IMAQ™

IMAQ PCI/PXI™-1408 User Manual

High-Quality Monochrome Image Acquisition Boards for PCI, PXI, and CompactPCI Bus

NATIONAL INSTRUMENTS™

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FCC/Canada Radio Frequency Interference Compliance*

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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.

Trade Name Model Number
Tested to Comply with FCC Standards
FOR HOME OR OFFICE USE

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.

Class B

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.

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* 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:

♦ — The ♦ symbol indicates that the following text applies only to a specific product, a specific operating system, or a specific software version.

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.

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.

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1 Introduction

This chapter describes the PCI-1408 and PXI-1408 devices and describes your software programming choices.

About Your 1408 Device

The PCI-1408 and PXI-1408 devices are high-accuracy, monochrome, IMAQ boards for PCI, PXI, or CompactPCI chassis that support RS-170, CCIR, NTSC, and PAL video standards as well as some nonstandard cameras from any of four input sources. The boards feature an 8-bit flash analog-to-digital converter (ADC) that converts video signals to digital formats. The 1408 devices acquire frames in real time and transfer them directly to system memory.

The 1408 device is simple to configure so that you can easily install the board and begin your image acquisition. The 1408 device ships with NI-IMAQ, the National Instruments complete image acquisition driver software you can use to directly control your 1408 device. Using NI-IMAQ, you can quickly and easily start your application without having to program the board at the register level.

Featuring low cost and high accuracy, the 1408 device is ideal for both industrial and scientific environments. As a standalone board, the 1408 device supports four video sources and four external I/O lines that you can use as triggers or digital I/O lines. If you require more advanced triggering or additional I/O lines (either digital or analog), you can use the 1408 device 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 1408 device 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 1408 device and up to four National Instruments DAQ boards in your computer. The RTSI bus can even synchronize multiple 1408 device image captures.

Detailed specifications of the PCI-1408 and PXI-1408 are in Appendix A, *Specifications*.

Using PXI with CompactPCI

Using PXI-compatible products with standard CompactPCI products is an important feature provided by the *PXI Specification*, Revision 1.0. If you use a PXI-compatible plug-in device in a standard CompactPCI chassis, you will be unable to use PXI-specific functions, but you can still use the basic plug-in device functions. For example, the RTSI bus on your PXI-1408 device is available in a PXI chassis, but not in a CompactPCI chassis.

The CompactPCI specification permits vendors to develop sub-buses that coexist with the basic PCI interface on the CompactPCI bus. Compatible operation is not guaranteed between CompactPCI devices with different sub-buses nor between CompactPCI devices with sub-buses and PXI. The standard implementation for CompactPCI does not include these sub-buses. Your PXI-1408 device will work in any standard CompactPCI chassis adhering to the *PICMG 2.0 R2.1 CompactPCI* core specification using the 64-bit definition for J2.

PXI specific features are implemented on the J2 connector of the CompactPCI bus. Table 1-1 lists the J2 pins your PXI-1408 device uses. Your PXI device is compatible with any CompactPCI chassis with a sub-bus that does not drive these lines. Even if the sub-bus is capable of driving these lines, the PXI device is still compatible as long as those pins on the sub-bus are disabled by default and not ever enabled. Damage may result if these lines are driven by the sub-bus.

Table 1-1. Pins Used by the PXI-1408 Device

PXI-1408 Signal	PXI Pin Name	PXI J2 Pin Number
RTSI Trigger <0..6>	PXI Trigger <0..6>	B16, A16, A17, A18, B18, C18, E18

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.

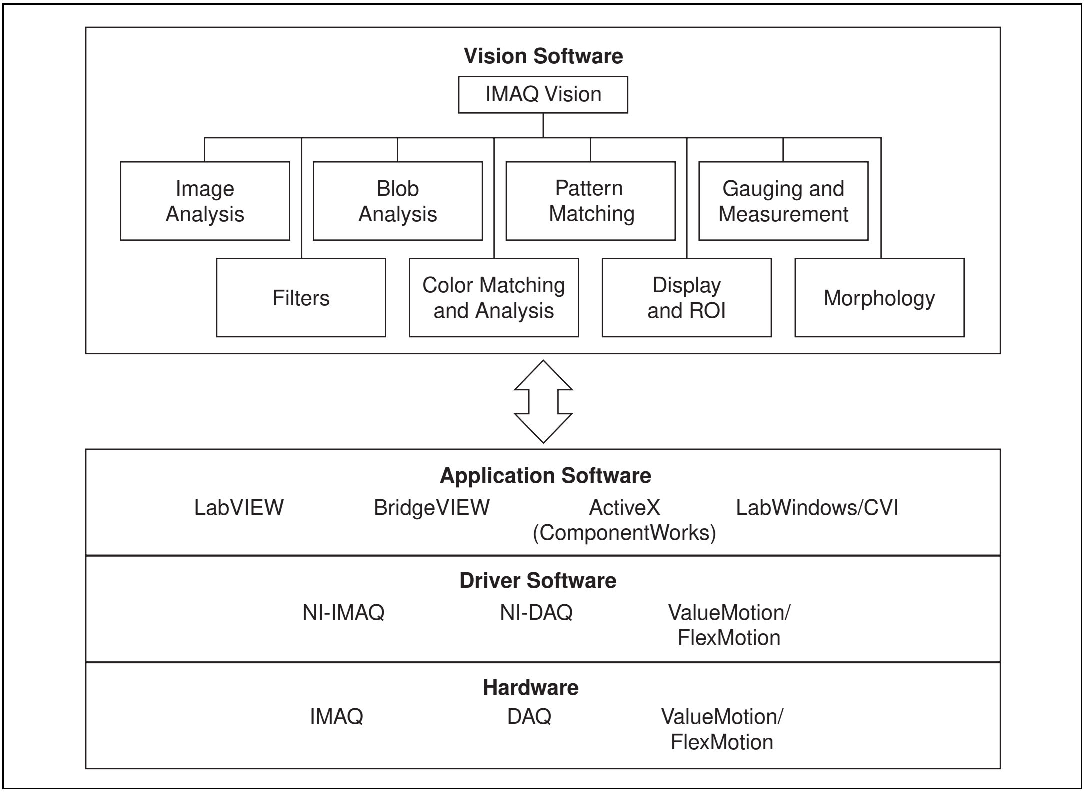


Figure 1-1. The Relationship between the Programming Environment, NI-IMAQ, and Your Hardware

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.

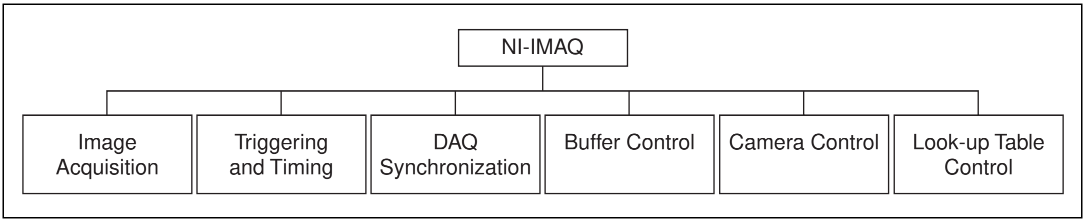


Figure 1-2. NI-IMAQ Functions

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.

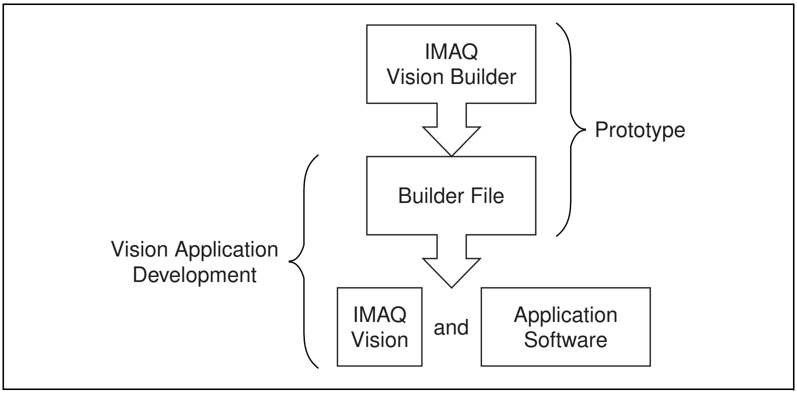


Figure 1-3. IMAQ Vision Builder and Application Development Tools

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.

2

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 1408 device, you will need the following:

- ❑ One of the following 1408 devices:
  - PCI-1408
  - PXI-1408
- ❑ *Getting Started with Your IMAQ System*
- ❑ NI-IMAQ release notes
- ❑ *IMAQ PCI/PXI-1408 User Manual*
- ❑ NI-IMAQ for Windows 2000/NT/9*x* and online documentation
- ❑ Optional software packages and documentation:
  - IMAQ Vision for G, LabWindows/CVI, or ComponentWorks
  - IMAQ Vision Builder
  - LabVIEW
  - BridgeVIEW
  - LabWindows/CVI
- ❑ IMAQ BNC-1 shielded, 75 Ω BNC cable for VIDEO0 (included with the 1408 device)
- ❑ IMAQ A2504 video cable (optional—for trigger and additional camera support)
- ❑ IMAQ A2514 video cable (optional—for complete trigger, additional camera, and external synchronization support)

❑ BNC-to-RCA adapter (included with your 1408 device)

❑ Your Pentium-based PCI, PXI, or CompactPCI computer running Windows 2000, Windows NT, Windows 98, or Windows 95

❑ A video camera or other video source

Note The IMAQ PCI-1408 and PXI-1408 devices rely on your computer's PCI interface chipset for the highest throughput to system memory. For the best results, your computer should have a Pentium or better processor and an Intel 430 or 440 series or compatible PCI interface chipset.

Optional Equipment

National Instruments offers a variety of products for use with your PCI/PXI-1408 board, including the following cables and other National Instruments products:

- A four-pod BNC cable, which routes video and trigger signals to a BNC connector block (IMAQ A2504)
- A 14-pod BNC cable, which routes all video, trigger, and synchronization signals to a BNC connector block (IMAQ A2514)
- RTSI bus cables for connecting the 1408 device 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 catalog 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.

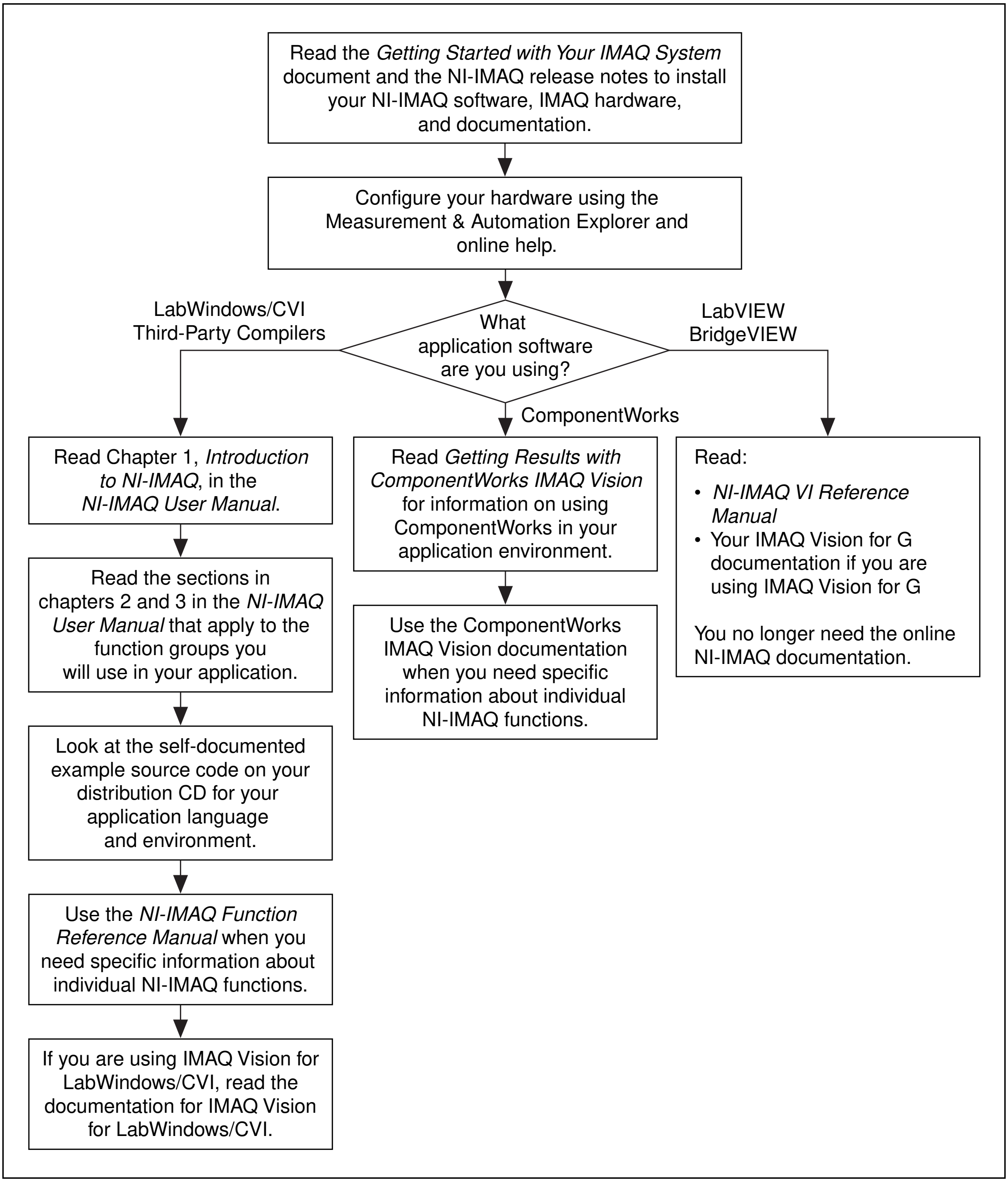


Figure 2-1. How to Set up Your IMAQ System

Unpacking

Your 1408 device 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.

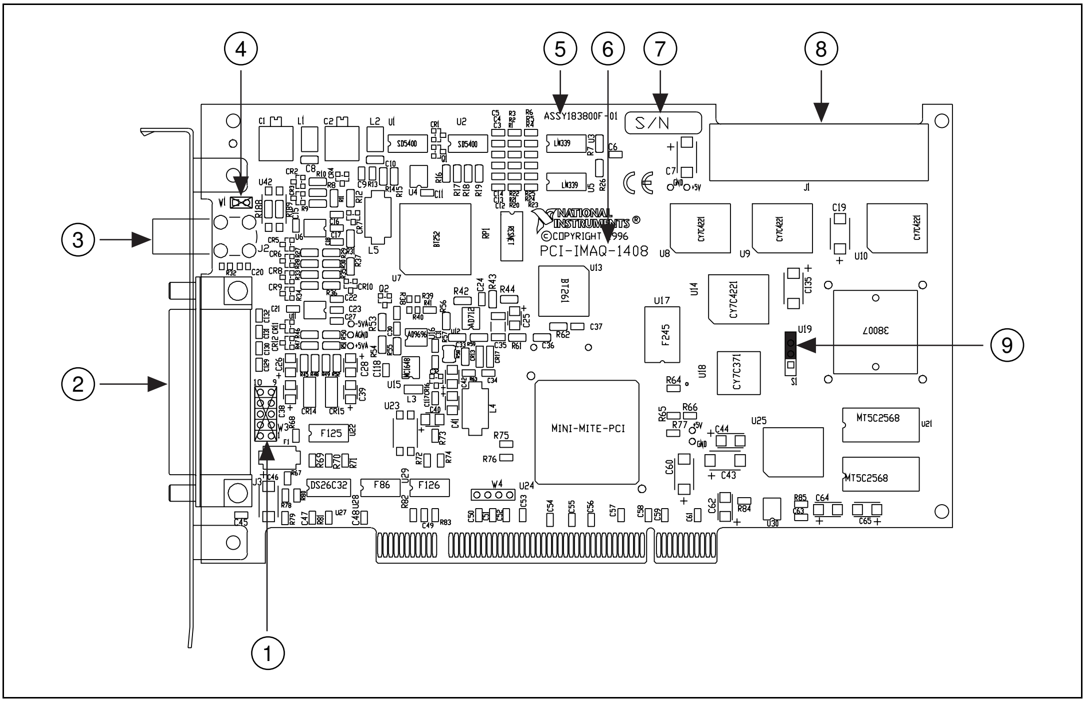
Board Configuration

This section describes how to configure the following options on the 1408 device:

- VIDEO0 input mode
- External CLK and synchronization input mode

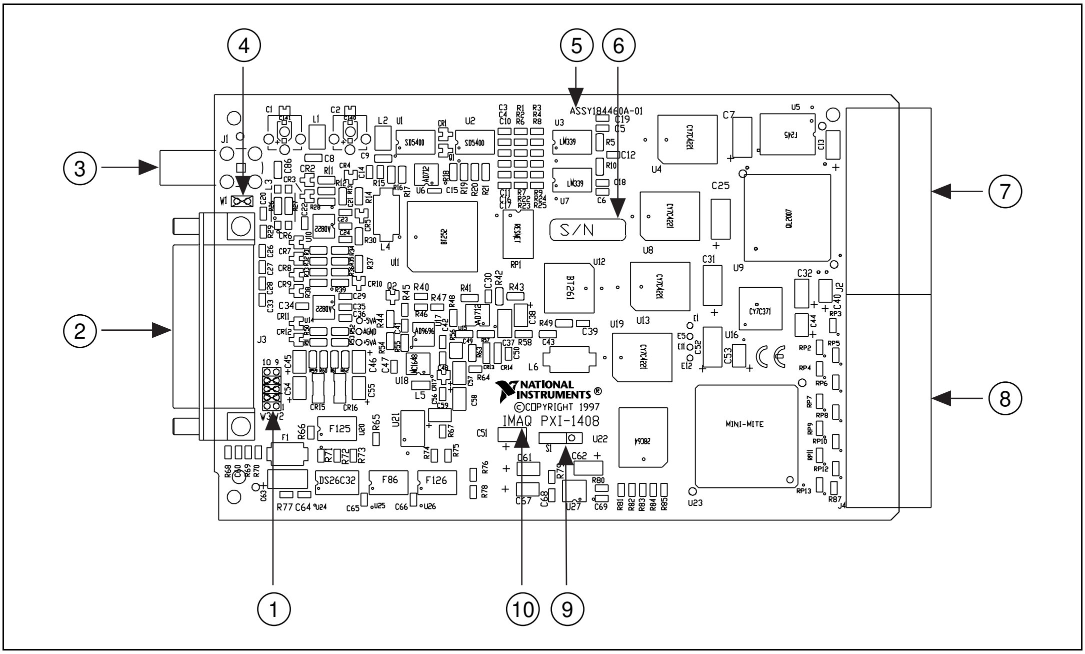
All other configuration options are software configurable.

Figures 2-2 and 2-3 show the locations of user-configurable jumpers and switches as well as factory-default settings on the PCI-1408 and PXI-1408 devices, respectively.



1	W3	3	BNC Connector	6	Product Name	8	RTSI Bus Connector
2	25-Pin DSUB Connector	4	W1	7	Serial Number	9	Logical Address Switch (S1)
		5	Assembly Number				

Figure 2-2. PCI-1408 Parts Locator Diagram



1 W2, W3	3 BNC Connector	6 Serial Number	9 Logical Address Switch (S1)
2 25-Pin DSUB Connector	4 W1	7 J2	10 Product Name
	5 Assembly Number	8 J4	

Figure 2-3. PXI-1408 Parts Locator Diagram

VIDEO0 Input Mode

VIDEO0 has two different input sources via a BNC connector or a 25-pin DSUB port and two different input modes—referenced single-ended (RSE) and differential (DIFF) input. When you use the BNC input for VIDEO0, set the input mode to RSE (W1 populated). When you use the 25-pin DSUB port for VIDEO0, set the input mode for either RSE or DIFF.

When in RSE mode, the video input uses one analog input line, which connects to the video multiplexer circuitry. The negative input to the video multiplexer is tied internally to analog ground. When in DIFF mode, the video input uses two analog input signals. One signal connects to the positive input of the video multiplexer circuitry while the other input signal connects to the negative input of the video multiplexer circuitry. Jumper W1 controls the input mode selection, as shown in Figure 2-4. Unpopulating W1 configures VIDEO0 for DIFF mode. Populating W1 configures VIDEO0 for RSE mode.

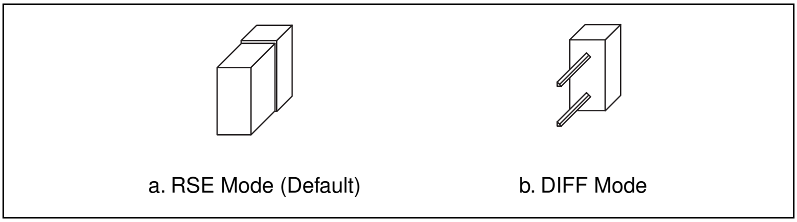


Figure 2-4. Configuring VIDEO0 with Jumper W1

Video channels 1, 2, and 3 are always in differential mode. To take an RSE measurement on these channels, tie the negative terminal of the connector to ground (Pin 9 on the 25-pin DSUB connector). See Chapter 4, *Signal Connections*, for more information on pin assignments.

External CLK and Synchronization Input Mode

The external PCLK, VSYNC, HSYNC, and CSYNC signals have two different input modes—RSE (TTL) and DIFF (RS-422) input. In RSE mode, the input uses one analog input line, which connects to the synchronization selection circuitry. The negative input to the synchronization selection circuitry is tied internally to analog ground. For RSE mode, populate all five sets of jumpers on W3, as shown in Figure 2-5. In DIFF mode, the input uses two analog input signals. One signal connects to the positive input of the synchronization selection circuitry while the other input connects to the negative input of the synchronization selection circuitry.

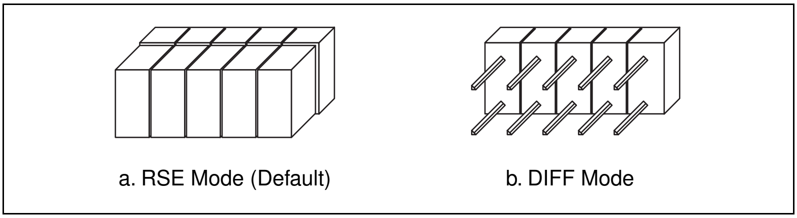


Figure 2-5. Configuring PCLK, VSYNC, HSYNC, and CSYNC with Jumper W3

Switch S1

Switch S1 is unused and should always be in the ON position, as shown in Figure 2-6.

Figure 2-6. Switch S1

Installation

Note You must install the NI-IMAQ driver software before installing your 1408 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.

♦ PCI-1408

You can install the PCI-1408 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-1408 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-1408 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 1408 device.

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-1408 with the 25-pin DSUB and BNC connectors near the cut-out on the back panel. Slowly push down on the top of the PCI-1408 until its card-edge connector is resting on the expansion slot receptacle. Using slow, evenly distributed pressure, press the PCI-1408 straight down until it seats in the expansion slot.
7. Reinstall the bracket-retaining screw to secure the PCI-1408 to the back panel rail.
8. Check the installation.
9. Replace the computer cover.

Your PCI-1408 is now installed.

- PXI-1408

You can install a PXI-1408 in any available 5 V peripheral slot in your PXI or CompactPCI chassis.

Note The PXI-1408 has connections to several reserved lines on the CompactPCI J2 connector. Before installing a PXI-1408 in a CompactPCI system that uses J2 connector lines for purposes other than PXI, see *Using PXI with CompactPCI*, in Chapter 1, *Introduction*, of this manual.

1. Turn off and unplug your PXI or CompactPCI chassis.
2. Choose an unused PXI or CompactPCI 5 V peripheral slot. Install the PXI-1408 in a slot that supports bus arbitration or bus-master cards. PXI-compliant chassis must have bus arbitration for all slots.
3. Remove the filler panel for the peripheral slot you have chosen.
4. Touch a metal part on your chassis to discharge any static electricity that might be on your clothes or body.
5. Insert the PXI-1408 in the selected 5 V slot. Use the injector/ejector handle to fully inject the device into place.
6. Screw the front panel of the PXI-1408 to the front panel mounting rails of the PXI or CompactPCI chassis.
7. Visually verify the installation.
8. Plug in and turn on the PXI or CompactPCI chassis.

Your PXI-1408 is now installed.

3

Hardware Overview

This chapter presents an overview of the hardware functions on your 1408 device and explains the operation of each functional unit making up the 1408 device.

Functional Overview

The 1408 device features an 8-bit flash ADC that converts video signals to digital formats, four video signal multiplexers, and programmable gain and offset. It also uses a PCI interface for high-speed data transfer, scatter-gather DMA controllers that control the transfer of data between the first-in, first-out (FIFO) memory buffers and the PCI bus, nonvolatile and static RAM for configuring registers on power-up and programming the DMA controllers, and acquisition and region-of-interest control circuitry that monitors video signals. The board also includes powerful trigger circuitry including four external triggers and RTSI bus triggers. Other features include internally generated or externally input CSYNC, HSYNC, VSYNC, and PCLK synchronization and clock signals.

The block diagram in Figure 3-1 illustrates the key functional components of the 1408 device.

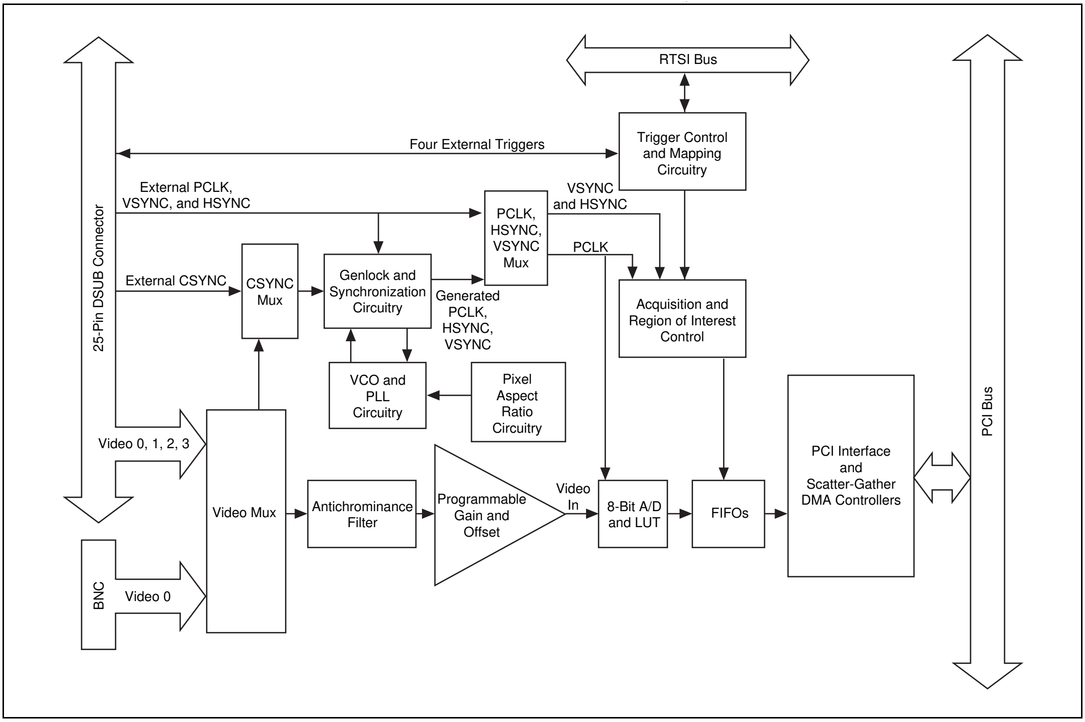


Figure 3-1. 1408 Device Block Diagram

Video Mux

You can select any of the four AC-coupled video inputs through the video multiplexer circuitry.

Antichrominance Filter

The 1408 device includes an antichrominance filter that removes chrominance from a composite color video signal. You can use two software-selectable antichrominance filters: a 3.58 MHz notch filter to remove color information from an NTSC signal and a 4.43 MHz notch filter to remove color information from a PAL signal.

Programmable Gain and Offset

The 1408 device uses programmable gain and offset circuitry to optimize the input signal range.

8-Bit ADC and LUT

An 8-bit flash ADC digitizes the image, which is passed to a 256-by-8 bit lookup table (LUT) RAM. You can configure the input LUT to implement simple imaging operations such as contrast enhancement, data inversion, gamma manipulation, or other nonlinear transfer functions.

CSYNC Mux

The composite synchronization (CSYNC) multiplexer lets the genlock and synchronization circuitry select the internally generated composite synchronization signal or the composite synchronization signal received from the I/O connector.

Genlock and Synchronization Circuitry

The genlock and synchronization circuitry receives the incoming video signal and generates a PCLK, HSYNC, and VSYNC signal for use by the acquisition and control circuitry. The synchronization circuitry interacts with the voltage-controlled oscillator (VCO) and phase-locked loop (PLL) circuitry, which generates and controls the PCLK.

VCO and PLL Circuitry

The VCO and PLL circuitry controls the internally generated PCLK signal frequency. The 1408 device can digitize an incoming video signal at rates of up to 16.4 MHz.

Pixel Aspect Ratio Circuitry

The pixel aspect ratio circuitry adjusts the ratio between the physical horizontal size and the vertical size of the region covered by the pixel. This value is used to figure the picture aspect ratio. For more information, see the *Acquisition Window Control* section later in this chapter.

PCLK, HSYNC, VSYNC Mux

The acquisition control circuitry selects the clock and synchronization signals through the pixel clock (PCLK), horizontal synchronization (HSYNC), and vertical synchronization (VSYNC) multiplexer. The onboard genlock and synchronization circuitry can generate clock and synchronization signals or the signals can be received from the I/O connector.

RTSI Bus

The seven trigger lines on the RTSI bus provide a flexible interconnection scheme between multiple 1408 devices as well as between any National Instruments DAQ devices and the 1408 device.

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 or stop 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 onboard status values (HSYNC, VSYNC, ACQUISITION_IN_PROGRESS, and ACQUISITION_DONE) to the lines.

Acquisition and Region of Interest Control

The acquisition and region of interest control circuitry monitors the incoming video signal and routes the active pixels to the FIFO buffers. The 1408 device can digitize an entire frame and perform pixel and line scaling and region-of-interest acquisition. Pixel and line scaling lets certain multiples (2, 4, or 8) of pixels and lines to be transferred to the PCI bus. In region-of-interest acquisition, you select an area in the acquisition window to transfer to the PCI bus.

FIFO Buffer

The 1408 device uses a 4 KB FIFO buffer for temporary storage of the image being transferred to the PCI system memory or display memory. The buffer stores six full video lines during image acquisition.

Scatter-Gather DMA Controllers

The PCI/PXI-1408 uses three independent onboard direct memory access (DMA) controllers. The DMA controllers transfer data between the onboard FIFO 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 1408 device can perform continuous image transfers to either contiguous or fragmented memory buffers.

PCI Interface

The 1408 device 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 master mode, which maximizes the available PCI bandwidth. 1408 devices can generate 8-, 16-, and 32-bit memory read and write cycles, both single and multiple. In slave mode, the 1408 device is a medium speed decoder that accepts both memory and configuration cycles. The interface logic ensures that the 1408 device meets the loading, driving, and timing requirements of the PCI specification.

Board Configuration NVRAM

The 1408 device contains onboard nonvolatile RAM (NVRAM) that configures all registers on power-up.

Video Acquisition

The 1408 device can acquire video signals in a variety of modes and transfer the digitized fields or frames to PCI system memory.

Start Conditions

The 1408 device can start acquisition on a variety of conditions:

- Software control—The 1408 device supports software control of acquisition start and stop. In addition, you can configure the PCI/PXI-1408 to capture a fixed number of frames. Use this configuration to capture single frames or a sequence of frames.
- Trigger control—You can also start an acquisition by enabling external or RTSI bus trigger lines. Each of these 11 inputs can start 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 and stop acquisitions instantaneously or after capturing a desired number of frames or fields. Use this feature for posttrigger or trigger applications.
- Frame/field selection—With an interlaced camera and the PCI/PXI-1408 in frame mode, you can program the 1408 device to start acquisition on any odd field or any even field.

Acquisition Window Control

You can configure numerous parameters on the 1408 device to control the video acquisition window. A brief description of each parameter follows:

- Horizontal sync—HSYNC is the synchronization pulse signal produced at the beginning of each video scan line that keeps a video monitor's horizontal scan rate in sequence with the transmission of each new line.
- Vertical sync—VSYNC is the synchronization pulse generated at the beginning of each video field that signals the video monitor when to start a new field.
- Pixel clock—PCLK times the sampling of pixels on a video line.
- Composite sync—CSYNC is the signal consisting of combined horizontal sync pulses and vertical sync pulses.
- Active pixel region—The active pixel region is the region of pixels actively being stored. The active pixel region is defined by a pixel start (relative to HSYNC) and a pixel count.
- Horizontal count—The horizontal count is the total number of pixels between two HSYNC signals. The horizontal count determines the frequency of the pixel clock.
- Active line region—The active line region is the region of lines actively being stored. The active line region is defined by a line start (relative to VSYNC) and a line count.
- Line count—The line count is the total number of horizontal lines in the picture.
- Video line—A video line consists of an HSYNC, back porch, active pixel region, and a front porch, as shown in Figure 3-2.

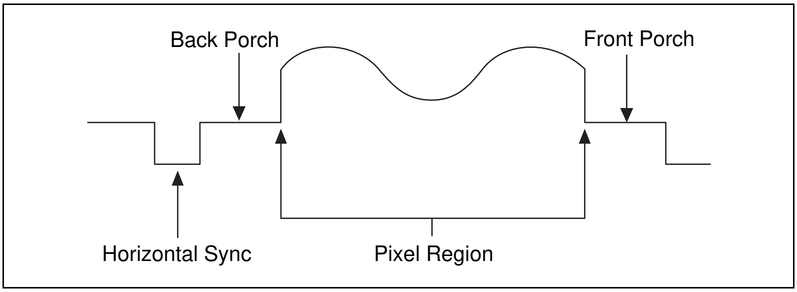


Figure 3-2. Video Line

- Picture aspect ratio—The picture aspect ratio is the ratio of the active pixel region to the active line region. For standard video signals like RS-170 or CCIR, the full-size picture aspect ratio normally is 4/3 (1.33).
- Pixel aspect ratio—The pixel aspect ratio is the ratio between the physical horizontal size and the vertical size of the region covered by the pixel. An acquired pixel should optimally be square, thus the optimal value is 1.0, but typically it falls between 0.95 and 1.05, depending on camera quality.
- Field—For an interlaced video signal, a field is half the number of horizontal lines needed to represent a frame, as shown in Figure 3-3. The first field of a frame contains all the odd-numbered lines. The second field contains all of the even-numbered lines.

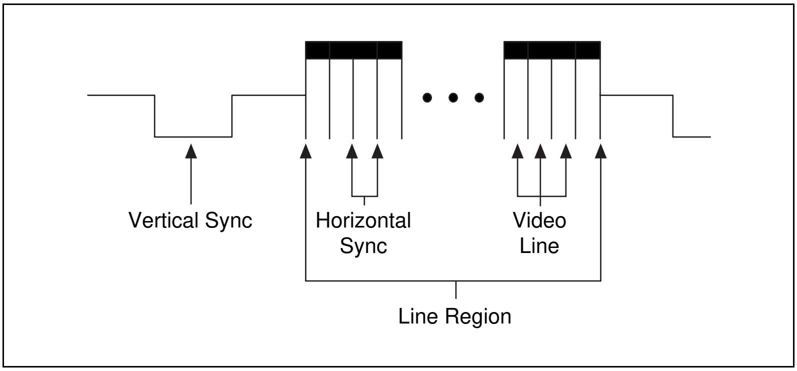


Figure 3-3. Video Field

- Frame—A frame is a complete image. In interlaced formats, a frame is composed of two fields.

Programming Video Parameters

You can program all of these video parameters on the 1408 device:

- Programmable pixel and line count—When generating an internal PCLK, the 1408 device uses a programmable clock generator with an advanced VCO circuit. This circuitry generates a PCLK frequency from 11 to 16.5 MHz, depending on the horizontal count. The standard sampling rate for RS-170/NTSC video signals is 12.3 MHz, and the standard sampling rate for CCIR/PAL is 14.75 MHz. To correct for external pixel aspect ratio errors of up to ±9%, the VCO covers the range from approximately 11.0 to 16.5 MHz.

The 1408 device also includes a programmable line count, which you use to switch between RS-170/NTSC (525 lines) and CCIR/PAL (625 lines). In addition, the 1408 device supports any line count up to 1,024 lines for nonstandard video inputs.

Note You can have up to 2,048 lines in interlaced mode by combining fields.

- Acquisition window—After setting the pixel and line count, you must program the active pixel region and active line region. The active pixel region selects the starting pixel and number of pixels to be acquired relative to the HSYNC signal. The active line region selects the starting line and number of lines to be acquired relative to the VSYNC signal.
- Region of interest—The 1408 device 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 system memory. However, when you enable the region of interest circuitry, the board transfers only a selected subset of the digitized frame to system memory.
- Scaling down—The scaling down circuitry also controls the active acquisition region. The 1408 device can scale down a frame by reducing pixel, lines, or both. For active pixel selection, the PCI/PXI-1408 can select every pixel, every other pixel, every fourth pixel, or every eighth pixel. For active line selection, the 1408 device can select every line, every odd line, or multiples of odd lines, for example, every other odd line or every fourth odd line. You can use the scaling-down circuitry in conjunction with the region-of-interest circuitry.
- Interlaced video—The 1408 device supports both interlaced and noninterlaced video signals. In interlaced mode, the 1408 device combines the odd and even field into one contiguous frame for analysis. In noninterlaced mode, each field is treated as an independent frame.

Acquisition Modes

The 1408 device supports three video acquisition modes:

- Standard mode—In standard mode, the 1408 device receives an incoming composite video signal from the external BNC or DSUB connector and generates CSYNC, HSYNC, VSYNC, and PCLK signals. The generated CSYNC signal is output on the DSUB connector for use by other image acquisition boards or to synchronize multiple cameras.
- CSYNC external mode—In CSYNC external mode, the 1408 device receives an incoming video signal (composite or luminance) and an external CSYNC from an external connector. The 1408 device takes the incoming video signal and CSYNC and generates HSYNC, VSYNC, and PCLK signals.
- External lock mode—You can use this mode to synchronize to a camera or any nonstandard video signal. In this mode, the PCI/PXI-1408 receives HSYNC, VSYNC, and PCLK signals for A/D sampling directly from the external connector.

Note If you are using an interlaced camera in external lock mode, connect a FIELD signal to the external connector. See Chapter 4, *Signal Connections*, for more information.

4

Signal Connections

This chapter describes cable connections for the PCI-1408 and PXI-1408 devices.

BNC Connector

The BNC external connector supplies an immediate connection to the 1408 device VIDEO0 input. Use the 2 m BNC cable shipped with the PCI/PXI-1408 to connect a camera to VIDEO0. You cannot use this connection with VIDEO0 on the 25-pin DSUB I/O connector. You can configure the BNC connector only for RSE mode.

Note Jumper W1 must be installed when using BNC input.

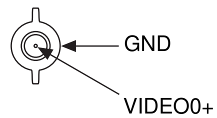


Figure 4-1. BNC Connector Pin Assignment

I/O Connector

The 25-pin DSUB connector connects to all video signals (VIDEO0, VIDEO1, VIDEO2, and VIDEO3), the external digital I/O lines and triggers, and external signals. To access these connections, you can build your own custom cable or use one of the optional cables from National Instruments. Figure 4-2 shows the pinout of the 25-pin DSUB connector.

Note Do *not* use the VIDEO0 connection on the 25-pin DSUB connector with the BNC connection.

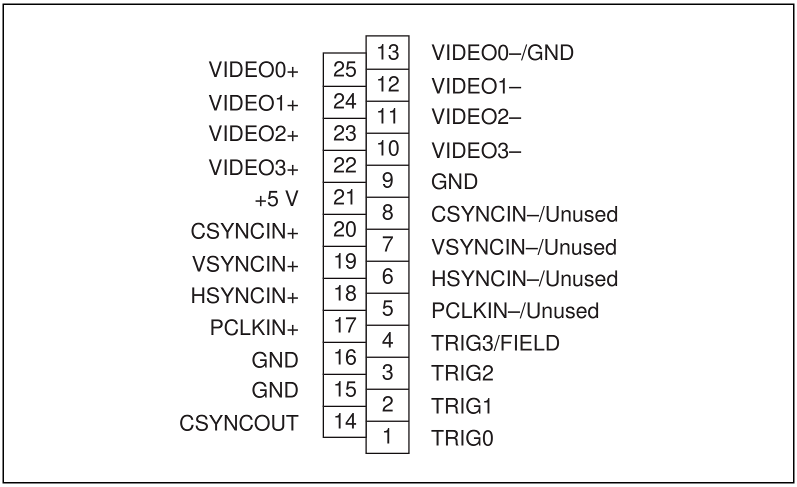


Figure 4-2. I/O Connector Pin Assignments

I/O Connector Signal Connection Descriptions

Table 4-1 describes each signal connection on the 25-pin DSUB connector.

Table 4-1. I/O Connector Signals

Signal Name	Description
VIDEO0±	VIDEO0± allows for a DIFF or RSE connection to video channel 0. To operate in RSE mode, connect VIDEO0– to GND. When you use VIDEO0+ or VIDEO0–, you must disconnect the BNC connector.
VIDEO<3..1>±	VIDEO<3..1>± allows for a DIFF or RSE connection to video channels 1, 2, and 3. To operate in RSE mode, connect VIDEO– to GND.
PCLKIN±	Use PCLKIN± when the 1408 device is in external lock mode. In this mode, PCLKIN represents the A/D sampling clock. You can select PCLKIN to be TTL or RS-422 mode, depending on the jumper W3 configuration. In RS-422 mode, both PCLKIN+ and PCLKIN– receive the PCLK signal. The PCLKIN polarity is programmable.
HSYNCIN±	Use HSYNCIN± when the 1408 device is in external lock mode. HSYNC is a synchronization pulse produced at the beginning of each video scan line that keeps a video monitor's horizontal scan rate in step with the transmission of each new line. You can set HSYNCIN in TTL or RS-422 mode depending on jumper W3 configuration. In RS-422 mode, both HSYNCIN+ and HSYNCIN– receive the HSYNC signal. The HSYNCIN polarity is programmable.

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

Signal Name	Description
VSYNCIN±	Use VSYNCIN± when the 1408 device is in external lock mode. VSYNC is a synchronization pulse generated at the beginning of each video frame that tells the video monitor when to start a new field. You can set VSYNCIN in TTL or RS-422 mode depending on jumper W3 configuration. In RS-422 mode, both VSYNCIN+ and VSYNCIN– receive the VSYNC signal. The VSYNCIN polarity is programmable.
CSYNCIN±	Use CSYNCIN± when the 1408 device is in CSYNC external mode. CSYNC is a signal consisting of horizontal sync pulses, vertical sync pulses, and equalizing pulses only. You can set CSYNCIN in TTL or RS-422 mode, depending on jumper W3 configuration. In RS-422 mode, both CSYNCIN+ and CSYNCIN– receive the CSYNC signal. The CSYNCIN polarity is programmable.
CSYNCOUT	CSYNCOUT is a TTL output of the internal CSYNC signal. In CSYNC external mode, CSYNCOUT maps directly to CSYNCIN. In standard mode, the synchronization circuitry of the 1408 device generates CSYNCOUT.
TRIG<3..0>	Triggers <3..0> are TTL I/O lines used to start or stop an acquisition or output an acquisition status. 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 in function to a digital I/O line. You can program TRIG<3..0> to reflect the following status bits: **Status Bit** — **Description** AQ_IN_PROGRESS — Signals an acquisition in progress AQ_DONE — Signals an acquisition is completed VSYNC — The appropriate VSYNC signal HSYNC — The appropriate HSYNC signal PCLK — The A/D sampling signal Connect a FIELD signal to TRIG3 when the 1408 is in external lock mode with an interlaced camera.
GND	GND is a direct connection to digital GND on the 1408 device.
+5V	+5V is a fused connection to +5 V on the 1408 device that allows you to power external triggering circuitry with up to 100 mA.

A

Specifications

This appendix lists the specifications of the PCI-1408 and PXI-1408 devices. These specifications are typical at 25 °C, unless otherwise stated.

Formats Supported

RS-170/NTSC	60 Hz (Interlaced mode: 60 fields/s)
CCIR/PAL	50 Hz (Interlaced mode: 50 fields/s)
Variable scan	Programmable

Video Input

Quantity	Four monochrome
Input impedance	75 Ω
VIDEO0	RSE (BNC)
VIDEO<3..0>	RSE or DIFF (DSUB)
Frequency response	20 MHz (–3 dB) typ
Antichrominance filter	Programmable (disabled, 3.58 MHz notch filter, or 4.43 MHz notch filter)
Filter characteristics	Attenuation at notch frequency > 25 dB
Gain	Programmable (1, 1.33, or 2)
Black reference	Programmable (0–1.26 V in 64 20 mV steps at a gain of 1)
White reference	Programmable (0–1.26 V in 64 20 mV steps at a gain of 1)

A/D Conversion

Gray levels	256 (8 bit)
Differential nonlinearity	±1 LSB max
RMS noise	< 0.5 LSB rms
Signal-to-noise ratio	48 dB typ
Sampling rate	5 to 20 MHz, externally clocked
Pixel aspect ratio	Programmable (VCO range 11.0 to 16.4 MHz)

External Connections

Trigger sense	TTL
Trigger level	Programmable (rising or falling)
PCLKIN sense	Selectable (TTL or RS-422)
PCLKIN level	Programmable (direct or invert)
HSYNCIN sense	Selectable (TTL or RS-422)
HSYNCIN level	Programmable (rising or falling)
VSYNCIN sense	Selectable (TTL or RS-422)
VSYNCIN level	Programmable (rising or falling)
CSYNCIN sense	Selectable (TTL or RS-422)
CSYNCIN level	Programmable (rising or falling)
Pulse width	50 ns
V_{IH} (TTL)	2 V
V_{IL} (TTL)	0.8 V

Internal Pixel Clock

Generate frequency .... 11.0 to 16.4 MHz

Pixel ratio for
standard video sources .... ±8%

Pixel jitter .... < 5 ns peak

PCI Interface

PCI initiator (master) capability............. Supported

PCI target (slave) capability................... Supported

Data path .... 32 bits

Card voltage .... 5 V only

Card type .... 32-bit half-size card

Parity generation/checking,
error reporting .... Supported

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

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

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

PCI interrupts .... Interrupts passed on
INTA# signal

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

Expansion ROM.................................... 4 KB

PCI master performance

- Ideal .... 133 Mbytes/s
- Sustained.. 100 Mbytes/s

Power Requirements

Voltage .... +5 V (1.34 A)
+12 V (100 mA)
–12 V (50 mA)

Physical

Dimensions

PCI-1408 .... 10.7 by 17.5 cm (4.2 by 6.9 in.)

PXI-1408 .... 10 by 16 cm (3.9 by 6.3 in.)

Weight

PCI-1408 .... 0.127 kg (0.28 lb.)

PXI-1408 .... 0.172 kg (0.38 lb.)

Environment

Operating temperature .... 0–55 °C

Storage temperature .... –20–70 °C

Relative humidity .... 5–90%, noncondensing

MTBF .... 181,259 h at 25 °C

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

Functional shock (PXI only) .... MIL-T-28800 E Class 3 (per Section 4.5.5.4.1) Half-sine shock pulse, 11 ms duration, 30 g peak, 30 shocks per face

Operational random vibration (PXI only) .... 5 to 500 Hz, 0.31 grms, 3 axes

Nonoperational random vibration (PXI only) .... 5 to 500 Hz, 2.5 grms, 3 axes

Note Random vibration profiles were developed in accordance with MIL-T-28800E and MIL-STD-810E Method 514. Test levels exceed those recommended in MIL-STD-810E for Category 1 (Basic Transportation, Figures 514.4-1 through 514.4-3).

B

Custom Cables

This appendix lists specifications for building custom cables for your 1408 device.

Cable Specification

National Instruments offers cables and accessories for you to connect to video sources, trigger sources, or synchronization sources. However, if you want to develop your own cables, the following guidelines must be met:

- For the video inputs, use a 75 Ω shielded coaxial cable.
- For the digital triggers and synchronization signals, twisted pairs for each signal yield the best result.
- For the 25-pin DSUB connector, use AMP part number 747912-2 or equivalent.

For information on connector pin assignments, see the *I/O Connector* section in Chapter 4, *Signal Connections*.

Connector specifications include:

• Video and sync signals	75 Ω impedance
• Trigger signals	TTL
• Type	75 Ω BNC or 25-pin DSUB receptacle (as shown in Figure B-1)

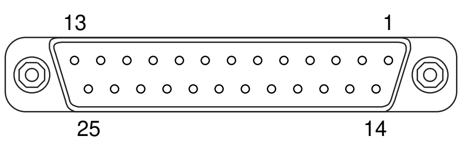


Figure B-1. 25-Pin DSUB Receptacle

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

National Instruments has offices located around the globe. Many branch offices maintain a Web site to provide information on local services. You can access these Web sites from `www.ni.com/worldwide`

If you have trouble connecting to our Web site, please contact your local National Instruments office or the source from which you purchased your National Instruments product(s) to obtain support.

For telephone support in the United States, dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 03 9879 5166, Austria 0662 45 79 90 0, Belgium 02 757 00 20, Brazil 011 284 5011, Canada (Calgary) 403 274 9391, Canada (Ontario) 905 785 0085, Canada (Québec) 514 694 8521, China 0755 3904939, Denmark 45 76 26 00, Finland 09 725 725 11, France 01 48 14 24 24, Germany 089 741 31 30, Greece 30 1 42 96 427, Hong Kong 2645 3186, India 91805275406, Israel 03 6120092, Italy 02 413091, Japan 03 5472 2970, Korea 02 596 7456, Mexico (D.F.) 5 280 7625, Mexico (Monterrey) 8 357 7695, Netherlands 0348 433466, Norway 32 27 73 00, Poland 48 22 528 94 06, 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	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}

Numbers/Symbols

%	percent
+	positive of, or plus
–	negative of, or minus
/	per
+5V	5 V signal
±	plus or minus
Ω	ohm

A

A	Amperes.
A/D	Analog-to-digital.
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.
ADC	Analog-to-digital converter. An electronic device, often an integrated circuit, that converts an analog voltage to a digital value.
address	Value that identifies a specific location (or series of locations) in memory.
ANSI	American National Standards Institute
antichrominance filter	Removes the color information from the video signal.
API	Application programming interface.
AQ_DONE	Signals that the acquisition of a frame or field is completed.
AQ_IN_PROGRESS	Signals that the acquisition of video data is in progress.
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.
aspect ratio	The ratio of a picture or image's width to its height.

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
back porch	The area of the video signal between the rising edge of the horizontal synchronization signal and the active video information.
black reference level	The level that represents the darkest an image can get. *See also* white reference level.

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.
CCIR	Comite Consultatif International des Radiocommunications. A committee that developed standards for video signals. Also used to describe signals, boards, and cameras that adhere to the CCIR standards.
chroma	The color information in a video signal.
chrominance	*See* chroma.
CMOS	Complementary metal-oxide semiconductor.
CompactPCI	Refers to the core specification defined by the PCI Industrial Computer Manufacturer's Group (PICMG).
compiler	A software utility that converts a source program in a high-level programming language, such as Basic, C, or Pascal, into an object or compiled program in machine language. Compiled programs run 10 to 1,000 times faster than interpreted programs. *See also* interpreter.
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.
CSYNC	Composite synchronization signal. A combination of the horizontal and vertical synchronization pulses.
CSYNCIN	Composite sync in signal.
CSYNCOUT	Composite sync out signal.

D

D/A	Digital-to-analog.
DAC	Digital-to-analog converter. An electronic device, often an integrated circuit, that converts a digital number into a corresponding analog voltage or current.
DAQ	Data acquisition. (1) Collecting and measuring electrical signals from sensors, transducers, and test probes or fixtures and inputting them to a computer for processing. (2) Collecting and measuring the same kinds of electrical signals with A/D or DIO boards plugged into a computer, and possibly generating control signals with D/A and/or DIO boards in the same computer.
dB	Decibel. The unit for expressing a logarithmic measure of the ratio of two signal levels: $dB = 20\log_{10} V1/V2$, 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
DLL	Dynamic link library. A software module in Microsoft Windows containing executable code and data that can be called or used by Windows applications or other DLLs; functions and data in a DLL are loaded and linked at run time when they are referenced by a Windows application or other DLLs.
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.
driver	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.

flash ADC — An ADC whose output code is determined in a single step by a bank of comparators and encoding logic.

frame — A complete image. In interlaced formats, a frame is composed of two fields.

front porch — The area of a video signal between the start of the horizontal blank and the start of the horizontal synchronization signal.

ft — Feet.

function — A set of software instructions executed by a single line of code that may have input and/or output parameters and returns a value when executed.

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.
GND	Ground signal.
GUI	Graphical user interface. An intuitive, easy-to-use means of communicating information to and from a computer program by means of graphical screen displays; GUIs can resemble the front panels of instruments or other objects associated with a computer program.

H

h	Hour.
hardware	The physical components of a computer system, such as the circuit boards, plug-in boards, chassis, enclosures, peripherals, cables, and so on.
HSYNC	Horizontal synchronization signal. The synchronization pulse signal produced at the beginning of each video scan line that keeps a video monitor's horizontal scan rate in step with the transmission of each new line.
HSYNCIN	Horizontal sync input signal.
hue	Represents the dominant color of a pixel. The hue function is a continuous function that covers all the possible colors generated using the R, G, and B primaries. *See also* RGB.
Hz	Hertz. 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.

INL — Integral nonlinearity. A measure in LSB of the worst-case deviation from the ideal A/D or D/A transfer characteristic of the analog I/O circuitry.

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. *See also* 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. *See* 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

library — A file containing compiled object modules, each comprised of one of more functions, that can be linked to other object modules that make use of these functions.

line count — The total number of horizontal lines in the picture.

LSB — Least significant bit.

luma	The brightness information in the video picture. The luma signal amplitude varies in proportion to the brightness of the video signal and corresponds exactly to the monochrome picture.
luminance	*See* luma.
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	*See* buffer.
memory window	Continuous blocks of memory that can be accessed quickly by changing addresses on the local processor.
MSB	Most significant bit.
MTBF	Mean time between failure.
mux	Multiplexer. A switching device with multiple inputs that selectively connects one of its inputs to its output.

N

NI-IMAQ	Driver software for National Instruments IMAQ hardware.
noninterlaced	A video frame where all the lines are scanned sequentially, instead of divided into two frames as in an interlaced video frame.

NTSC — National Television Standards Committee. The committee that developed the color video standard used primarily in North America, which uses 525 lines per frame. *See also* PAL.

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.

PCLK — Pixel clock signal. Times the sampling of pixels on a video line.

PCLKIN — Pixel clock in signal.

PFI — Programmable function input.

PGIA — Programmable gain instrumentation amplifier.

picture aspect ratio — The ratio of the active pixel region to the active line region; for standard video signals like RS-170 or CCIR, the full-size picture aspect ratio normally is 4/3 (1.33).

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 aspect ratio — The ratio between the physical horizontal size and the vertical size of the region covered by the pixel; an acquired pixel should optimally be square, thus the optimal value is 1.0, but typically it falls between 0.95 and 1.05, depending on camera quality.

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.
PXI	PCI eXtensions for Instrumentation. An open specification that builds on the CompactPCI specification by adding instrumentation-specific features.

R

RAM	Random-access memory.
real time	A property of an event or system in which data is processed as it is acquired instead of being accumulated and processed at a later time.
relative accuracy	A measure in LSB of the accuracy of an ADC; it includes all nonlinearity and quantization errors but does not include offset and gain errors of the circuitry feeding the ADC.
resolution	The smallest signal increment that can be detected by a measurement system. Resolution can be expressed in bits, in proportions, or in percent of full scale. For example, a system has 12-bit resolution, one part in 4,096 resolution, and 0.0244 percent of full scale.
RGB	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. 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.

RSE	Referenced single-ended. All measurements are made with respect to a common reference measurement system or a ground. Also called a grounded measurement system.
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.
SRAM	Static RAM.
StillColor	A post-processing algorithm that allows the acquisition of high-quality color images generated either by an RGB or composite (NTSC or PAL) camera using a monochrome video acquisition board.
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.
syntax	The set of rules to which statements must conform in a particular programming language.
system RAM	RAM installed on a personal computer and used by the operating system, as contrasted with onboard RAM.

T

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.
TRIG	Trigger signal.

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.

U

UV plane	*See* YUV.

V

V	Volts.
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.
video line	A video line consists of an HSYNC, back porch, active pixel region, and a front porch.
VSYNC	Vertical synchronization signal. The synchronization pulse generated at the beginning of each video field that tells the video monitor when to start a new field.
VSYNCIN	Vertical sync in signal.

W

white reference level	The level that defines what is white for a particular video system. *See also* black reference level.

Y

YUV — A representation of a color image used for the coding of NTSC or PAL video signals. The luma information is called Y, while the chroma information is represented by two components, U and V representing the coordinates in a color plane.

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