

IMAQ™

IMAQ PCI-1424 User Manual

High-Quality Digital Image Acquisition Board for PCI

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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-1424 User Manual* describes the features, functions, and operation of the IMAQ PCI-1424 device.

The IMAQ PCI-1424 is a universal digital camera image acquisition (IMAQ) board designed to acquire color and grayscale images and control digital cameras. The *IMAQ PCI-1424 User Manual* is intended for users with a basic knowledge of image acquisition.

Organization of This Manual

The *IMAQ PCI-1424 User Manual* is organized as follows:

- Chapter 1, *Introduction*, describes the PCI-1424; 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-1424.
- Chapter 2, *Configuration and Installation*, explains how to configure and install your PCI-1424 board.
- Chapter 3, *Hardware Overview*, 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.
- Chapter 4, *Signal Connections*, describes signal connections for the PCI-1424.
- Appendix A, *Specifications*, lists the specifications of the PCI-1424.
- 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 enclose the name of a key on the keyboard—for example, <shift>. 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

Bold text denotes the names of dialog box buttons or options.

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. This font also denotes text from which you supply the appropriate word or value, as in NI-DAQ 6.x.

monospace

Text in this font denotes proper names of disk drives, paths, or directories.

National Instruments Documentation

The *IMAQ PCI-1424 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.

Introduction

This chapter describes the PCI-1424; 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-1424.

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 and is factory calibrated 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.

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

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 the IMAQ Configuration Utility.

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*.

What You Need to Get Started

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

- Your PCI-1424
- Setup and Test Your IMAQ PCI-1424*
- IMAQ PCI-1424 User Manual*
- NI-IMAQ for Windows 95/NT Release Notes*
- NI-IMAQ for Windows 95/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 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 or Windows NT
- A digital video camera or other digital video source

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-1424, 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-1424, 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-1424 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-1424 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.

NI-IMAQ Driver Software

The NI-IMAQ driver software is included at no charge with the PCI-1424. 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. 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-1424 and image acquisition.

NI-IMAQ also internally resolves many of the complex issues between the computer and the PCI-1424, 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-1424.

Any platform that supports NI-IMAQ also supports NI-DAQ and a variety of National Instruments DAQ boards, so your PCI-1424 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 1-1.

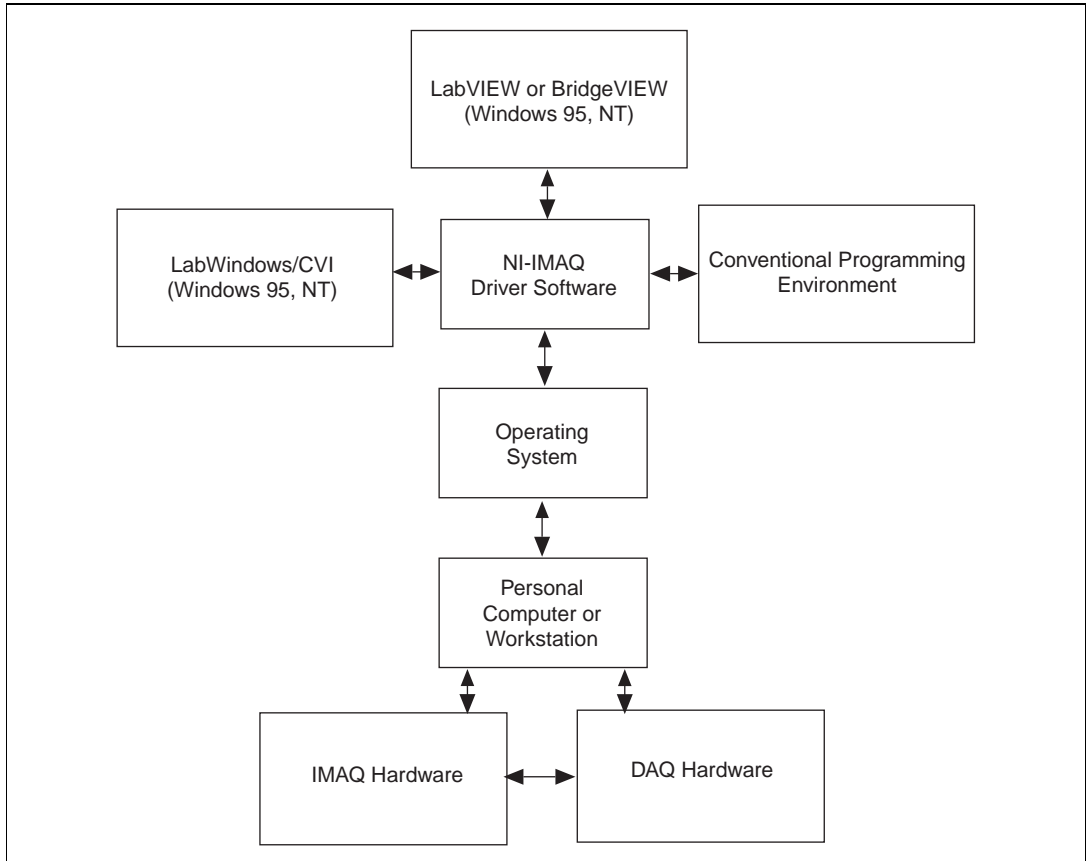


Figure 1-1. The Relationship between the Programming Environment, NI-IMAQ, and Your Hardware

Optional Equipment

National Instruments offers a variety of products for use with your PCI-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.

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.

How to Set up Your IMAQ System

Use Figure 1-2 to install your software and hardware, configure your hardware, and begin using NI-IMAQ in your application programs.

Follow the instructions in the *Setup and Test Your IMAQ PCI-1424* 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.

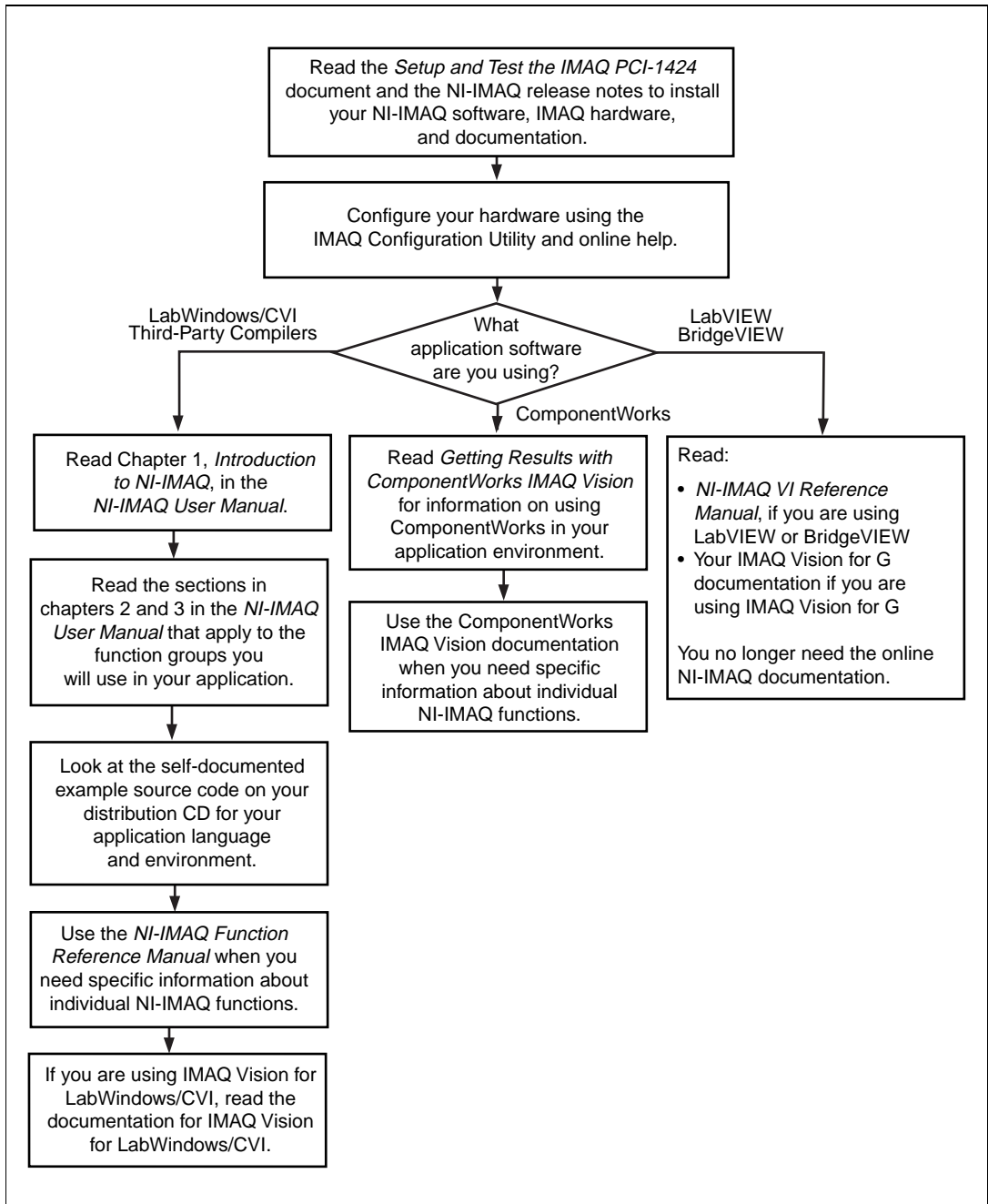


Figure 1-2. How to Set up Your IMAQ System

Configuration and Installation

This chapter explains how to configure and install your PCI-1424 board.

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 2-1 shows the location of this switch as well as the factory-default settings on the PCI-1424 device.

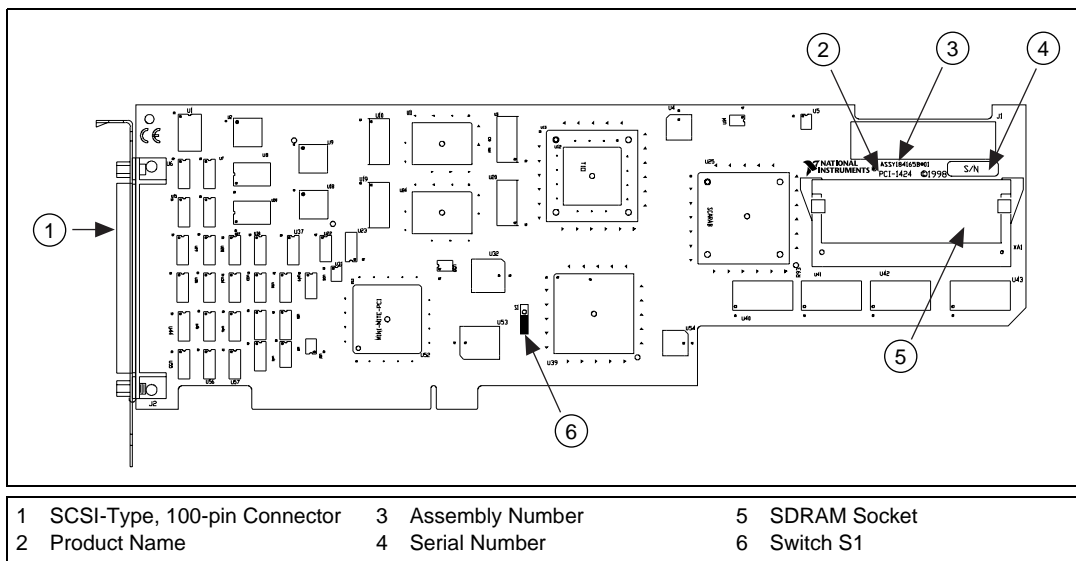


Figure 2-1. PCI-1424 Parts Locator Diagram

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 Setup and Test Your IMAQ PCI-1424 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.

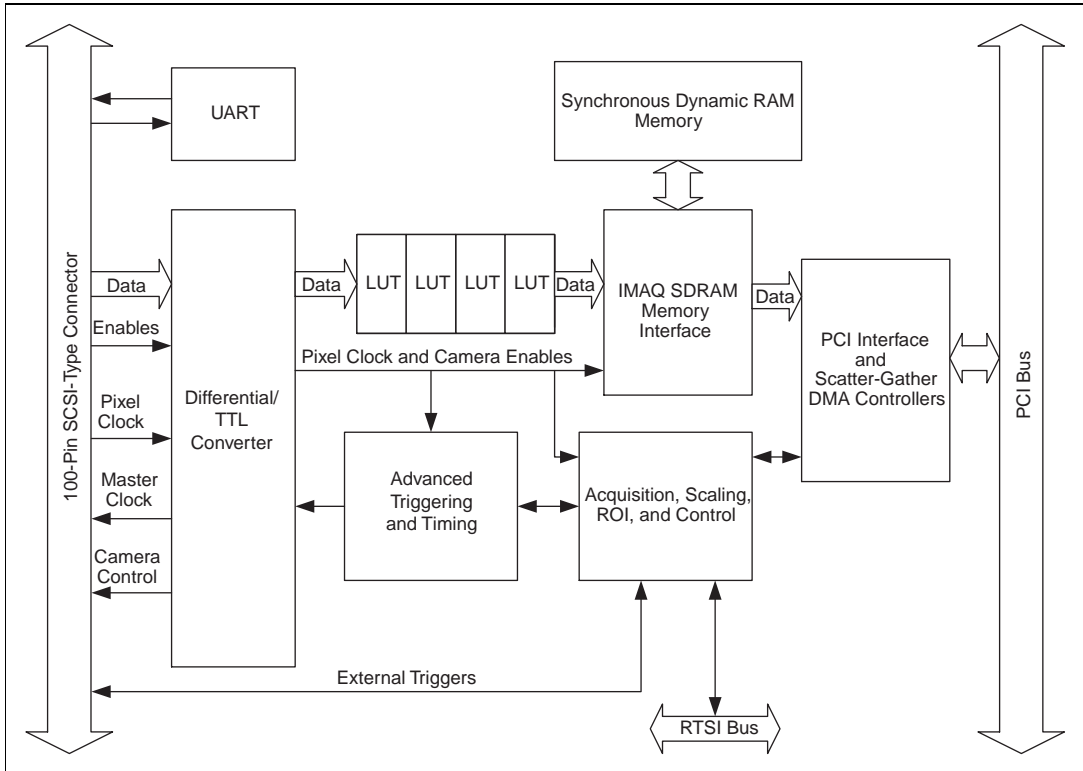


Figure 3-1. PCI-1424 Block Diagram

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-type 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 into with 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.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	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> \pm	Data<31..0> \pm allows you to connect data up to 32 bits wide in either TTL or differential format to the PCI-1424.
Control<3..0> \pm	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> \pm	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> \pm	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.
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.

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

Signal Name	Description
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 the IMAQ Configuration Utility.

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

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.

National Instruments has technical assistance through electronic, fax, and telephone systems to quickly provide the information you need. Our electronic services include a bulletin board service, an FTP site, a fax-on-demand system, and e-mail support. If you have a hardware or software problem, first try the electronic support systems. If the information available on these systems does not answer your questions, we offer fax and telephone support through our technical support centers, which are staffed by applications engineers.

Electronic Services

Bulletin Board Support

National Instruments has BBS and FTP sites dedicated for 24-hour support with a collection of files and documents to answer most common customer questions. From these sites, you can also download the latest instrument drivers, updates, and example programs. For recorded instructions on how to use the bulletin board and FTP services and for BBS automated information, call 512 795 6990. You can access these services at:

United States: 512 794 5422

Up to 14,400 baud, 8 data bits, 1 stop bit, no parity

United Kingdom: 01635 551422

Up to 9,600 baud, 8 data bits, 1 stop bit, no parity

France: 01 48 65 15 59

Up to 9,600 baud, 8 data bits, 1 stop bit, no parity

FTP Support

To access our FTP site, log on to our Internet host, `ftp.natinst.com`, as anonymous and use your Internet address, such as `joesmith@anywhere.com`, as your password. The support files and documents are located in the `/support` directories.

Fax-on-Demand Support

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

Telephone and Fax Support

National Instruments has branch offices all over the world. Use the list below to find the technical support number for your country. If there is no National Instruments office in your country, contact the source from which you purchased your software to obtain support.

Country	Telephone	Fax
Australia	03 9879 5166	03 9879 6277
Austria	0662 45 79 90 0	0662 45 79 90 19
Belgium	02 757 00 20	02 757 03 11
Brazil	011 288 3336	011 288 8528
Canada (Ontario)	905 785 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	01 48 14 24 24	01 48 14 24 14
Germany	089 741 31 30	089 714 60 35
Hong Kong	2645 3186	2686 8505
Israel	03 6120092	03 6120095
Italy	02 413091	02 41309215
Japan	03 5472 2970	03 5472 2977
Korea	02 596 7456	02 596 7455
Mexico	5 520 2635	5 520 3282
Netherlands	0348 433466	0348 430673
Norway	32 84 84 00	32 84 86 00
Singapore	2265886	2265887
Spain	91 640 0085	91 640 0533
Sweden	08 730 49 70	08 730 43 70
Switzerland	056 200 51 51	056 200 51 55
Taiwan	02 377 1200	02 737 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-1424 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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Title: *IMAQ PCI-1424 User Manual*

Edition Date: June 1998

Part Number: 321869A-01

Please comment on the completeness, clarity, and organization of the manual.

If you find errors in the manual, please record the page numbers and describe the errors.

Thank you for your help.

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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
+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 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

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: $\text{dB} = 20\log_{10} V_1/V_2$, 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. <i>See also</i> RGB.
Hz	hertz—the number of scans read or updates written per 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
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
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 ConfigurationUtility 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	<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.
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

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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