

IMAQ™

IMAQ PCI-1424 User Manual

**High-Quality Digital Image
Acquisition Board for PCI**

Worldwide Technical Support and Product Information

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Compliance

FCC/Canada Radio Frequency Interference Compliance*

Determining FCC Class

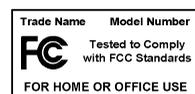
The Federal Communications Commission (FCC) has rules to protect wireless communications from interference. The FCC places digital electronics into two classes. These classes are known as Class A (for use in industrial-commercial locations only) or Class B (for use in residential or commercial locations). Depending on where it is operated, this product could be subject to restrictions in the FCC rules. (In Canada, the Department of Communications (DOC), of Industry Canada, regulates wireless interference in much the same way.)

Digital electronics emit weak signals during normal operation that can affect radio, television, or other wireless products. By examining the product you purchased, you can determine the FCC Class and therefore which of the two FCC/DOC Warnings apply in the following sections. (Some products may not be labelled at all for FCC, if so the reader should then assume these are Class A devices.)

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

FCC Class B products display either a FCC ID code, starting with the letters **EXN**, or the FCC Class B compliance mark that appears as shown here on the right.

The curious reader can consult the FCC web site <http://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 Mark 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 National Instruments 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 will be required to correct the interference at his 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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Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful

interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Canadian Department of Communications

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

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

European Union - Compliance to EEC Directives

Readers in the EU/EEC/EEA must refer to the Manufacturer's Declaration of Conformity (DoC) for information** pertaining to the CE Mark compliance scheme. The Manufacturer includes a DoC for most every hardware product except for those bought for OEMs, if also available from an original manufacturer that also markets in the EU, or where compliance is not required as for electrically benign apparatus or cables.

* Certain exemptions may apply in the USA, see FCC Rules §15.103 **Exempted devices**, and §15.105(c). Also available in sections of CFR 47.

** The CE Mark Declaration of Conformity will contain important supplementary information and instructions for the user or installer.

Conventions

The following conventions are used in this manual:



This icon denotes a note, which alerts you to important information.



This icon denotes a warning, which advises you of precautions to take to avoid being electrically shocked.

bold

Bold text denotes items that you must select or click on 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, and code excerpts.

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Introduction

This chapter describes the PCI-1424 and describes your software programming choices.

About the PCI-1424

The PCI-1424 is a highly flexible, monochrome and color, PCI-based IMAQ board that supports a diverse range of digital cameras from many camera companies. The PCI-1424 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 32 bits of data at a time at clock speeds up to 50 MHz.¹

The PCI-1424 is simple to configure so that you can easily install the board and begin acquiring images. The PCI-1424 ships with NI-IMAQ, the National Instruments complete IMAQ driver software you can use to directly control the PCI-1424 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-1424 is ideal for both industrial and scientific environments. As a standalone board, the PCI-1424 supports up to 32 bits of differential or TTL level 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-1424 and NI-IMAQ with the National Instruments data acquisition (DAQ) product line.

¹ Early versions of the PCI-1424 may not support acquisitions at 50 MHz. For the exact maximum acquisition clock rate of your PCI-1424, see the **Maximum Clock Rate** indicator in Measurement & Automation Explorer.

A common problem with image acquisition boards is that you cannot easily synchronize several functions to a common trigger or timing event. The PCI-1424 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-1424 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-1424 are in Appendix A, [Specifications](#).

Software Programming Choices

Using NI-IMAQ, the National Instruments image acquisition driver software, you can program your IMAQ board to acquire and save images. You can use NI-IMAQ with other National Instruments software for a complete image acquisition and analysis solution, as shown in Figure 1. NI-IMAQ works with LabVIEW, BridgeVIEW, LabWindows/CVI, as well as conventional programming languages. National Instruments IMAQ Vision adds powerful image processing and analysis to these programming environments. You can also use IMAQ Vision Builder to quickly and easily prototype your IMAQ image analysis applications.

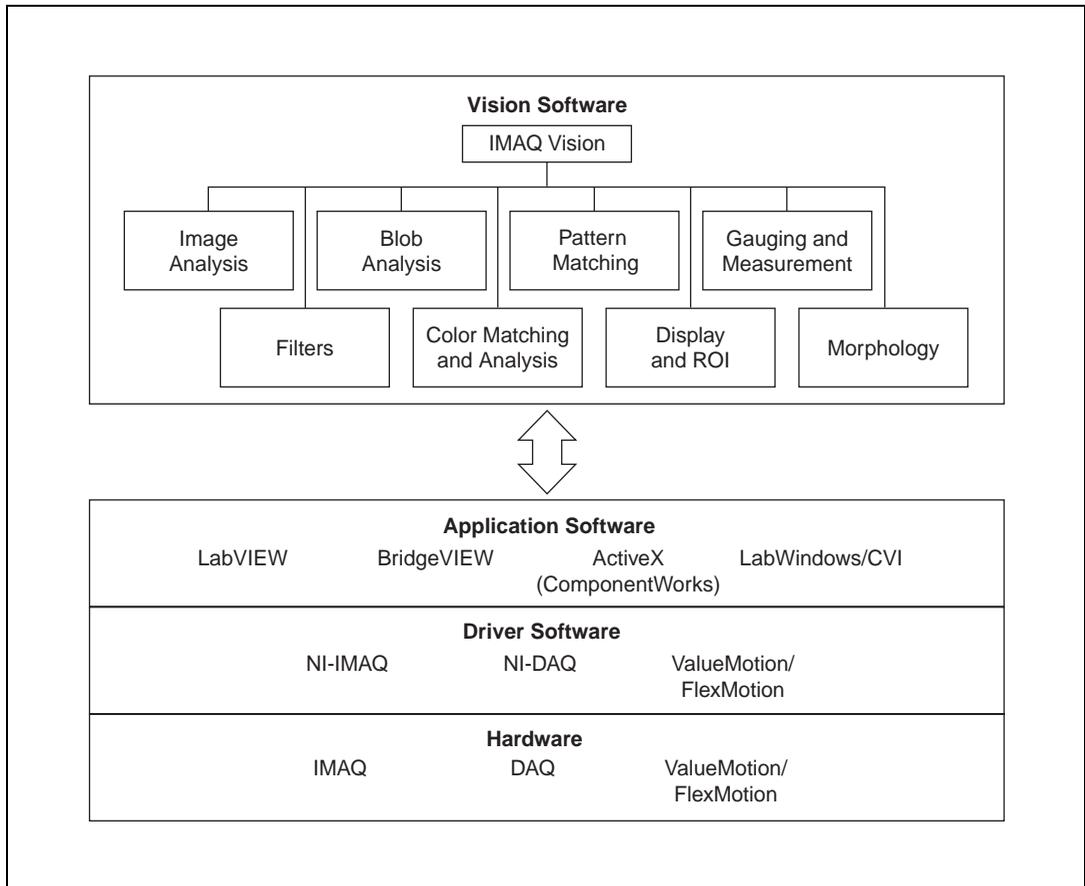


Figure 1-1. The Relationship between the Programming Environment, NI-IMAQ, and Your Hardware

NI-IMAQ Driver Software

The NI-IMAQ driver software is included with your IMAQ device. 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.

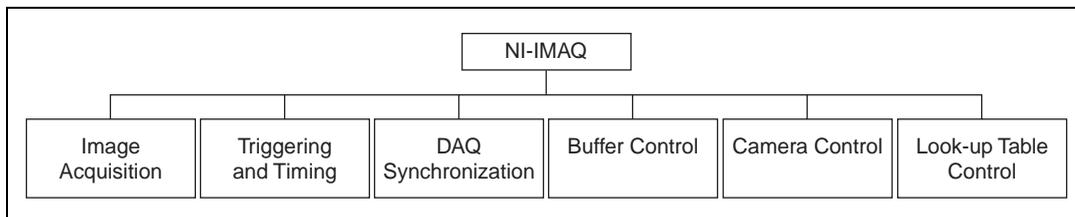


Figure 1-2. NI-IMAQ Functions

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 IMAQ Vision* section 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 your IMAQ device and image acquisition.

NI-IMAQ internally resolves many of the complex issues between the computer and your IMAQ device, such as programming interrupts and DMA controllers.

NI-IMAQ is also the interface path between LabVIEW, BridgeVIEW, LabWindows/CVI, or a conventional programming environment and your IMAQ device. The NI-IMAQ software kit includes a series of libraries for G, LabWindows/CVI, and ComponentWorks (ActiveX) that are functionally equivalent to the NI-IMAQ software.

National Instruments IMAQ Vision

IMAQ Vision is an image acquisition, processing, and analysis library of more than 200 functions for grayscale, color, and binary image display, image processing, pattern matching, shape matching, blob analysis, gauging, and measurement.

You can use IMAQ Vision functions directly or in combination for unique image processing. With IMAQ Vision you can acquire, display, manipulate, and store images as well as perform image analysis, processing, and

interpretation. Using IMAQ Vision, 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 is available for LabVIEW, BridgeVIEW, LabWindows/CVI, Microsoft Visual C++, or ComponentWorks.

IMAQ Vision Builder

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 1-3, IMAQ Vision Builder generates a Builder file, which is a text description that contains a recipe of the machine vision and image processing functions. This Builder file provides a guide you can use to develop applications with IMAQ Vision in LabVIEW, BridgeVIEW, LabWindows/CVI, and ComponentWorks.

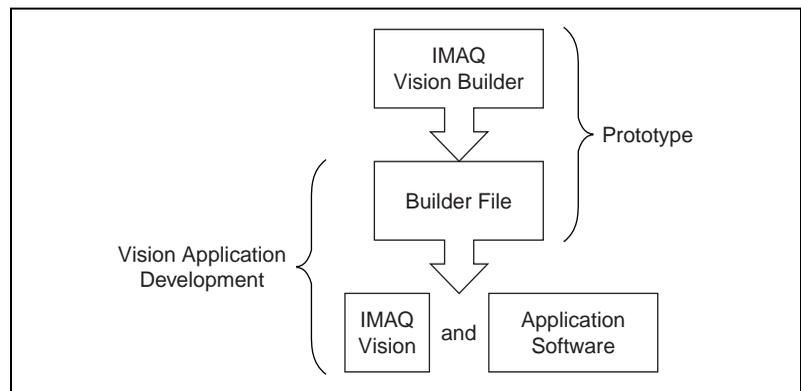


Figure 1-3. IMAQ Vision Builder and Application Development Tools

Integration with DAQ

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

Vision and Motion

With National Instruments IMAQ hardware and IMAQ Vision pattern matching software you can quickly and accurately locate objects in instances where objects vary in size, orientation, focus, and even when the part is poorly illuminated. 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.

Configuration and Installation

This chapter lists what you need to get started acquiring images with your IMAQ device; describes optional equipment and custom cables; and explains how to unpack, configure, and install your IMAQ device.

What You Need to Get Started

To set up and use your PCI-1424, you will need the following:

- Your PCI-1424
- Getting Started with Your IMAQ System*
- IMAQ PCI-1424 User Manual*
- NI-IMAQ release notes
- NI-IMAQ for Windows 2000/NT/9x and documentation
- Optional software packages and documentation:
 - IMAQ Vision for G, LabWindows/CVI, or ComponentWorks
 - IMAQ Vision Builder
 - LabVIEW
 - BridgeVIEW
 - LabWindows/CVI
- 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 2000, Windows NT, or Windows 9x
- A digital video camera or other digital video source

Optional Equipment

National Instruments offers a variety of products for use with your PCI-1424, including the following cables and other National Instruments products:

- Cables to connect your digital camera to the PCI-1424
- A four-pod BNC cable, which routes trigger signals to a BNC connector block (IMAQ D2504)
- IMAQ memory modules to increase PCI-1424 onboard memory
- RTSI bus cables for connecting the PCI-1424 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.

How to Set up Your IMAQ System

Use Figure 2-1 as a guide while you install your software and hardware, configure your hardware, and begin using NI-IMAQ in your application programs.

Follow the instructions in the *Getting Started with Your IMAQ System* 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.

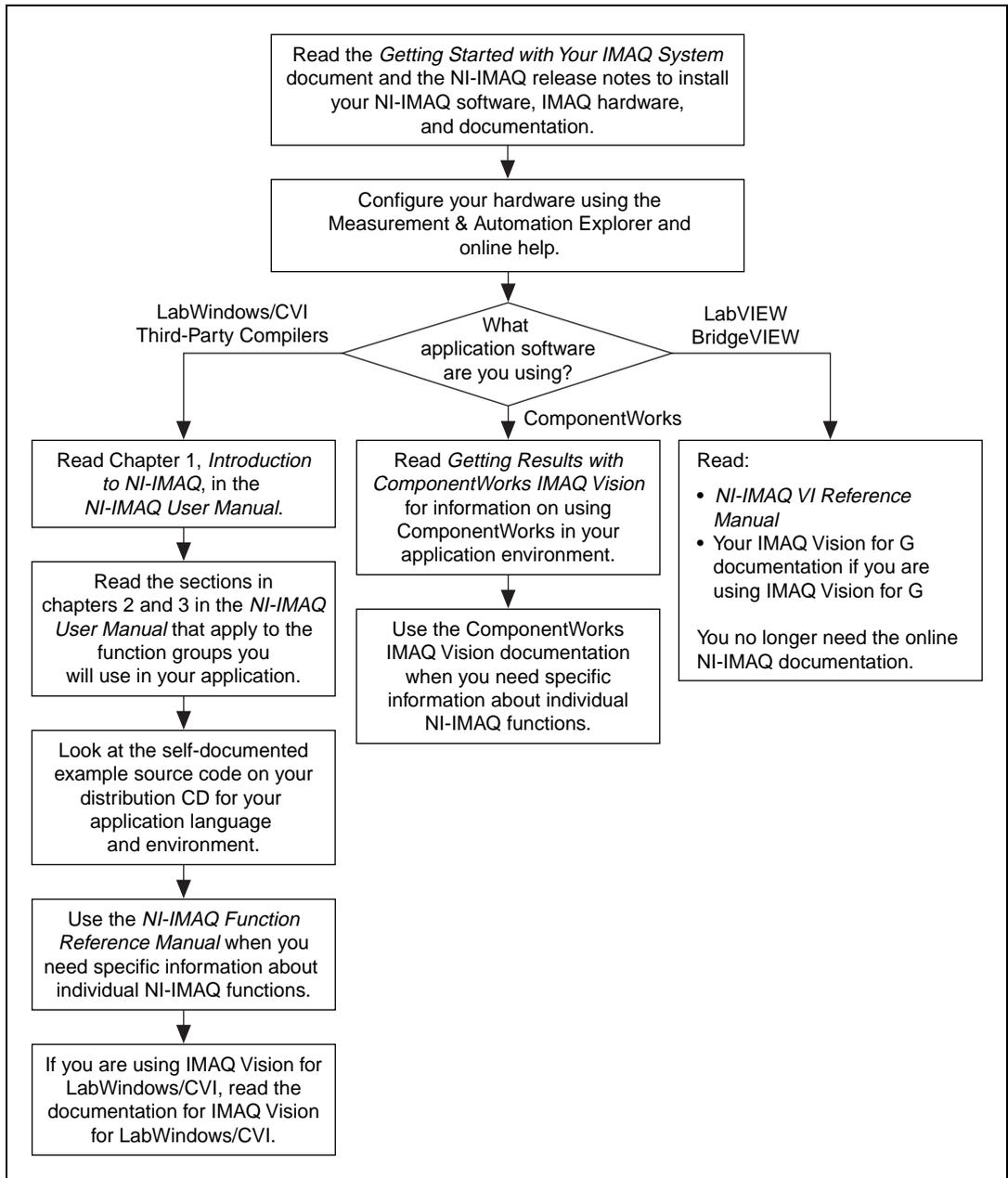


Figure 2-1. How to Set up Your IMAQ System

Unpacking

Your PCI-1424 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.

Board Configuration

The PCI-1424 is fully software configurable. There is only one switch, S1, on this board and it should never be switched. Figure 2-2 shows the location of this switch as well as the factory-default settings on the PCI-1424 device.

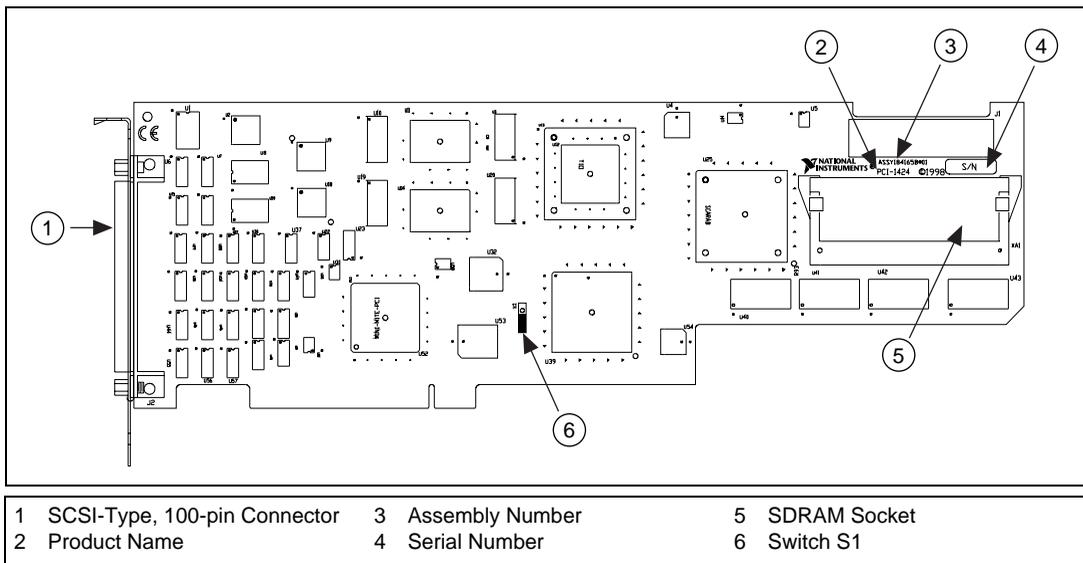


Figure 2-2. PCI-1424 Parts Locator Diagram

Installation



Note You must install the NI-IMAQ driver software before installing your 1424 device. For information on how to install NI-IMAQ, please see the *Getting Started with Your IMAQ System* document and your NI-IMAQ release notes.

You can install the PCI-1424 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-1424 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-1424 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-1424.

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-1424 with the 100-pin SCSI-type connector near the cut-out on the back panel. Slowly push down on the top of the PCI-1424 until its card-edge connector is resting on the expansion slot receptacle. Using slow, evenly distributed pressure, press the PCI-1424 straight down until it seats in the expansion slot.
7. Reinstall the bracket-retaining screw to secure the PCI-1424 to the back panel rail.
8. Check the installation.
9. Replace the computer cover.

Your PCI-1424 is now installed.

Hardware Overview

This chapter presents an overview of the hardware functions on your PCI-1424 board and explains the operation of each functional unit making up the PCI-1424.

Functional Overview

The PCI-1424 features a flexible, high-speed data path optimized for the reception and formatting of video data from digital monochrome and color cameras.

The block diagram in Figure 3-1 illustrates the key functional components of the PCI-1424.

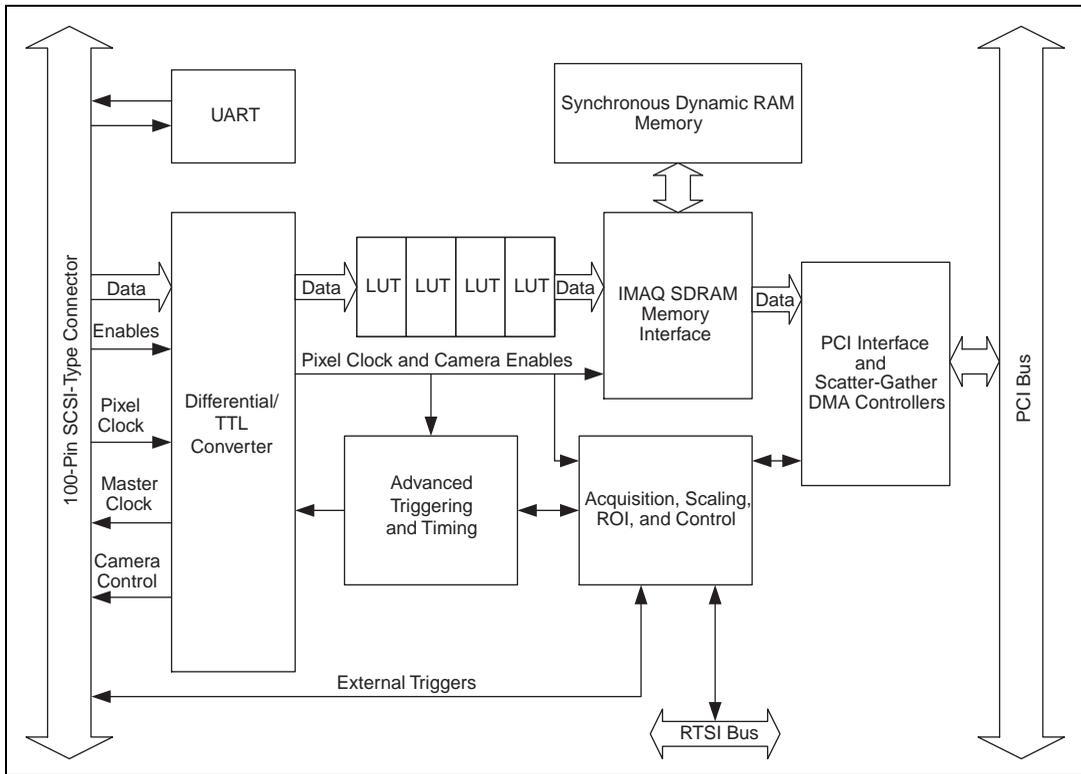


Figure 3-1. PCI-1424 Block Diagram

Differential/TTL Level Converters

The PCI-1424 can drive and receive either TTL or differential-level signals. These signal levels can be controlled independently for the data, control, and enable lines on the 100-pin SCSI connector.

LUTs

The PCI-1424 uses two 64 KB-by-16 bit lookup tables (LUTs) that can also be used to do up to four 256 B-by-8 bit LUT operations. You can configure these LUTs to perform simple imaging operations such as contrast enhancement, data inversion, gamma manipulation, or other nonlinear transfer functions.

Multiple-Tap Data Formatter

Many of the digital cameras on the market send multiple channels or taps of data over the cable 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-1424 can reorder the data from up to four 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-1424 comes with 8 MB of onboard high-speed synchronous dynamic RAM (SDRAM). Additionally, a 144-pin SO-DIMM socket is located on the rear end of the board for adding up to an additional 64 MB of RAM. For more information on purchasing additional RAM, contact National Instruments.

The PCI-1424 can also use the onboard RAM as a first-in first-out (FIFO) buffer so that in some instances, the PCI-1424 can capture images larger than the amount of RAM on the board.

Advanced Clock Generation

The advanced clock generation circuitry on the PCI-1424 generates frequencies from 500 kHz to 50 MHz for digital cameras that require an external clock. Two clock connections on the 100-pin SCSI-type connector can control up to two cameras simultaneously.

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.

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-1424 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-1424, 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-1424 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-1424 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-1424 can perform continuous image transfers directly to either contiguous or fragmented memory buffers.

Bus Master PCI Interface

The PCI-1424 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-1424 can generate 8-, 16-, and 32-bit memory read and write cycles, both single and multiple. In slave mode, the

PCI-1424 is a medium-speed decoder that accepts both memory and configuration cycles. The interface logic ensures that the PCI-1424 can meet PCI loading, driving, and timing requirements.

Board Configuration NVRAM

The PCI-1424 contains onboard nonvolatile RAM (NVRAM) that configures all registers on power-up.

Video Acquisition

The PCI-1424 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-1424 can start acquisitions in a variety of conditions:

- **Software control**—The PCI-1424 supports software control of acquisition start. You can configure the PCI-1424 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-1424 in frame mode, you can program the PCI-1424 to start an acquisition on any odd or even field.

Acquisition Window Control

You can configure numerous parameters on the PCI-1424 to control the video acquisition window. A brief description of each parameter follows:

- **Acquisition window**—The PCI-1424 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-1424 uses a second level of active pixel and active line regions for selecting a region of interest. When you disable the region-of-interest circuitry, the board stores the entire acquisition window in onboard or system memory. However, when you enable the region-of-interest circuitry, the board acquires only a selected subset of the image frame.
- **Scaling down**—The scaling down circuitry also controls the active acquisition region. The PCI-1424 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-1424 can select every pixel, every other pixel, every fourth pixel, or every eighth pixel. For active line selection, the PCI-1424 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-1424 supports both interlaced and non-interlaced, or progressive scan, digital video signals. In interlaced mode, the PCI-1424 combines the odd and even fields into one contiguous frame for analysis. In non-interlaced mode, each field is treated as an independent frame.

Signal Connections

This chapter describes cable connections for the PCI-1424.

I/O Connector

The PCI-1424 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.ni.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-type connector.

Data0+	1	51	Data16+
Data0-	2	52	Data16-
Data1+	3	53	Data17+
Data1-	4	54	Data17-
Data2+	5	55	Data18+
Data2-	6	56	Data18-
Data3+	7	57	Data19+
Data3-	8	58	Data19-
Data4+	9	59	Data20+
Data4-	10	60	Data20-
Data5+	11	61	Data21+
Data5-	12	62	Data21-
Data6+	13	63	Data22+
Data6-	14	64	Data22-
Data7+	15	65	Data23+
Data7-	16	66	Data23-
Data8+	17	67	Data24+
Data8-	18	68	Data24-
Data9+	19	69	Data25+
Data9-	20	70	Data25-
Data10+	21	71	Data26+
Data10-	22	72	Data26-
Data11+	23	73	Data27+
Data11-	24	74	Data27-
Data12+	25	75	Data28+
Data12-	26	76	Data28-
Data13+	27	77	Data29+
Data13-	28	78	Data29-
Data14+	29	79	Data30+
Data14-	30	80	Data30-
Data15+	31	81	Data31+
Data15-	32	82	Data31-
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-1424 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
Data<31..0>±	Data<31..0>± allows you to connect data up to 32 bits wide in either TTL or differential format to the PCI-1424.
Control<3..0>±	You can use the control lines on the PCI-1424 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.
Enable<D..A>±	The PCI-1424 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.
Master Clock<1..0>±	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 50 MHz.
SOUT	Serial Data Out is used for RS-232 connections.
SIN	Serial Data In is used for RS-232 connections.
RI	Ring Indicator is used for RS-232 connections.
DTR	Data Terminal Ready is used for RS-232 connections.
DSR	Data Set Ready is used for RS-232 connections.
RTS	Request to Send is used for RS-232 connections.
CTS	Clear to Send is used for RS-232 connections.
DCD	Data Carrier Detect is used for RS-232 connections.

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

Signal Name	Description
External Trigger<3..0>	External Trigger<3..0> are TTL I/O lines used to start an acquisition or output to control external events. You can program the triggers to be rising 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.
Pixel Clock±	The PCI-1424 uses the Pixel Clock input as a reference clock to latch the incoming video data.
GND	GND is a direct connection to digital ground on the PCI-1424.

Specifications

This appendix lists the specifications of the PCI-1424. 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	Selectable (TTL or differential)

Clocks

Master clock frequency range	500 kHz–50 MHz (± 0.5% of selected frequency) ¹
Pixel clock frequency range	0–50 MHz

¹ Early versions of the PCI-1424 may not support acquisitions at 50 MHz. For the exact maximum acquisition clock rate of your PCI-1424, see the **Maximum Clock Rate** indicator in Measurement & Automation Explorer.

PCI Interface

PCI initiator (master) capability	Supported
PCI target (slave) capability	Supported
Data path.....	32 bits
Card voltage.....	5 V, 12 V, -12 V
Card type.....	32-bit full-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 (2.135 A)
	+12 V (25 mA)
	-12 V (20 mA)

Physical

Dimensions	106.68 by 312 cm (4.2 by 12.283 in.)
Weight	1.1 kg (0.5 lb)

Environment

Operating temperature..... 0–50 °C

Storage temperature –25–70 °C

Technical Support Resources

This appendix describes the comprehensive resources available to you in the Technical Support section of the National Instruments Web site and provides technical support telephone numbers for you to use if you have trouble connecting to our Web site or if you do not have internet access.

NI Web Support

To provide you with immediate answers and solutions 24 hours a day, 365 days a year, National Instruments maintains extensive online technical support resources. They are available to you at no cost, are updated daily, and can be found in the Technical Support section of our Web site at www.ni.com/support

Online Problem-Solving and Diagnostic Resources

- **KnowledgeBase**—A searchable database containing thousands of frequently asked questions (FAQs) and their corresponding answers or solutions, including special sections devoted to our newest products. The database is updated daily in response to new customer experiences and feedback.
- **Troubleshooting Wizards**—Step-by-step guides lead you through common problems and answer questions about our entire product line. Wizards include screen shots that illustrate the steps being described and provide detailed information ranging from simple getting started instructions to advanced topics.
- **Product Manuals**—A comprehensive, searchable library of the latest editions of National Instruments hardware and software product manuals.
- **Hardware Reference Database**—A searchable database containing brief hardware descriptions, mechanical drawings, and helpful images of jumper settings and connector pinouts.
- **Application Notes**—A library with more than 100 short papers addressing specific topics such as creating and calling DLLs, developing your own instrument driver software, and porting applications between platforms and operating systems.

Software-Related Resources

- **Instrument Driver Network**—A library with hundreds of instrument drivers for control of standalone instruments via GPIB, VXI, or serial interfaces. You also can submit a request for a particular instrument driver if it does not already appear in the library.
- **Example Programs Database**—A database with numerous, non-shipping example programs for National Instruments programming environments. You can use them to complement the example programs that are already included with National Instruments products.
- **Software Library**—A library with updates and patches to application software, links to the latest versions of driver software for National Instruments hardware products, and utility routines.

Worldwide Support

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Portugal 351 1 726 9011, Singapore 2265886, Spain 91 640 0085,
Sweden 08 587 895 00, Switzerland 056 200 51 51,
Taiwan 02 2377 1200, United Kingdom 01635 523545

Glossary

Prefix	Meaning	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.
+5V	5 V signal.
/	Per.
Ω	Ohm.
\pm	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 (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.
address	Value 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 specific customer needs.

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	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

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

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: $\text{dB} = 20\log_{10} V1/V2$, 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. A format for electrical connectors.

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 image acquisition board.

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.
- 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. <i>See also</i> RGB.
Hz	Hertz. Frequency in units of 1/second.

I

I/O	Input/output. The transfer of data to/from a computer system involving communications channels, operator interface devices, and/or data acquisition and control interfaces.
IC	Integrated circuit.
IEEE	Institute of Electrical and Electronics Engineers.
in.	Inches.
instrument driver	A set of high-level software functions, such as NI-IMAQ, that control 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. <i>See also</i> compiler.
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.
IRQ	Interrupt request. <i>See</i> interrupt.

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. Table containing values used to transform the gray-level values of an image. For each gray-level value in the image, the corresponding new value is obtained from the look-up table.

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	Megabyte of memory.
Mbytes/s	A unit for data transfer that means 1 million or 10^6 bytes/s.
memory buffer	<i>See</i> 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. *See also* NTSC.

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 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 horizontal synchronization signals. 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 horizontal synchronization 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.

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 Color encoding scheme using red, green, and blue (RGB) color information where each pixel in the color image is encoded using 32 bits: 8 bits for red, 8 bits for green, 8 bits for blue, and 8 bits for the alpha value (unused).

ribbon cable A flat cable in which the conductors are side by side.

ROI Region of interest. An area of the image from a window displaying the image.

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 amount of white added to a pure color. Saturation relates to the richness of a color. A saturation of zero corresponds to a pure color with no white added. 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 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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