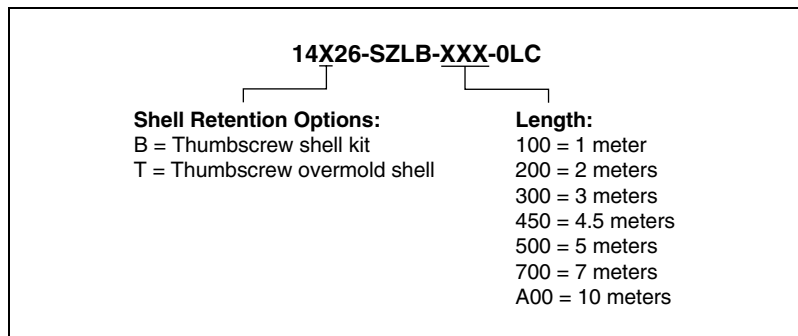

14X26-SZLB-XXX-0LC

Shell Retention Options:
B = Thumbscrew shell kit
T = Thumbscrew overmold shell

Length:
100 = 1 meter
200 = 2 meters
300 = 3 meters
450 = 4.5 meters
500 = 5 meters
700 = 7 meters
A00 = 10 meters

Figure A-2. 3M Part Number Ordering Information

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`.

- **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.

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.

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

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

L

LVDS   Low Voltage Differential Signaling (EIA-644).

N

NI-IMAQ   Driver software for National Instruments IMAQ hardware.

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.

protocol	The exact sequence of bits, characters, and control codes used to transfer data between computers and peripherals through a communications channel.

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.
RTSI bus	Real-Time System Integration Bus. The National Instruments timing bus that connects IMAQ 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.

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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