IMAQ™

IMAQ PCI/PXI-1422 User Manual

High-Quality Digital Image Acquisition Board for PCI, PXI, and CompactPCI Chassis

NATIONAL INSTRUMENTS™

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FCC/DOC Radio Frequency Interference Class A Compliance

This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual, 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). This equipment has been tested and found to comply with the following two regulatory agencies:

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 will be required to correct the interference at his own expense.

Notices to User: *Changes or modifications not expressly approved by National Instruments could void the user's authority to operate the equipment under the FCC Rules.*

This device complies with the FCC rules only if used with shielded interface cables of suitable quality and construction. National Instruments used such cables to test this device and provides them for sale to the user. The use of inferior or nonshielded interface cables could void the user's authority to operate the equipment under the FCC rules.

If necessary, consult National Instruments or an experienced radio/television technician for additional suggestions. The following booklet prepared by the FCC may also be helpful: *Interference to Home Electronic Entertainment Equipment Handbook*. This booklet is available from the U.S. Government Printing Office, Washington, DC 20402.

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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About This Manual

The *IMAQ PCI/PXI-1422 User Manual* describes the features, functions, and operation of the IMAQ PCI-1422 and PXI-1422 devices.

The IMAQ PCI-1422 and PXI-1422 devices are universal digital image acquisition (IMAQ) boards designed to acquire images from and control digital cameras. The *IMAQ PCI/PXI-1422 User Manual* is intended for users with a basic knowledge of image acquisition.

Organization of This Manual

The *IMAQ PCI/PXI-1422 User Manual* is organized as follows:

- Chapter 1, *Introduction*, describes the PCI-1422 and PXI-1422; lists what you need to get started; describes software programming choices, optional equipment, and custom cables; and explains how to unpack and set up the PCI/PXI-1422.

- Chapter 2, *Installation*, explains how to install your PCI-1422 or PXI-1422 board.

- Chapter 3, *Hardware Overview*, presents an overview of the hardware functions on your PCI/PXI-1422 board and explains the operation of each functional unit making up the PCI/PXI-1422.

- Chapter 4, *Signal Connections*, describes signal connections for the PCI/PXI-1422.

- Appendix A, *Specifications*, lists the specifications of the PCI/PXI-1422.

- Appendix B, *Customer Communication*, contains forms you can use to request help from National Instruments or to comment on our products and manuals.

- The *Glossary* contains an alphabetical list and description of terms used in this manual, including abbreviations, acronyms, metric prefixes, mnemonics, and symbols.

- The *Index* contains an alphabetical list of key terms and topics in this manual, including the page where you can find each one.

Conventions Used in This Manual

The following conventions are used in this manual:

<>	Angle brackets containing numbers separated by an ellipsis represent a range of values associated with a bit or signal name—for example, DBIO<3..0>.
☞	This icon to the left of bold italicized text denotes a note, which alerts you to important information.
⚡	This icon to the left of bold italicized text denotes a warning, which advises you of precautions to take to avoid being electrically shocked.
bold italic	Bold italic text denotes a note, caution, or warning.
italic	Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept.
`monospace`	Text in this font denotes proper names of disk drives, paths, or directories.

National Instruments Documentation

The *IMAQ PCI/PXI-1422 User Manual* is one piece of the documentation set for your image acquisition system. You could have any of several types of manuals, depending on the hardware and software in your system. Use the different types of manuals you have as follows:

- Software documentation—You may have both application software and NI-IMAQ software documentation. National Instruments application software includes LabVIEW, BridgeVIEW, ComponentWorks, and LabWindows/CVI. After you set up your hardware system, use either the application software (LabVIEW, BridgeVIEW, ComponentWorks, or LabWindows/CVI) documentation, or the NI-IMAQ documentation to help you write your application. If you have a large and complicated system, it is worthwhile to look through the software documentation before you configure your hardware.

- Accessory installation guides or manuals—If you are using accessory products, read the terminal block and cable assembly installation guides or accessory board user manuals. They explain how to physically connect the relevant pieces of the system. Consult these guides when you are making your connections.

Customer Communication

National Instruments wants to receive your comments on our products and manuals. We are interested in the applications you develop with our products, and we want to help if you have problems with them. To make it easy for you to contact us, this manual contains comment and configuration forms for you to complete. These forms are in Appendix B, *Customer Communication*, at the end of this manual.

1

Introduction

This chapter describes the PCI-1422 and PXI-1422; lists what you need to get started; describes software programming choices, optional equipment, and custom cables; and explains how to unpack and set up the PCI/PXI-1422.

About the PCI/PXI-1422

The PCI/PXI-1422 is a highly flexible IMAQ board for PCI, PXI, and CompactPCI chassis that supports a diverse range of digital cameras from many camera companies. The PCI/PXI-1422 acquires digital images in real time and can store these images in onboard frame memory, or transfer these images directly to system memory. The board can capture up to 16 bits of data at a time at clock speeds up to 40 MHz.

The PCI/PXI-1422 is simple to configure and is factory calibrated so that you can easily install the board and begin acquiring images. The PCI/PXI-1422 ships with NI-IMAQ, the National Instruments complete IMAQ driver software you can use to directly control the PCI/PXI-1422 and other National Instruments IMAQ hardware products. Using NI-IMAQ, you can quickly and easily start your applications without having to program the board at the register level.

Featuring a high-speed data flow path, the PCI/PXI-1422 is ideal for both industrial and scientific environments. As a standalone board, the PCI/PXI-1422 supports up to 16 bits of differential video data, four general-purpose control lines that can be configured to generate precise timing signals to control digital camera acquisition, and four external input/output (I/O) lines that you can use as triggers or as high-speed digital I/O lines. If you require more advanced triggering or digital I/O lines (either digital or analog), you can use the PCI/PXI-1422 and NI-IMAQ with the National Instruments data acquisition (DAQ) product line.

A common problem with image acquisition boards is that you cannot easily synchronize several functions to a common trigger or timing event. The PCI/PXI-1422 uses its Real-Time System Integration (RTSI) bus to solve this problem. The RTSI bus consists of the National Instruments RTSI bus interface and ribbon cable to route additional timing and trigger signals

between the PCI/PXI-1422 and up to four National Instruments DAQ or IMAQ boards in your computer. The RTSI bus can even synchronize multiple IMAQ hardware captures.

Detailed specifications of the PCI/PXI-1422 are in Appendix A, *Specifications*.

Using PXI with CompactPCI

Using PXI-compatible products with standard CompactPCI products is an important feature provided by the *PXI Specification*, Revision 1.0. If you use a PXI-compatible plug-in device in a standard CompactPCI chassis, you will be unable to use PXI-specific functions, but you can still use the basic plug-in device functions. For example, the RTSI bus on your PXI-1422 device is available in a PXI chassis, but not in a CompactPCI chassis.

The CompactPCI specification permits vendors to develop sub-buses that coexist with the basic PCI interface on the CompactPCI bus. Compatible operation is not guaranteed between CompactPCI devices with different sub-buses nor between CompactPCI devices with sub-buses and PXI. The standard implementation for CompactPCI does not include these sub-buses. Your PXI-1422 device will work in any standard CompactPCI chassis adhering to the *PICMG 2.0 R2.1 CompactPCI* core specification using the 64-bit definition for J2.

PXI-specific features are implemented on the J2 connector of the CompactPCI bus. Table 1-1 lists the J2 pins your PXI-1422 device uses. Your PXI device is compatible with any CompactPCI chassis with a sub-bus that does not drive these lines. Even if the sub-bus is capable of driving these lines, the PXI device is still compatible as long as those pins on the sub-bus are disabled by default and not ever enabled. Damage may result if these lines are driven by the sub-bus.

Table 1-1. Pins Used by the PXI-1422 Device

PXI-1422 Signal	PXI Pin Name	PXI J2 Pin Number
RTSI Trigger (0..6)	PXI Trigger (0..6)	B16, A16, A17, A18, B18, C18, E18

What You Need to Get Started

To set up and use your PCI/PXI-1422, you will need the following:

❑ One of the following 1422 devices:

– PCI-1422

– PXI-1422

❑ *Set up and Test the PCI/PXI-1422*

❑ *IMAQ PCI/PXI-1422 User Manual*

❑ *NI-IMAQ for Windows 95/98/NT Release Notes*

❑ NI-IMAQ for Windows 95/98/NT and documentation

❑ Optional software packages and documentation:

– LabVIEW

– BridgeVIEW

– LabWindows/CVI

– IMAQ Vision for G

– IMAQ Vision for LabWindows/CVI

– ComponentWorks IMAQ Vision

– IMAQ Vision Builder

❑ IMAQ D100 series camera cables, depending on your camera

❑ IMAQ D2504 video cable (optional—for access to trigger lines)

❑ Your Pentium-based PCI computer running Windows 95, Windows 98, or Windows NT

❑ A digital video camera

Software Programming Choices

You have several options to choose from when programming your National Instruments IMAQ hardware. You can use National Instruments application software such as LabVIEW, BridgeVIEW, and LabWindows/CVI; National Instruments image analysis software such as IMAQ Vision; the ComponentWorks IMAQ Vision collection of ActiveX controls; or the NI-IMAQ driver software.

National Instruments Application Software

LabVIEW and BridgeVIEW feature interactive graphics, a state-of-the-art user interface, and a powerful graphical programming language, G. The NI-IMAQ VI Library for G, a series of virtual instruments (VIs) for using LabVIEW and BridgeVIEW with the PCI/PXI-1422, is included with the NI-IMAQ software kit. The NI-IMAQ VI Library for G is functionally equivalent to the NI-IMAQ software.

LabWindows/CVI features interactive graphics, a state-of-the-art user interface, and uses the ANSI standard C programming language. The LabWindows/CVI IMAQ Library, a series of functions for using LabWindows/CVI with the PCI/PXI-1422, is included with the NI-IMAQ software kit. The LabWindows/CVI IMAQ Library is functionally equivalent to the NI-IMAQ software.

IMAQ Vision for G is an image acquisition, processing, and analysis library that consists of more than 400 VIs for using the PCI/PXI-1422 with LabVIEW and BridgeVIEW. You can use IMAQ Vision for G functions directly or in combination for unique image processing. There are two versions of IMAQ Vision for G. The Base version gives you the ability to acquire, display, manipulate, and store images. The Advanced version is a complete set of functions for image analysis, processing, and interpretation. Using IMAQ Vision for G, an imaging novice or expert can perform graphical programming of the most basic or complicated image applications without knowledge of any algorithm implementations.

IMAQ Vision for LabWindows/CVI is an image acquisition and analysis library consisting of a series of routines for using the PCI/PXI-1422 with LabWindows/CVI. IMAQ Vision for LabWindows/CVI brings the same functionality to LabWindows/CVI as IMAQ Vision for G does for LabVIEW and BridgeVIEW.

ComponentWorks IMAQ Vision is an image acquisition, processing, and analysis library for use in Visual Basic, Visual C++, Borland Delphi, and Microsoft Internet Explorer. ComponentWorks IMAQ Vision brings the same functionality to ComponentWorks as IMAQ Vision for G does for LabVIEW and BridgeVIEW. The ComponentWorks IMAQ hardware interface control, an ActiveX control for controlling IMAQ devices, is included with the NI-IMAQ software kit. The ComponentWorks IMAQ hardware interface control is functionally equivalent to the NI-IMAQ software.

IMAQ Vision Builder is an interactive prototyping tool for machine vision and scientific imaging developers. With IMAQ Vision Builder, you can prototype vision software quickly or test how various vision image processing functions work. As shown in Figure 1-1, IMAQ Vision Builder generates a text description—a recipe of the machine vision and image processing functions. This description file provides a guide for developing applications with IMAQ Vision in LabVIEW, BridgeVIEW, LabWindows/CVI, and ComponentWorks.

Figure 1-1. IMAQ Vision Builder and Application Development Tools

NI-IMAQ Driver Software

The NI-IMAQ driver software is included at no charge with the PCI/PXI-1422. NI-IMAQ has an extensive library of functions that you can call from your application programming environment. These functions include routines for video configuration, image acquisition (continuous and single-shot), memory buffer allocation, trigger control, and board configuration, as shown in Figure 1-2.

Figure 1-2. NI-IMAQ Functions

The NI-IMAQ driver software performs all functions required for acquiring and saving images. The NI-IMAQ software does not perform any image analysis. For image analysis functionality, refer to the *National Instruments Application Software* section earlier in this chapter.

NI-IMAQ has both high-level and low-level functions for maximum flexibility and performance. Examples of high-level functions include the functions to acquire images in single-shot or continuous mode. An example of a low-level function is configuring an image sequence since it requires advanced understanding of the PCI/PXI-1422 and image acquisition.

NI-IMAQ also internally resolves many of the complex issues between the computer and the PCI/PXI-1422, such as programming interrupts and DMA controllers. NI-IMAQ is the interface path between LabVIEW, BridgeVIEW, LabWindows/CVI, or a conventional programming environment and the PCI/PXI-1422.

Any platform that supports NI-IMAQ also supports NI-DAQ and a variety of National Instruments DAQ boards, so your PCI/PXI-1422 and NI-IMAQ development can integrate with National Instruments DAQ products.

Whether you are using conventional programming languages or National Instruments software, your application uses the NI-IMAQ driver software, as illustrated in Figure 1-3.

Vision Software

IMAQ Vision

Image Analysis	Blob Analysis	Correlation	Gauging and Measurement

Filters	Color Analysis	Display and ROI	Morphology

Application Software

LabVIEW   BridgeVIEW   ActiveX   LabWindows/CVI
(ComponentWorks)

Driver Software

NI-IMAQ   NI-DAQ   ValueMotion/
FlexMotion

Hardware

IMAQ   NI-DAQ   ValueMotion/
FlexMotion

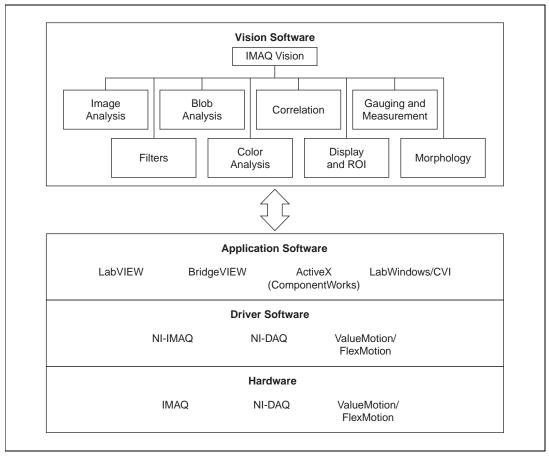**Figure 1-3.** The Relationship between the Programming Environment,
NI-IMAQ, and Your Hardware

Optional Equipment

National Instruments offers a variety of products for use with your
PCI/PXI-1422, including the following cables and other National
Instruments products:

- Cables to connect your digital camera to the PCI/PXI-1422

- A four-pod BNC cable, which routes trigger signals to a BNC
  connector block (IMAQ D2504)

- RTSI bus cables for connecting the PCI/PXI-1422 to other IMAQ or DAQ hardware

- Other National Instruments DAQ devices for enhanced triggering, timing, or input/output

For more specific information about these products, refer to your National Instruments catalogue or web site, or call the office nearest you.

Unpacking

Your PCI/PXI-1422 is shipped in an antistatic package to prevent electrostatic damage to the board. Electrostatic discharge can damage several components on the board. To avoid such damage in handling the board, take the following precautions:

- Ground yourself via a grounding strap or by holding a grounded object.

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

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

- *Never* touch the exposed pins of connectors.

How to Set up Your IMAQ System

Use Figure 1-4 to install your software and hardware, configure your hardware, and begin using NI-IMAQ in your application programs.

Follow the instructions in the *Set up and Test the PCI/PXI-1422* document to install your NI-IMAQ software and IMAQ hardware.

If you will be accessing the NI-IMAQ device drivers through LabVIEW or BridgeVIEW, you should read the NI-IMAQ release notes and the *NI-IMAQ VI Reference Manual* to help you get started.

Read the *Set up and Test the PCI/PXI-1422*
document and the NI-IMAQ release notes to install
your NI-IMAQ software, IMAQ hardware,
and documentation.

Configure your hardware using the
IMAQ Configuration Utility and online help.

LabWindows/CVI
Third-Party Compilers

What
application software
are you using?

LabVIEW
BridgeVIEW

ComponentWorks

Read Chapter 1, *Introduction
to NI-IMAQ*, in the
NI-IMAQ User Manual.

Read the sections in
chapters 2 and 3 in the *NI-IMAQ
User Manual* that apply to the
function groups you
will use in your application.

Look at the self-documented
example source code on your
distribution CD for your
application language
and environment.

Use the *NI-IMAQ Function
Reference Manual* when you
need specific information about
individual NI-IMAQ functions.

If you are using IMAQ Vision for
LabWindows/CVI, read the
documentation for IMAQ Vision
for LabWindows/CVI.

Read *Getting Results with
ComponentWorks IMAQ Vision*
for information on using
ComponentWorks in your
application environment.

Use the ComponentWorks
IMAQ Vision documentation
when you need specific
information about individual
NI-IMAQ functions.

Read:

• *NI-IMAQ VI Reference
  Manual*, if you are using
  LabVIEW or BridgeVIEW
• Your IMAQ Vision for G
  documentation if you are
  using IMAQ Vision for G

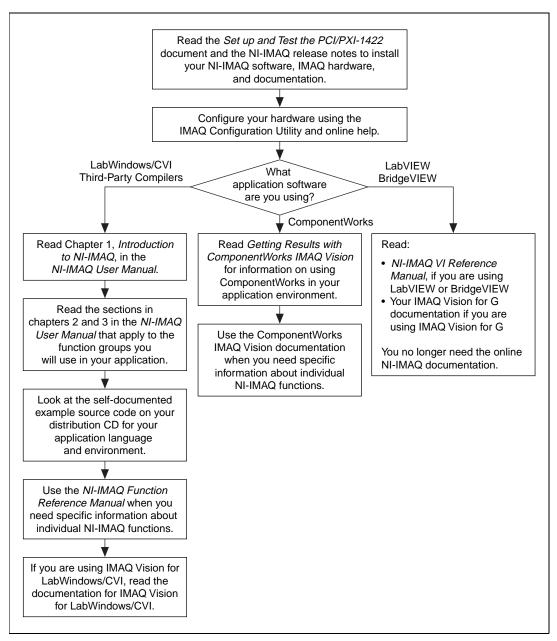You no longer need the online
NI-IMAQ documentation.

Figure 1-4. How to Set up Your IMAQ System

2

Installation

This chapter explains how install your PCI-1422 or PXI-1422 board.

Installation

☞ **Note**   *You must install the NI-IMAQ driver software before installing your 1422 device. For information on how to install NI-IMAQ, please see the* Set up and Test the PCI/PXI-1422 *document and your NI-IMAQ release notes.*

◆   PCI-1422

You can install the PCI-1422 in any available PCI expansion slot in your computer. However, to achieve the best noise performance, you should leave as much room as possible between the PCI-1422 and other boards and hardware. The following are general instructions, but consult your computer user manual or technical reference manual for specific instructions and warnings.

1.   Plug in but do not turn on your computer before installing the PCI-1422 device. The power cord grounds the computer and protects it from electrical damage while you are installing the module.

⚠ **Warning**   *To protect both yourself and the computer from electrical hazards, the computer should remain off until you finish installing the PCI-1422.*

2.   Remove the top cover or access port to the PCI bus.

3.   Select any available PCI expansion slot.

4.   Locate the metal bracket that covers the cut-out in the back panel of the chassis for the slot you have selected. Remove and save the bracket-retaining screw and the bracket cover.

5.   Touch the metal part of the power supply case inside the computer to discharge any static electricity that might be on your clothes or body.

6.   Line up the PCI-1422 with the 100-pin SCSI-type connector near the cut-out on the back panel. Slowly push down on the top of the PCI-1422 until its card-edge connector is resting on the expansion slot receptacle. Using slow, evenly distributed pressure, press the PCI-1422 straight down until it seats in the expansion slot.

7. Reinstall the bracket-retaining screw to secure the PCI-1422 to the back panel rail.

8. Check the installation.

9. Replace the computer cover.

Your PCI-1422 is now installed.

♦ PXI-1422

You can install a PXI-1422 in any available 5 V peripheral slot in your PXI or CompactPCI chassis.

☞ **Note**   *The PXI-1422 has connections to several reserved lines on the CompactPCI J2 connector. Before installing a PXI-1422 in a CompactPCI system that uses J2 connector lines for purposes other than PXI, see Using PXI with CompactPCI, in Chapter 1, Introduction, of this manual.*

1. Turn off and unplug your PXI or CompactPCI chassis.

2. Choose an unused PXI or CompactPCI 5 V peripheral slot. Install the PXI-1422 in a slot that supports bus arbitration or bus-master cards. PXI-compliant chassis must have bus arbitration for all slots.

3. Remove the filler panel for the peripheral slot you have chosen.

4. Touch a metal part on your chassis to discharge any static electricity that might be on your clothes or body.

5. Insert the PXI-1422 in the selected 5 V slot. Use the injector/ejector handle to fully inject the device into place.

6. Screw the front panel of the PXI-1422 to the front panel mounting rails of the PXI or CompactPCI chassis.

7. Visually verify the installation.

8. Plug in and turn on the PXI or CompactPCI chassis.

Your PXI-1422 is now installed.

3

Hardware Overview

This chapter presents an overview of the hardware functions on your PCI/PXI-1422 board and explains the operation of each functional unit making up the PCI/PXI-1422.

Functional Overview

The PCI/PXI-1422 features a flexible, high-speed data path optimized for the reception and formatting of video data from digital cameras.

The block diagram in Figure 3-1 illustrates the key functional components of the PCI/PXI-1422.
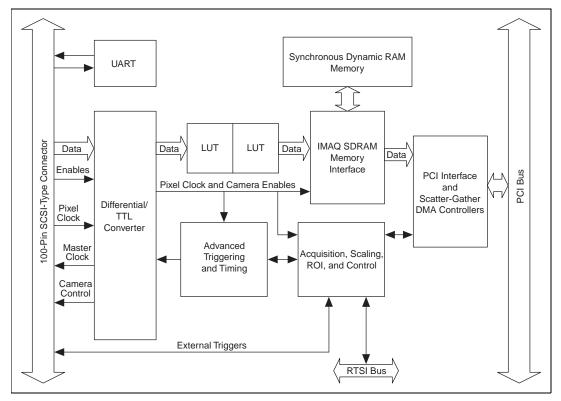
Figure 3-1. PCI/PXI-1422 Block Diagram

Differential/TTL Level Converters

The PCI/PXI-1422 can drive and receive either TTL or differential-level camera control signals. These signal levels can be controlled independently for the control and enable lines on the 100-pin SCSI-type connector.

LUTs

The PCI/PXI-1422 uses a 64 KB-by-16 bit lookup table (LUT) that you can use for two 256 B-by-8 bit LUT operations. You can configure this LUT to perform simple imaging operations such as contrast enhancement, data inversion, gamma manipulation, or other nonlinear transfer functions.

Multiple-Tap Data Formatter

Many digital cameras transfer multiple channels, or taps, 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 similar directions.

The multiple-tap data formatting circuitry on the PCI/PXI-1422 can reorder the data from up to two 8-bit 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.
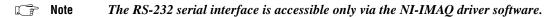
SDRAM

The PCI/PXI-1422 comes with 16 MB of onboard high-speed synchronous dynamic RAM (SDRAM). The PCI/PXI-1422 can use the onboard RAM as a first-in first-out (FIFO) buffer so that in some instances, the PCI/PXI-1422 can capture images larger than the amount of RAM on the board.

Advanced Clock Generation

The advanced clock generation circuitry on the PCI/PXI-1422 generates frequencies from 500 kHz to 40 MHz for digital cameras that require an external clock.

RS-232 Serial Interface

You can use the RS-232 serial interface on the 100-pin SCSI-type connector to control digital cameras that also have a serial interface for camera control and configuration.

☞ **Note**   *The RS-232 serial interface is accessible only via the NI-IMAQ driver software.*

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 of these lines to start an acquisition on a rising or falling edge. In addition, you can drive each line asserted or unasserted, similar to a digital I/O line. You can also map pulses from the high-speed timing circuitry or many of the PCI/PXI-1422 status signals to these trigger lines. There are four external and four RTSI bus triggers. You can program each of these triggers in polarity and direction.

High-Speed Timing

The high-speed timing circuitry on the PCI/PXI-1422, built from high-speed counters, allows you to specify or generate precise, real-time control signals. You can map the output of this circuitry to a trigger line to provide accurate pulses and pulse trains.

Acquisition, Scaling, ROI

The acquisition, scaling, and region-of-interest (ROI) circuitry monitors the incoming video signals and routes the active pixels to the multiple-tap data formatter and SDRAM memory. The PCI/PXI-1422 can perform ROI and scaling on all video lines and frames. Pixel and line scaling transfers certain multiples (two, four, or eight) of pixels and lines to onboard memory. In an ROI acquisition, you select an area within the acquisition window to transfer to the PCI bus.

Scatter-Gather DMA Controllers

The PCI/PXI-1422 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. Thus, the PCI/PXI-1422 can perform continuous image transfers directly to either contiguous or fragmented memory buffers.

Bus Master PCI Interface

The PCI/PXI-1422 implements the PCI interface with a National Instruments custom application-specific integrated circuit (ASIC), the PCI MITE. The PCI interface can transfer data at a maximum rate of 132 Mbytes/s in bus master mode. The PCI/PXI-1422 can generate 8-, 16-, and 32-bit memory read and write cycles, both single and multiple. In slave

mode, the PCI/PXI-1422 is a medium-speed decoder that accepts both memory and configuration cycles. The interface logic ensures that the PCI/PXI-1422 can meet PCI loading, driving, and timing requirements.

Board Configuration NVRAM

The PCI/PXI-1422 contains onboard nonvolatile RAM (NVRAM) that configures all registers on power-up.

Video Acquisition

The PCI/PXI-1422 can acquire digital video in a variety of modes and store the images in the onboard SDRAM memory or transfer the images directly to PCI system memory.

Start Conditions

The PCI/PXI-1422 can start acquisitions in a variety of conditions:

- Software control—The PCI/PXI-1422 supports software control of acquisition start. You can configure the PCI/PXI-1422 to capture a fixed number of fields or 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 11 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—You can use either software or triggers to start acquisitions instantaneously or after skipping a specific period of time. You can use delayed acquisition for posttrigger applications.

- Frame/field selection—With an interlaced camera and the PCI/PXI-1422 in frame mode, you can program the PCI/PXI-1422 to start an acquisition on any odd or even field.

Acquisition Window Control

You can configure numerous parameters on the PCI/PXI-1422 to control the video acquisition window. A brief description of each parameter follows:

- *Acquisition window*—The PCI/PXI-1422 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 PCI/PXI-1422 uses a second level of active pixel and active line regions for selecting a region of interest. Using the region-of-interest circuitry, the board acquires only a selected subset of the acquisition window.

- *Scaling down*—The scaling-down circuitry also controls the active acquisition region. The PCI/PXI-1422 can scale down a frame by reducing the number of pixels per line, the number of lines per frame, or both. For active pixel selection, the PCI/PXI-1422 can select every pixel, every other pixel, every fourth pixel, or every eighth pixel. For active line selection, the PCI/PXI-1422 can select every line, every other line, every fourth line, or every eighth line. You can use the scaling-down circuitry in conjunction with the region-of-interest circuitry.

- *Interlaced video*—The PCI/PXI-1422 supports both interlaced and non-interlaced digital video signals. In interlaced mode, the PCI/PXI-1422 combines the odd and even fields into one contiguous frame for analysis. In non-interlaced mode, each field is treated as an independent frame.

4

Signal Connections

This chapter describes signal connections for the PCI/PXI-1422.

I/O Connector

The PCI/PXI-1422 100-pin SCSI-type connector connects to all digital video data inputs, digital enable inputs, camera control outputs, RS-232 serial interface, and the external trigger signals. To access these connections, you can build your own custom cable or use one of the optional cables from National Instruments.

☞ **Note** *Refer to the National Instruments web site,* `http://www.natinst.com/imaq`, *for the latest information on optional cables and the cameras they support.*

Figure 4-1 shows the pinout of the 100-pin SCSI connector.

Data0+	1	51	Not Used
Data0–	2	52	Not Used
Data1+	3	53	Not Used
Data1–	4	54	Not Used
Data2+	5	55	Not Used
Data2–	6	56	Not Used
Data3+	7	57	Not Used
Data3–	8	58	Not Used
Data4+	9	59	Not Used
Data4–	10	60	Not Used
Data5+	11	61	Not Used
Data5–	12	62	Not Used
Data6+	13	63	Not Used
Data6–	14	64	Not Used
Data7+	15	65	Not Used
Data7–	16	66	Not Used
Data8+	17	67	Not Used
Data8–	18	68	Not Used
Data9+	19	69	Not Used
Data9–	20	70	Not Used
Data10+	21	71	Not Used
Data10–	22	72	Not Used
Data11+	23	73	Not Used
Data11–	24	74	Not Used
Data12+	25	75	Not Used
Data12–	26	76	Not Used
Data13+	27	77	Not Used
Data13–	28	78	Not Used
Data14+	29	79	Not Used
Data14–	30	80	Not Used
Data15+	31	81	Not Used
Data15–	32	82	Not Used
Control0+	33	83	RI (RS-232)
Control0–	34	84	DTR (RS-232)
Control1+	35	85	DSR (RS-232)
Control1–	36	86	RTS (RS-232)
Control2+	37	87	CTS (RS-232)
Control2–	38	88	DCD (RS-232)
Control3+	39	89	Master Clock1+
Control3–	40	90	Master Clock1–
EnableA+	41	91	Master Clock0+
EnableA–	42	92	Master Clock0–
EnableB+	43	93	SOUT (RS-232)
EnableB–	44	94	SIN (RS-232)
EnableC+	45	95	External Trigger0
EnableC–	46	96	External Trigger1
EnableD+	47	97	External Trigger2
EnableD–	48	98	External Trigger3
Pixel Clock +	49	99	GND
Pixel Clock –	50	100	GND

Figure 4-1. PCI/PXI-1422 Pin Assignments

Signal Description

Table 4-1 describes each signal connection on the 100-pin SCSI connector.

Table 4-1. I/O Connector Signals

Signal Name	Description
Control<0..3>±	You can use the control lines on the PCI/PXI-1422 to control digital camera features and timing information. Either static or dynamic, TTL or differential, signals can be generated on these lines to perform such functions as generating integration or shutter pulses to the digital cameras.
CTS	Clear to Send is used for RS-232 connections.
Data<0..15>±	Data<0..15>± allows you to connect data up to 16 bits wide in differential format to the PCI/PXI-1422.
DCD	Data Carrier Detect is used for RS-232 connections.
DSR	Data Set Ready is used for RS-232 connections.
DTR	Data Terminal Ready is used for RS-232 connections.
Enable<A..D>±	The PCI/PXI-1422 can receive any combination of up to four enable signals. These signals can be either TTL or differential. Examples of camera signals which might be connected to these pins are frame enable, line enable, even enable and odd enable. If your camera has a separate field signal, that line should be connected to Enable C.
External Trigger<0..3>	External Trigger<0..3> are TTL I/O lines used to start an acquisition or output to control external events. You can program the triggers to be rising-edge or falling-edge sensitive. You can also program the triggers to be programmatically asserted or unasserted similar to the function of a digital I/O line or to contain internal status signals (by using the onboard events) or specific pulse widths.
GND	GND is a direct connection to digital ground on the PCI/PXI-1422.
Master Clock<0..1>±	You can use these two sets of pins to generate a master clock signal for your digital camera. Possible clock frequencies range from 500 kHz to 40 MHz.
Pixel Clock±	The PCI/PXI-1422 uses the Pixel Clock input as a reference clock to latch the incoming video data.
RI	Ring Indicator is used for RS-232 connections.

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

Signal Name	Description
RTS	Request to Send is used for RS-232 connections.
SIN	Serial Data In is used for RS-232 connections.
SOUT	Serial Data Out is used for RS-232 connections.

A

Specifications

This appendix lists the specifications of the PCI/PXI-1422. These specifications are typical at 25 °C, unless otherwise stated.

External Connections

Trigger sense .... TTL

Trigger level .... Programmable (rising or falling)

Pixel clock sense .... Selectable (TTL or differential)

Pixel clock level .... Programmable (rising or falling)

Enable sense .... Selectable (TTL or differential)

Enable level .... Programmable (rising or falling)

Master clock drive .... Selectable (TTL or differential)

Master clock level .... Rising edge

Control signal drive .... Selectable (TTL or differential)

Control signal level .... Programmable (rising or falling)

Minimum control signal pulse width ..... 20 ns

Video data sense .... Differential

Clocks

Master clock frequency range .... 500 kHz–40 MHz
(± 0.5% of selected frequency)

Pixel clock frequency range .... 500 kHz–40 MHz

PCI Interface

PCI initiator (master) capability ....Supported

PCI target (slave) capability ....Supported

Data path...16 bits

Card voltage...5 V, 12 V, –12 V

Card type..32-bit half-size card

Parity generation/checking,
error reporting..Supported

Target decode speed ....Medium (1 clock)

Target fast back-to-back capability ....Supported

Resource locking ....Supported as a master and slave

PCI interrupts..Interrupts passed on
INTA# signal

Base address registers............................BAR0 (16 KB)
BAR1 (64 KB)

Expansion ROM ....4 KB

PCI master performance
    Ideal ....133 Mbytes/s
    Sustained..100 Mbytes/s

Power Requirements

Voltage..+5 V_{DC} – 2 A_{DC}
+12 V_{AC} – 24 mA
–12 V_{DC} – 20 mA

Physical

Dimensions

    PCI-1422 .... 10.668 by 17.463 cm
                                                         (4.2 by 6.875 in.)

Weight

    PCI-1422 .... 0.127 kg (0.028 lb.)

Environment

Emissions .... EN 55011:1991 Group 1 Class A
                                                      at 10 m FCC Class A at 10 m

B

Customer Communication

For your convenience, this appendix contains forms to help you gather the information necessary to help us solve your technical problems and a form you can use to comment on the product documentation. When you contact us, we need the information on the Technical Support Form and the configuration form, if your manual contains one, about your system configuration to answer your questions as quickly as possible.

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Fax-on-Demand is a 24-hour information retrieval system containing a library of documents on a wide range of technical information. You can access Fax-on-Demand from a touch-tone telephone at 512 418 1111.

E-Mail Support (Currently USA Only)

You can submit technical support questions to the applications engineering team through e-mail at the Internet address listed below. Remember to include your name, address, and phone number so we can contact you with solutions and suggestions.

`support@natinst.com`

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Austria	0662 45 79 90 0	0662 45 79 90 19
Belgium	02 757 00 20	02 757 03 11
Brazil	011 284 5011	011 288 8528
Canada (Ontario)	905 694 0085	905 785 0086
Canada (Quebec)	514 694 8521	514 694 4399
Denmark	45 76 26 00	45 76 26 02
Finland	09 725 725 11	09 725 725 55
France	0 1 48 14 24 24	0 1 48 14 24 14
Germany	089 741 31 30	089 714 60 35
Hong Kong	2645 3186	2686 8505
India	91805275406	91805275410
Israel	03 6120092	03 6120095
Italy	02 413091	02 4139215
Japan	03 5472 2970	03 5472 2977
Korea	02 596 7456	02 596 7455
Mexico (D.F.)	5 280 7625	5 520 3282
Mexico (Monterrey)	8 357 7695	8 365 8543
Netherlands	0348 433466	0348 430673
Norway	32 84 84 00	32 84 86 00
Singapore	2265886	2265887
Spain (Madrid)	91 640 0085	91 640 0533
Spain (Barcelona)	93 582 0251	93 582 4370
Sweden	08 587 895 00	08 730 43 70
Switzerland	056 200 51 51	056 200 51 55
Taiwan	02 2377 1200	02 2737 4644
United Kingdom	01635 523545	01635 523154
United States	512 795 8248	512 794 5678

Technical Support Form

Photocopy this form and update it each time you make changes to your software or hardware, and use the completed copy of this form as a reference for your current configuration. Completing this form accurately before contacting National Instruments for technical support helps our applications engineers answer your questions more efficiently.

If you are using any National Instruments hardware or software products related to this problem, include the configuration forms from their user manuals. Include additional pages if necessary.

Name _____

Company _____

Address _____

_____

Fax (___) _____Phone (___) _____

Computer brand_____ Model _____Processor_____

Operating system (include version number) _____

Clock speed _____MHz RAM _____MB   Display adapter _____

Mouse ___yes ___no   Other adapters installed _____

Hard disk capacity _____MB Brand_____

Instruments used _____

_____

National Instruments hardware product model _____ Revision _____

Configuration _____

National Instruments software product _____ Version _____

Configuration _____

The problem is: _____

_____

_____

_____

_____

List any error messages: _____

_____

_____

The following steps reproduce the problem: _____

_____

_____

_____

_____

IMAQ PCI/PXI-1422 Hardware and Software Configuration Form

Record the settings and revisions of your hardware and software on the line to the right of each item. Complete a new copy of this form each time you revise your software or hardware configuration, and use this form as a reference for your current configuration. Completing this form accurately before contacting National Instruments for technical support helps our applications engineers answer your questions more efficiently.

National Instruments Products

Hardware revision _____

Interrupt level of hardware _____

Base I/O address of hardware _____

Programming choice _____

National Instruments software _____

Other boards in system _____

Base I/O address of other boards _____

DMA channels of other boards _____

Interrupt level of other boards _____

Other Products

Computer make and model _____

Microprocessor _____

Clock frequency or speed _____

Type of video board installed _____

Operating system version _____

Operating system mode _____

Programming language _____

Programming language version _____

Other boards in system _____

Base I/O address of other boards _____

DMA channels of other boards _____

Interrupt level of other boards _____

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Glossary

Prefix	Meanings	Value
p-	pico-	10^{-12}
n-	nano-	10^{-9}
μ-	micro-	10^{-6}
m-	milli-	10^{-3}
k-	kilo-	10^{3}
M-	mega-	10^{6}
G-	giga-	10^{9}
t-	tera-	10^{12}

Numbers/Symbols

%   percent

+   positive of, or plus

/   per

Ω   ohm

±   plus or minus

–   negative of, or minus

A

A   amperes

AC   alternating current

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 and a line count
active pixel region	the region of pixels actively being stored; defined by a pixel start and a pixel count
address	character code that identifies a specific location (or series of locations) in memory
ANSI	American National Standards Institute
API	application programming interface
area	a rectangular portion of an acquisition window or frame that is controlled and defined by software
array	ordered, indexed set of data elements of the same type
ASIC	Application-Specific Integrated Circuit—a proprietary semiconductor component designed and manufactured to perform a set of specific functions for a specific customer

B

b	bit—one binary digit, either 0 or 1
B	byte—eight related bits of data, an eight-bit binary number; also used to denote the amount of memory required to store one byte of data
buffer	temporary storage for acquired data
bus	the 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

C	Celsius
cache	high-speed processor memory that buffers commonly used instructions or data to increase processing throughput
CMOS	complementary metal-oxide semiconductor

Compact PCI	refers to the core specification defined by the PCI Industrial Computer Manufacturer's Group (PICMG)
conversion device	device that transforms a signal from one form to another; for example, analog-to-digital converters (ADCs) for analog input and digital-to-analog converters (DACs) for analog output
CPU	central processing unit

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
dB	decibel—the unit for expressing a logarithmic measure of the ratio of two signal levels: dB = 20log10 V1/V2, for signals in volts
DC	direct current
default setting	a default parameter value recorded in the driver; in many cases, the default input of a control is a certain value (often 0) that means *use the current default setting*.
DIN	Deutsche Industrie Norme
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
DRAM	dynamic RAM
drivers	software that controls a specific hardware device such as an IMAQ or DAQ device
dynamic range	the ratio of the largest signal level a circuit can handle to the smallest signal level it can handle (usually taken to be the noise level), normally expressed in decibels

E

EEPROM   electrically erasable programmable read-only memory—ROM that can
                          be erased with an electrical signal and reprogrammed

external trigger   a voltage pulse from an external source that triggers an event such as
                          A/D conversion

F

field   For an interlaced video signal, a field is half the number of horizontal
                          lines needed to represent a frame of video; the first field of a frame
                          contains all the odd-numbered lines, the second field contains all of the
                          even-numbered lines.

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. For example, an analog input
                          FIFO stores the results of A/D conversions until the data can be retrieved
                          into system memory, a process that requires the servicing of interrupts and
                          often the programming of the DMA controller. This process can take
                          several milliseconds in some cases. During this time, data accumulates in
                          the FIFO for future retrieval.

frame   a complete image; in interlaced formats, a frame is composed of two
                          fields

ft   feet

G

gamma   the nonlinear change in the difference between the video signal's
                          brightness level and the voltage level needed to produce that brightness

genlock   circuitry that aligns the video timing signals by locking together the
                          horizontal, vertical, and color subcarrier frequencies and phases and
                          generates a pixel clock to clock pixel data into memory for display or
                          into another circuit for processing

H

h	hour
hue	represents the dominant color of a pixel. The hue function is a continuous function that covers all the possible colors generated using the R, G, and B primaries. *See also* RGB.
Hz	hertz—the number of scans read or updates written per second

I

IC	integrated circuit
ID	identification
IEEE	Institute of Electrical and Electronics Engineers
in.	inches
instrument driver	a set of high-level software functions, such as NI-IMAQ, that controls specific plug-in computer boards; instrument drivers are available in several forms, ranging from a function callable from a programming language to a virtual instrument (VI) in LabVIEW
interlaced	a video frame composed of two interleaved fields; the number of lines in a field are half the number of lines in an interlaced frame
interpreter	a software utility that executes source code from a high-level language such as Basic, C or Pascal, by reading one line at a time and executing the specified operation
interrupt	a computer signal indicating that the CPU should suspend its current task to service a designated activity
interrupt level	the relative priority at which a device can interrupt
I/O	input/output—the transfer of data to/from a computer system involving communications channels, operator interface devices, and/or data acquisition and control interfaces
IRQ	interrupt request

K

k	kilo—the standard metric prefix for 1,000, or 10^3, used with units of measure such as volts, hertz, and meters
K	kilo—the prefix for 1,024, or 2^{10}, used with B in quantifying data or computer memory
kbytes/s	a unit for data transfer that means 1,000 or 10^3 bytes/s
Kword	1,024 words of memory

L

line count	the total number of horizontal lines in the picture
LSB	least significant bit
LUT	look-up table—a selection in the IMAQ Configuration Utility that contains formulas that let you implement simple imaging operations such as contrast enhancement, data inversion, gamma manipulation, or other nonlinear transfer functions

M

m	meters
M	(1) Mega, the standard metric prefix for 1 million or 10^6, when used with units of measure such as volts and hertz; (2) mega, the prefix for 1,048,576, or 2^{20}, when used with B to quantify data or computer memory
MB	megabytes of memory
Mbytes/s	a unit for data transfer that means 1 million or 10^6 bytes/s
memory buffer	*See* buffer.
memory window	continuous blocks of memory that can be accessed quickly by changing addresses on the local processor
MSB	most significant bit

MTBF	mean time between failure
mux	multiplexer—a switching device with multiple inputs that selectively connects one of its inputs to its output

N

NI-IMAQ	driver software for National Instruments IMAQ hardware
noninterlaced	a video frame where all the lines are scanned sequentially, instead of divided into two frames as in an interlaced video frame
NVRAM	nonvolatile RAM—RAM that is not erased when a device loses power or is turned off

O

operating system	base-level software that controls a computer, runs programs, interacts with users, and communicates with installed hardware or peripheral devices

P

PAL	Phase Alternation Line—one of the European video color standards; uses 625 lines per frame.
PCI	Peripheral Component Interconnect—a high-performance expansion bus architecture originally developed by Intel to replace ISA and EISA; it is achieving widespread acceptance as a standard for PCs and workstations and offers a theoretical maximum transfer rate of 132 Mbytes/s
PFI	programmable function input
PGIA	programmable gain instrumentation amplifier
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

pixel count	the total number of pixels between two HYSNCs; the pixel count determines the frequency of the pixel clock
PLL	phase-locked loop—circuitry that provides a very stable pixel clock that is referenced to another signal, for example, an incoming HSYNC signal
protocol	the exact sequence of bits, characters, and control codes used to transfer data between computers and peripherals through a communications channel
pts	points
PXI	PCI eXtensions for Instrumentation—an open specification that builds on the CompactPCI specification by adding instrumentation-specific features

R

RAM	random-access memory
real time	a property of an event or system in which data is processed as it is acquired instead of being accumulated and processed at a later time
relative accuracy	a measure in LSB of the accuracy of an ADC; it includes all nonlinearity and quantization errors but does not include offset and gain errors of the circuitry feeding the ADC
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	red, green, and blue—the three primary colors used to represent a color picture. An RGB camera is a camera that deliver three signals, one for each primary.
ribbon cable	a flat cable in which the conductors are side by side
ROI	region of interest—a hardware-programmable rectangular portion of the acquisition window
ROM	read-only memory
RS-170	the U.S. standard used for black-and-white television

RTSI bus	Real-Time System Integration Bus—the National Instruments timing bus that connects IMAQ and DAQ boards directly, by means of connectors on top of the boards, for precise synchronization of functions

S

s	seconds
saturation	the richness of a color. A saturation of zero corresponds to no color, that is, a gray pixel. Pink is a red with low saturation.
scaling down circuitry	circuitry that scales down the resolution of a video signal
scatter-gather DMA	a type of DMA that allows the DMA controller to reconfigure on-the-fly
SDRAM	synchronous dynamic RAM
SO-DIMM	small outline dual inline memory module
SRAM	static RAM
sync	tells the display where to put a video picture; the horizontal sync indicates the picture's left-to-right placement and the vertical sync indicates top-to-bottom placement
system RAM	RAM installed on a personal computer and used by the operating system, as contrasted with onboard 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 the 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

VCO	voltage-controlled oscillator—an oscillator that changes frequency depending on a control signal; used in a PLL to generate a stable pixel clock
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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