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for PCI, PXI, and CompactPCI Bus

October 1997 Edition
Part Number 321325B-01

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Important Information

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The IMAQ PCI-1408 and PXI-1408 devices are warranted against defects in materials and workmanship for a period of one year from the date of shipment, as evidenced by receipts or other documentation. National Instruments will, at its option, repair or replace equipment that proves to be defective during the warranty period. This warranty includes parts and labor.

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This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual, may cause interference to radio and television reception. Classification requirements are the same for the Federal Communications Commission (FCC) and the Canadian Department of Communications (DOC). This equipment has been tested and found to comply with the following two regulatory agencies:

Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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

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

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

Canadian Department of Communications

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

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

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About This Manual

Getting Started with Your IMAQ PCI/PXI-1408 and the NI-IMAQ Software for Windows 95/NT describes the features, functions, and operation of the IMAQ PCI-1408 and PXI-1408 devices.

The 1408 devices are high-accuracy, monochrome image acquisition (IMAQ) boards for PCI, PXI, or CompactPCI that supports RS-170, CCIR, NTSC, and PAL video standards from any of four inputs. *Getting Started with Your IMAQ PCI/PXI-1408 and the NI-IMAQ Software for Windows 95/NT* is intended for users with a basic knowledge of image acquisition.

Organization of This Manual

Getting Started with Your IMAQ PCI/PXI-1408 and the NI-IMAQ Software for Windows 95/NT is organized as follows:

- Chapter 1, *Introduction*, describes the PCI-1408 and PXI-1408 devices; lists what you need to get started; describes software programming choices, optional equipment, and custom cables; and explains how to unpack and set up your 1408 device.
- Chapter 2, *Configuration and Installation*, explains how to configure and install your 1408 device.
- Chapter 3, *Hardware Overview*, presents an overview of the hardware functions on your 1408 device and explains the operation of each functional unit making up the 1408 device.
- Chapter 4, *Signal Connections*, describes cable connections for the PCI-1408 and PXI-1408 devices.
- Chapter 5, *Configuration Utility*, describes the basic functions of `IMAQconf`, the configuration and diagnostic utility included with the 1408 device.
- Appendix A, *Specifications*, lists the specifications of the PCI-1408 and PXI-1408 devices.

- Appendix B, *StillColor*, describes the different methods you can use to acquire a color image using the IMAQ PCI/ PXI-1408 and National Instruments StillColor technology, explains basic color theories, and describes the different output options supported by StillColor.
- Appendix C, *Custom Cables*, lists specifications for building custom cabling for your 1408 device.
- Appendix D, *Customer Communication*, contains forms you can use to request help from National Instruments or to comment on our products and manuals.
- The *Glossary* contains an alphabetical list and description of terms used in this manual, including abbreviations, acronyms, metric prefixes, mnemonics, and symbols.
- The *Index* contains an alphabetical list of key terms and topics in this manual, including the page where you can find each one.

Conventions Used in This Manual

The following conventions are used in this manual:

<> — Angle brackets containing numbers separated by an ellipses represent a range of values associated with a bit or signal name (for example, ACH<0..7>).

– — A hyphen between two or more key names enclosed in angle brackets denotes that you should simultaneously press the named keys—for example, <Control–Alt–Delete>.

» — The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options»Substitute Fonts** directs you to pull down the **File** menu, select the **Page Setup** item, select **Options**, and finally select the **Substitute Fonts** options from the last dialog box.

☞ — 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.

1408 device — 1408 device refers to the IMAQ PCI-1408 and PXI-1408 image acquisition boards, unless otherwise noted.

bold	Bold text denotes menus, menu items, or dialog box buttons or options.
italic	Italic text denotes emphasis, a cross reference, or an introduction to a key concept. This font also denotes text for which you supply the appropriate word or value, such as in Windows 3.*x*.
bold italic	Bold italic text denotes a note, caution, or warning.
`monospace`	Lowercase text in this font denotes text or characters that are to be literally input from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, variables, filenames and extensions, and for statements and comments taken from programs.

National Instruments Documentation

Getting Started with Your IMAQ PCI/PXI-1408 and the NI-IMAQ Software for Windows 95/NT 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 and LabWindows™/CVI. After you set up your hardware system, use either the application software (LabVIEW 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.

Related Documentation

The following documents contain information that you may find helpful as you read this manual:

- Your computer's technical reference manual
- National Instruments *PXI Specification*, rev. 1.0
- *PICMG CompactPCI 2.0 R2.1*

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 D, *Customer Communication*, at the end of this manual.

Chapter 1

Introduction

This chapter describes the PCI-1408 and PXI-1408 devices; lists what you need to get started; describes software programming choices, optional equipment, and custom cables; and explains how to unpack and set up your 1408 device.

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 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 transfers them directly to system memory.

The 1408 device is simple to configure and is factory calibrated 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*, rev. 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 CompactPCI 2.0 R2.1* document.

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

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
- ❑ *NI-IMAQ for Windows 95/NT Release Notes*
- ❑ *Getting Started with Your IMAQ PCI/PXI-1408 and the NI-IMAQ Software for Windows 95/NT*
- ❑ NI-IMAQ for Windows 95/NT and online documentation
- ❑ Optional software packages and documentation:
  - – LabVIEW
  - – BridgeVIEW
  - – LabWindows/CVI
  - – IMAQ Vision for G
  - – IMAQ Vision for 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 95 or Windows NT
- ❑ 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 Triton I, Triton II, or compatible PCI interface chipset.***

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, 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 1408 device, 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 1408 device, is included with the NI-IMAQ software kit. The LabWindows/CVI IMAQ Library is functionally equivalent to the NI-IMAQ software.

IMAQ Vision for G is an image acquisition, processing, and analysis library that consists of more than 400 VIs for using the PCI/PXI-1408 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 1408 device 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.

NI-IMAQ Driver Software

The NI-IMAQ driver software is included at no charge with the PCI/PXI-1408. 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 1408 device and image acquisition.

NI-IMAQ also internally resolves many of the complex issues between the computer and the 1408 device, 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 1408 device.

Any platform that supports NI-IMAQ also supports NI-DAQ and a variety of National Instruments DAQ boards, so your 1408 device 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.

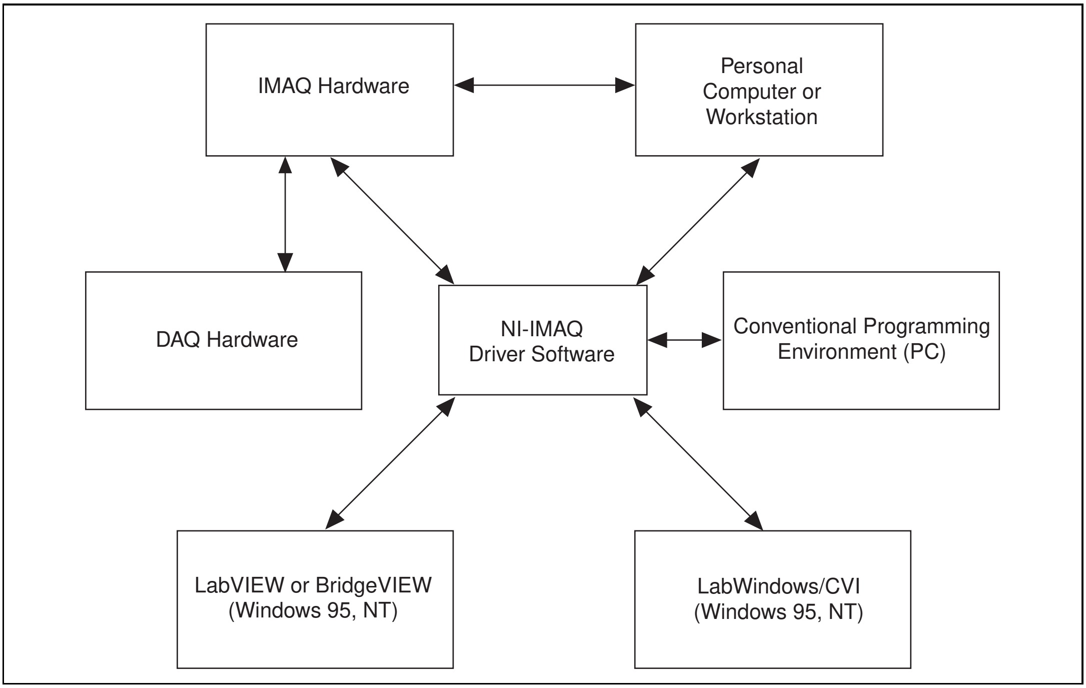


Figure 1-1. The Relationship between the Programming Environment, NI-IMAQ, and Your Hardware

Optional Equipment

National Instruments offers a variety of products for use with your PCI/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 catalogue or call the office nearest you.

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.

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.

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 VIs for G Reference Manual* to help you get started.

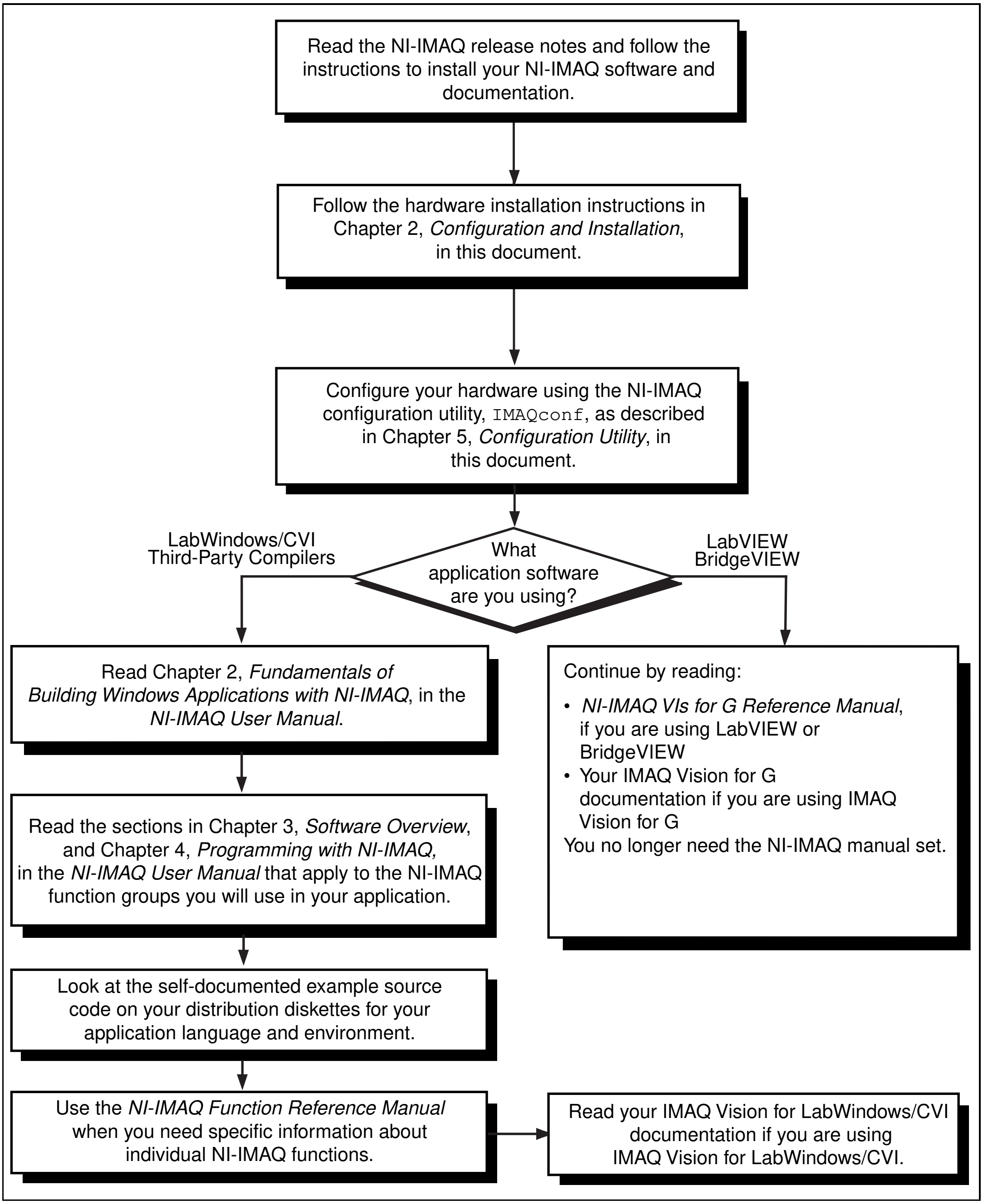


Figure 1-2. How to Set up Your IMAQ System

Configuration and Installation

Chapter 2

This chapter explains how to configure and install your 1408 device.

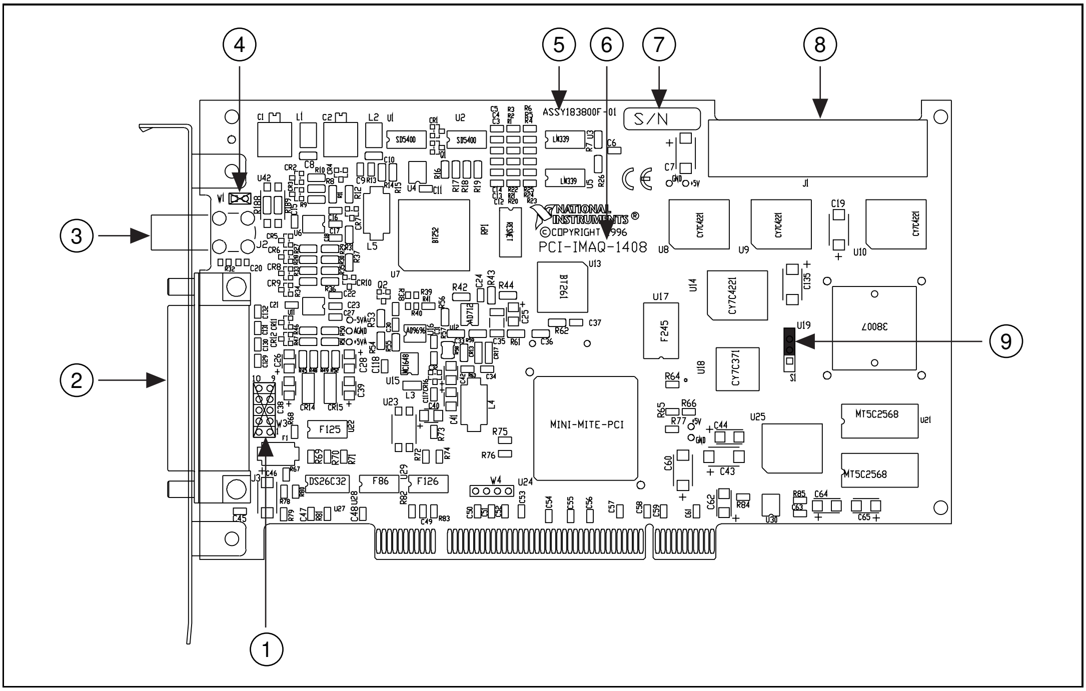
Board Configuration

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

- VIDEO0 input mode
- External CLK and synchronization input mode

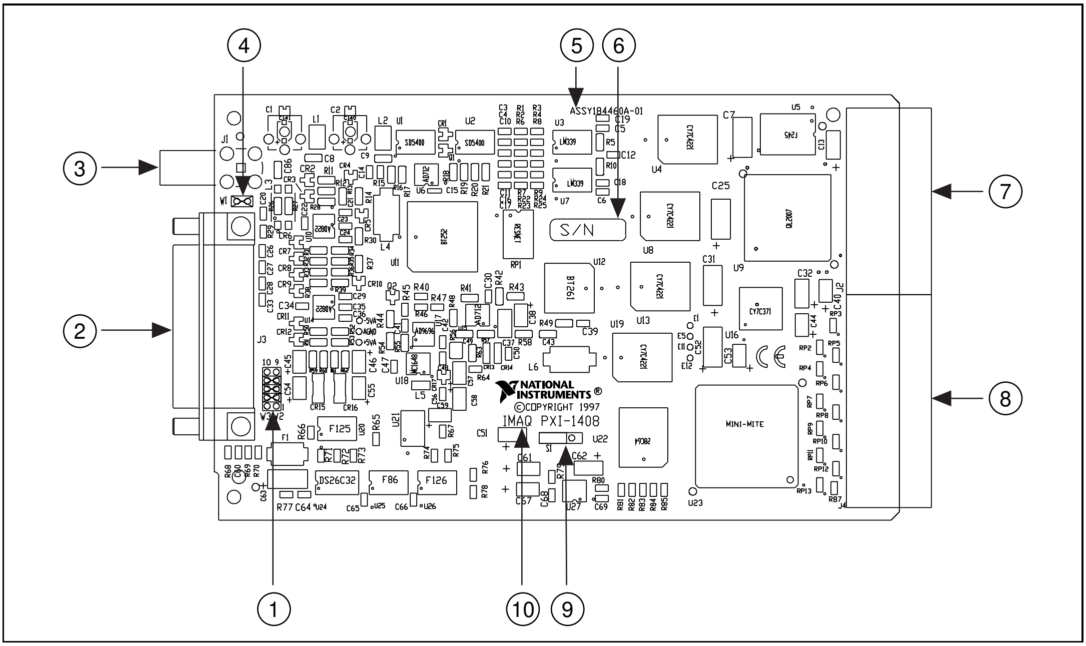
All other configuration options are software configurable.

Figures 2-1 and 2-2 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 2-1. 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 2-2. 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 2-3. Unpopulating W1 configures VIDEO0 for DIFF mode. Populating W1 configures VIDEO0 for RSE mode.

a. RSE Mode (Default) b. DIFF Mode

Figure 2-3. Configuring VIDEO0 with Jumper W1

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 2-4. 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.

a. RSE Mode (Default) b. DIFF Mode

Figure 2-4. 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 2-5.

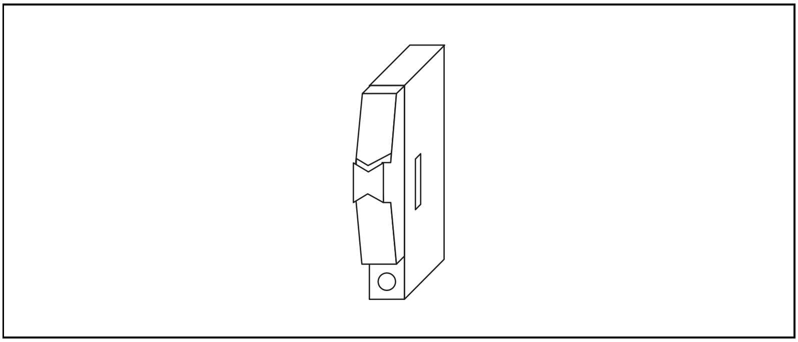


Figure 2-5. Switch S1

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 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.

Chapter 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.

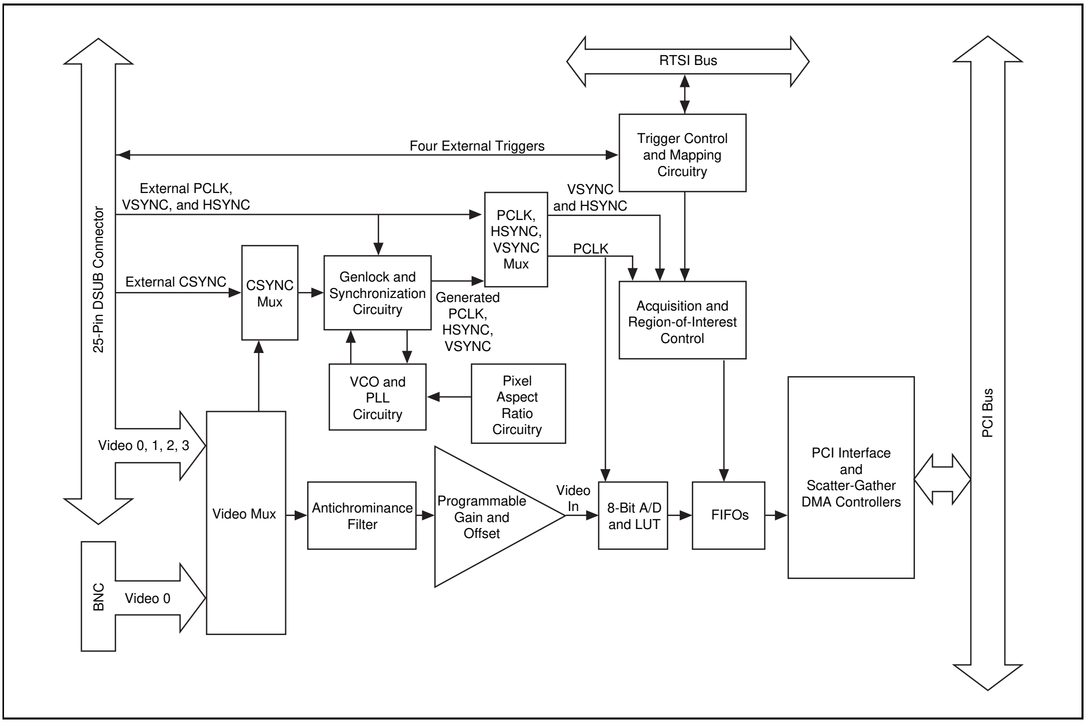


Figure 3-1. 1408 Device Block Diagram

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 first-in first-out (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/Stop Conditions

The 1408 device can start and stop 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 and stop acquisition by enabling external or RTSI bus trigger lines. Each of these 11 inputs can start or stop video acquisition on a rising or falling edge. You can use all four external triggers and up to two 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 post- or pre-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 or stop 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.

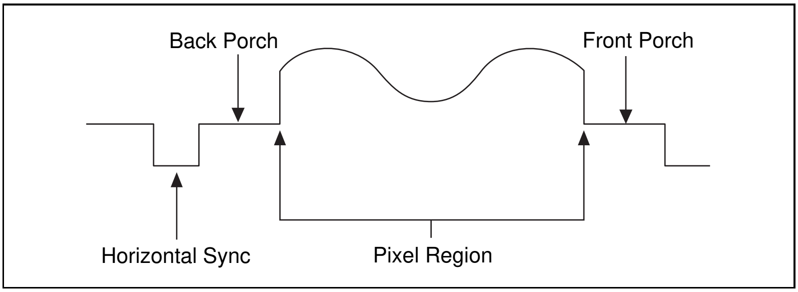


Figure 3-2. Video Line

- 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.

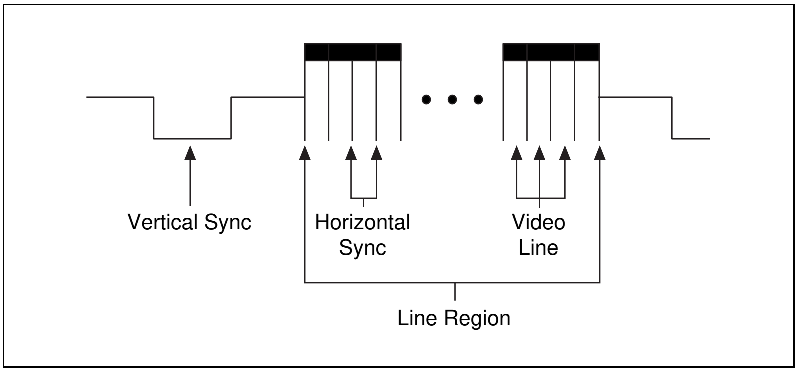


Figure 3-3. Video Field

- 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.

Chapter 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.***

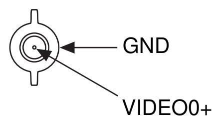


Figure 4-1. BNC Connector Pin Assignment

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.***

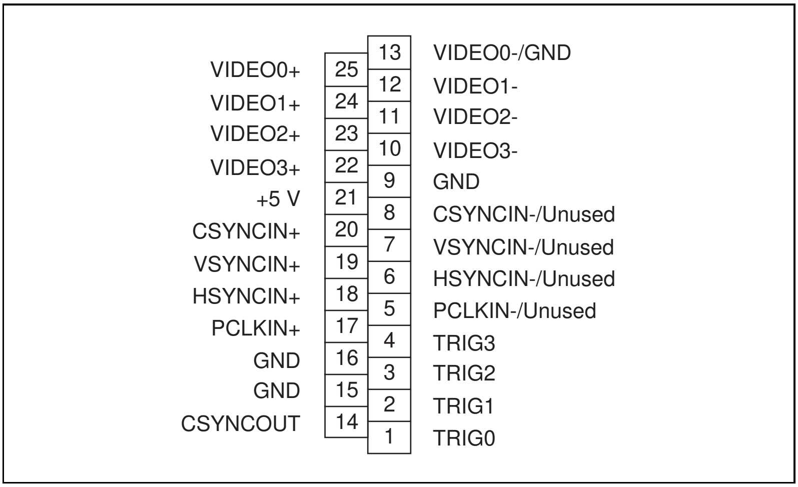


Figure 4-2. I/O Connector Pin Assignments

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 HSYNC — The appropriate HSYNC signal PCLK — The A/D sampling signal
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.

Chapter 5

Configuration Utility

This chapter describes the basic functions of `IMAQconf`, the configuration and diagnostic utility included with the 1408 device.

Introduction

`IMAQconf` performs the following functions:

- Configures the video parameters, which are automatically loaded when the saved interface is loaded in NI-IMAQ
- Displays a histograph, which acts as an aid to configuring your board
- Displays various look-up tables that let you implement small image processing functions in the hardware
- Performs snap and continuous video acquisition for diagnostics and verification
- Creates new camera files for non-standard cameras
- Saves acquired images to a `bmp` format

Using IMAQconf

To configure your IMAQ device, make sure the device is properly installed (see Chapter 2, *Configuration and Installation*) and then run the `IMAQconf` configuration utility. `IMAQconf` is located under the Windows 95/NT Start menu: **Start»Program»NI-IMAQ»IMAQconf**.

Whether you are capturing monochrome or StillColor images, Figure 5-1 shows which configuration tabs are active for each mode. The **Basic** and **Advanced** camera settings tabs are active for all modes.

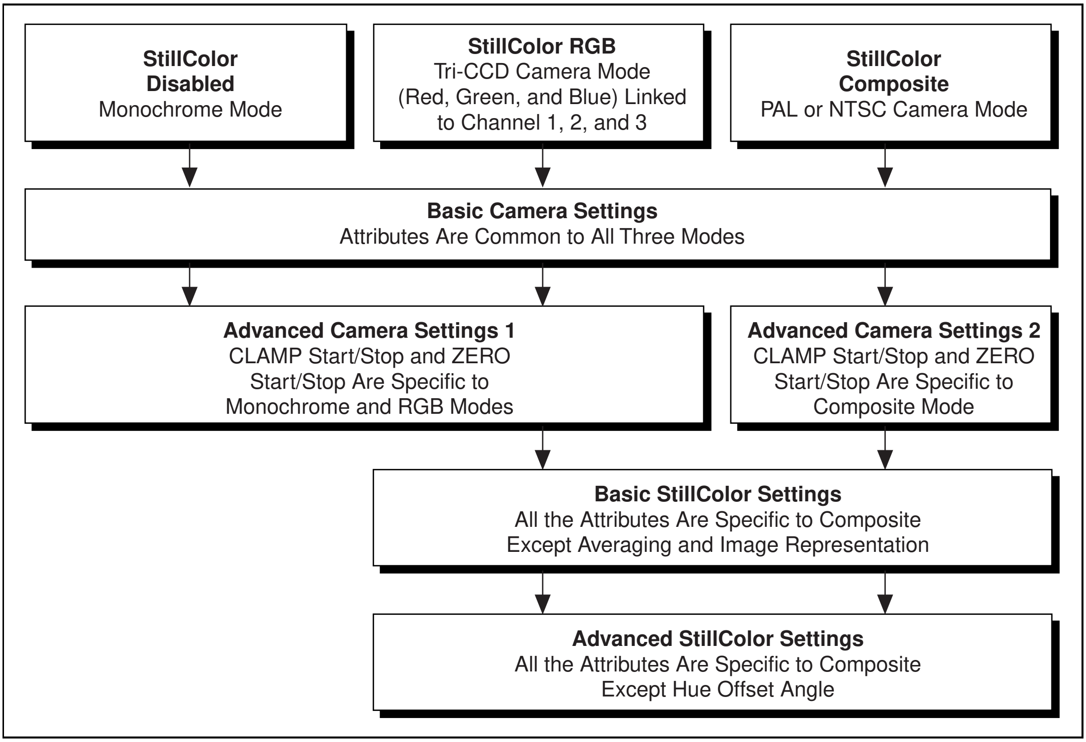


Figure 5-1. StillColor Modes Dialog Boxes

The following is a description of each of the tabs in the `IMAQconf` utility.

Description Tab

The **Description** tab in the `IMAQconf` configuration utility is where basic information about your IMAQ board is stored, such as the interface name, board type, base address, and interrupt the board uses. Figure 5-2 shows the information included in this tab. `IMAQconf` automatically fills in this information.

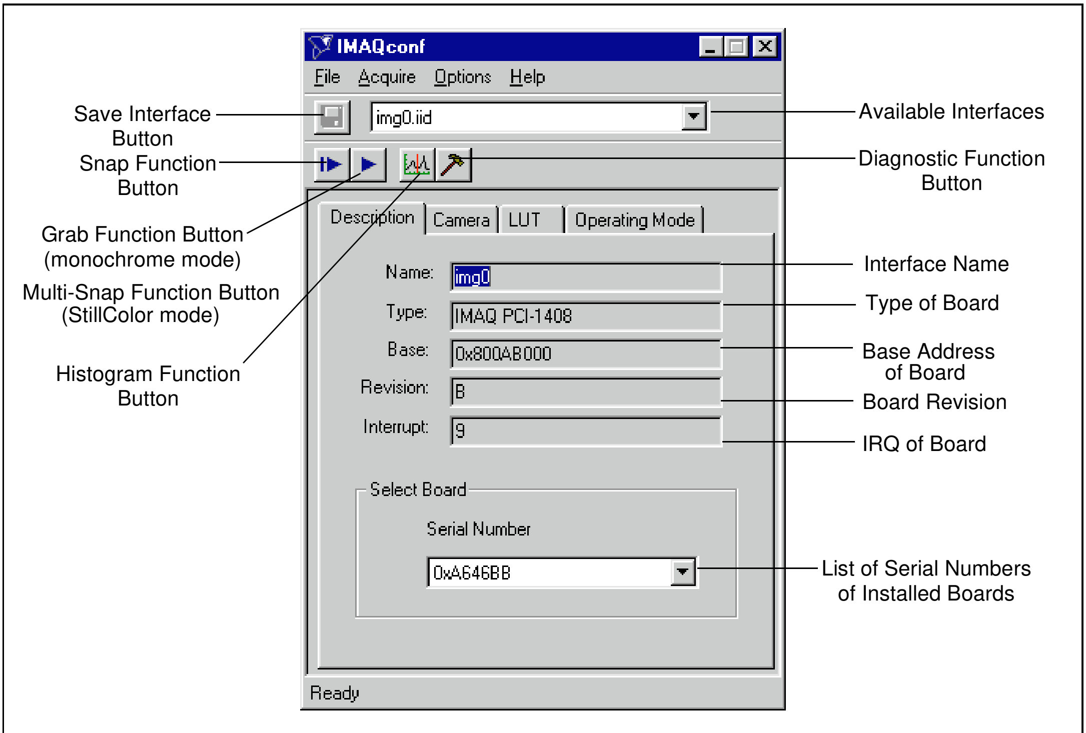


Figure 5-2. Description Tab

Camera Tab

The **Camera** tab stores a list of available cameras and camera settings. You can modify existing camera settings or create a new camera file by saving the existing camera file via the **File»Save As...** menu selection. Figure 5-3 shows each item included in this tab.

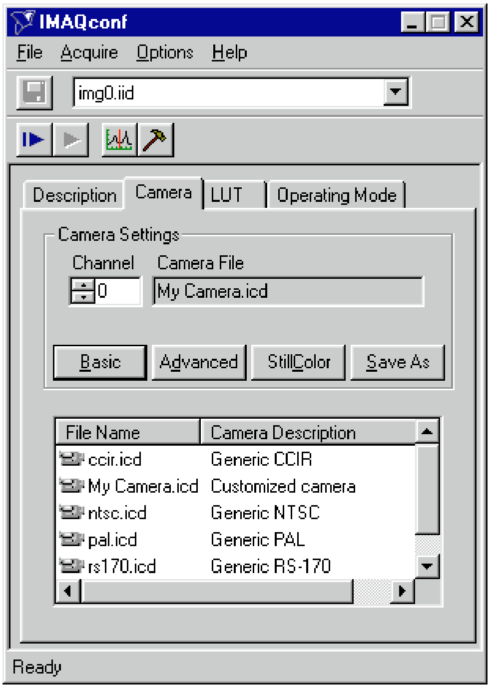


Figure 5-3. Camera Tab

You use `IMAQconf` to configure each active video channel. You can configure only one video channel at a time. You can access VIDEO0 through the BNC connector or the 25-pin DSUB connector. You can access all other video signals only via the 25-pin DSUB connector.

The **Camera** tab includes four buttons that pop up additional configuration dialog boxes. These buttons are as follows:

- **Basic**—This button brings up the **Basic** camera settings dialog box shown in Figure 5-6.
- **Advanced**—This button brings up the **Advanced** camera settings dialog box shown in Figure 5-7.

- **StillColor**—This button brings up the basic **StillColor** settings dialog box shown in Figure 5-8.
- **Save As**—This button allows you to save your modifications in your own camera file.

Refer to Figure 5-4 for parameter timing information as you use the **Basic** and **Advanced** camera settings dialog boxes for a monochrome acquisition from a monochrome or color camera and for a StillColor acquisition from an RGB camera.

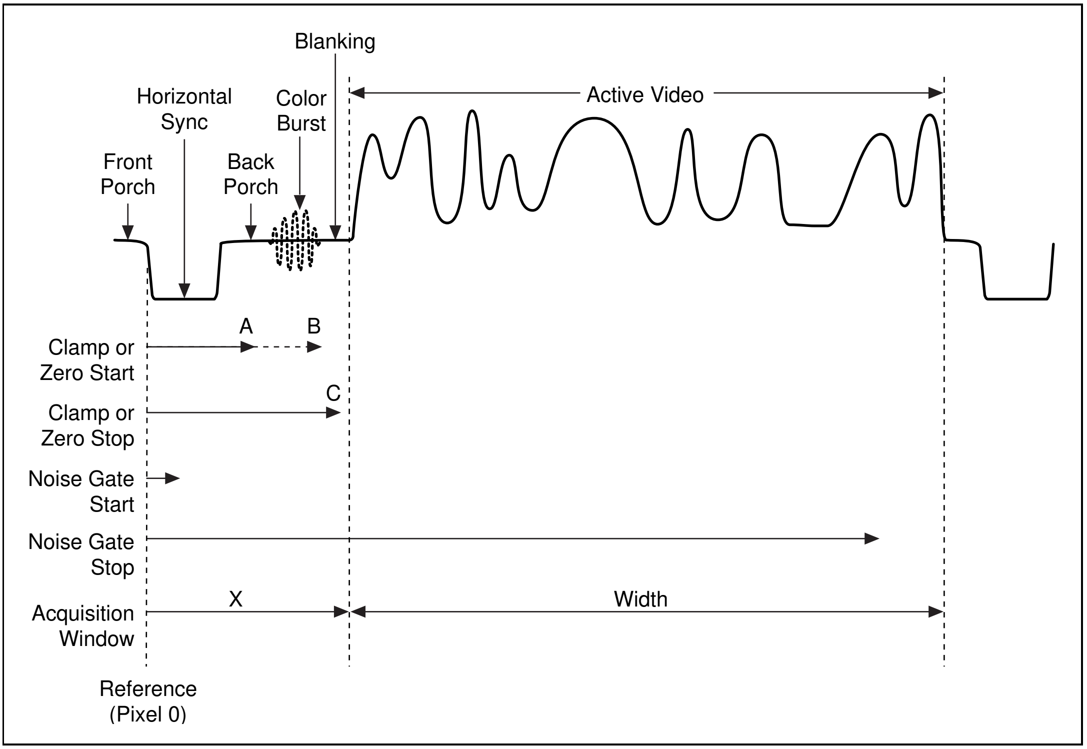


Figure 5-4. Monochrome and Color Used as Monochrome Video Line

Refer to Figures 5-4 and 5-5 for parameter timing information as you use the **Basic**, **Advanced**, and **StillColor** dialog boxes for a StillColor acquisition from a color composite camera.

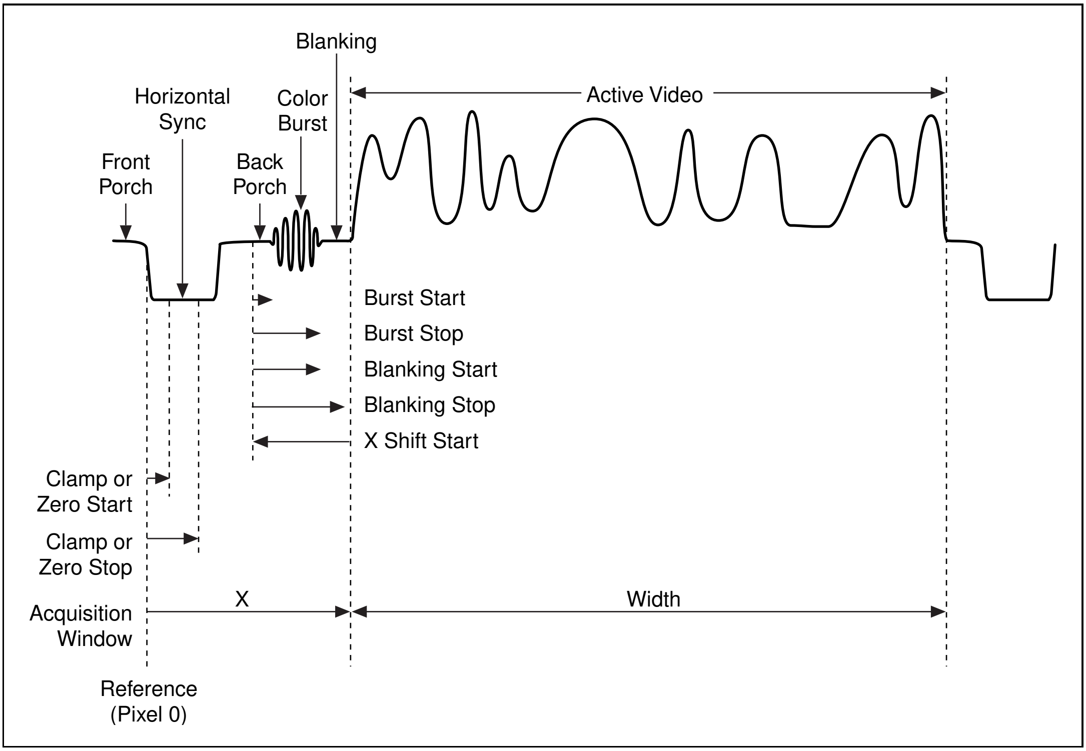


Figure 5-5. Composite Color Video Line

Basic Camera Settings

Figure 5-6 shows the **Basic** dialog box.

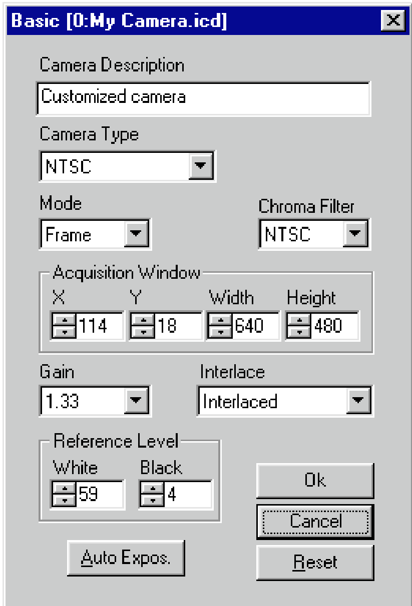


Figure 5-6. Basic Camera Settings

Basic settings include:

- **Camera Description**—You can enter a description of up to 64 characters for this camera.
- **Camera Type**—Use this setting to select your camera type. If you are using a standard camera, choose **RS-170**, **NTSC**, **CCIR**, or **PAL**. If you are using a nonstandard camera, choose **AREA SCAN**.
- **Mode**—You can place the 1408 device in frame or field mode. Use frame mode with interlaced video signals. In frame mode, the PCI/PXI-1408 waits for a programmable (odd or even) field before starting a video acquisition. In addition, the 1408 device combines the odd and even fields into one video frame in system memory for analysis.

  Use field mode with either interlaced or noninterlaced video signals. In field mode, the 1408 device acquires any video field and transfers it to PCI system memory.

- **Chroma Filter**—The 1408 device includes optional antichrominance filters to use with NTSC and PAL video signals. The three options for the color filters are as follows:
  - **None**—The antichrominance filter is disabled.
  - **NTSC**—The antichrominance filter is enabled for NTSC-coded signals. The filtering is implemented by a 3.58 MHz notch filter.
  - **PAL**—The antichrominance filter is enabled for PAL-coded signals. The filtering is implemented by a 4.43 MHz notch filter.
- **Acquisition Window**—The acquisition window determines the window offset and window size of the start of the video frame as well as the number of active horizontal pixels and active lines.
- **Gain**—The 1408 device has three programmable gain values: 1, 1.33, and 2, which correspond to a fine adjustment of the black and white reference levels of 20, 15, and 10 mV steps. Monitor the displayed histograph to choose the appropriate gain level.
- **Interlace**—This specifies whether the camera is interlaced or non-interlaced.
- **Reference Level**—This setting optimizes the input signal range and includes two components:
  - **White**—The 1408 device uses a programmable white reference level to optimize the input signal range. Monitor the displayed histograph to choose the appropriate white offset level. With a gain of 1, the white reference level is programmable in the range of 0 to 1.28 V in 64 steps of 20 mV each.
  - **Black**—The 1408 device uses a programmable black reference level to optimize the input signal range. Monitor the displayed histograph to choose the appropriate black offset level. With a gain of 1, the black reference level is programmable in the range of 0 to 1.28 V in 64 steps of 20 mV each.
- **Auto Expos.**—Pressing this button tells `IMAQconf` to perform a single acquisition and then calculate the optimum gain and white and black reference levels.

Advanced Camera Settings

The **Advanced** camera settings button lets you fine-tune the configuration for your specific camera.

Figure 5-7 shows the advanced camera settings dialog box.

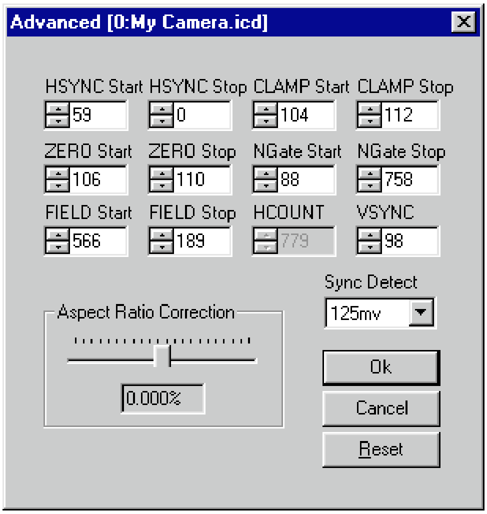


Figure 5-7. Advanced Camera Settings

All settings except **Sync Detect** and **Aspect Ratio Correction** are measured in pixels from the beginning of the horizontal synchronization pulse. The **Start** parameter specifies the rising edge of the internally generated pulse while the **Stop** parameter specifies the falling edge of the pulse.

Advanced camera settings include:

- **HSYNC Start** and **HSYNC Stop**—These settings define the positioning and duration of the internally generated horizontal (line) synchronization pulse. To generate a negative edge at position zero, set the **HSYNC Stop** value to 0. The width of the pulse in samples is defined by the difference in pixels between **HSYNC Start** and **HSYNC Stop** and is typically 4.7 μs for standard video.

- **CLAMP Start** and **CLAMP Stop**—The clamp signal restores the DC level of the AC-coupled video signal. **CLAMP Start** and **CLAMP Stop** are specific to the current StillColor mode.
  - Monochrome (StillColor disabled) or StillColor RGB mode—The clamping pulse must be positive (**CLAMP Stop > CLAMP Start**) and must be applied on each line somewhere during the blanking period of the video signal. For a color camera, this typically occurs between the end of the color burst and the beginning of the active video line. For a monochrome camera, this typically occurs anytime on the back porch period of the video signal.

    The duration of the pulse (**CLAMP Stop – CLAMP Start**) should be as long as possible and greater than five samples. As shown in Figure 5-4, position A corresponds to the position of **CLAMP Start** for a monochrome camera and position B corresponds to the position of **CLAMP Start** for a monochrome acquisition from a color composite camera. Position C corresponds to **CLAMP Stop** for either a monochrome or color camera.
  - StillColor Composite mode—The clamping pulse must be positive (**CLAMP Stop > CLAMP Start**) and must be applied on each line somewhere during the horizontal synchronization pulse of the video signal. The duration of the pulse (**CLAMP Stop – CLAMP Start**) should be as long as possible and greater than five samples. Figure 5-5 illustrates the correct position of **CLAMP Start** and **CLAMP Stop**.
- **ZERO Start** and **ZERO Stop**—The zero signal calibrates the ADC on each video line. The pulse conditions—positioning and duration—are the same as for the clamping pulse. **ZERO Start** and **ZERO Stop** are also specific to the current StillColor mode. Positioning information is the same as **CLAMP Start** and **CLAMP Stop**.
- **NGate Start** and **NGate Stop**—The noise gate (NGate) settings define the period of a video line after lock to a video source where the genlock circuitry will not detect a HSYNC pulse. The 1408 device uses this nondetection period to avoid false HSYNC detection due to noise in the video signal or equalization pulses during the vertical synchronization period. For a typical video signal, the NGate signal starts after **HSYNC Stop** and stops approximately 3% before the end of the video line defined by **HCOUNT**. Figure 5-4 illustrates the correct position of **NGATE Start** and **NGATE Stop**.

- **FIELD Start** and **FIELD Stop**—The field gate signal defines the portion of the video line during vertical synchronization where the field conditions are detected. The duration of the field gate pulse must be approximately 50% of the duration of the line defined by **HCOUNT** and the positioning should be approximately 25% of the line. By swapping the values of **FIELD Start** and **FIELD Stop**, you can reverse the order of the acquired fields (even/odd or odd/even).
- **HCOUNT**—This setting defines the total number of pixels minus 1 for the entire video line, including synchronization and blanking signals. For example, the total duration of a video line is 64 µs for a CCIR signal, but the duration of the active video line containing image information is only 52 µs. To acquire a picture with 768 pixels, enter the value of $768 \times 64/52 - 1$, rounded to 943, into **HCOUNT**. Changing the value of **HCOUNT** affects the pixel aspect ratio of the picture. (See **Aspect Ratio Correction** later in this section.)
- **VSYNC**—This setting defines the duration of the internally generated vertical synchronization pulse. For standard video, the value of **HCOUNT**/8 is recommended.
- **Sync Detect**—This setting defines the comparator voltage used to detect a horizontal synchronization pulse. The reference level is the voltage of the sync tips. For a typical video signal, the sync tips is approximately 300 mV below the blanking level and the highest detection value of 125 mV is recommended. Lower values may be used if the incoming video signal is weak or noisy.
- **Aspect Ratio Correction**—This function adjusts the pixel aspect ratio of the acquired picture and also compensates for pixel aspect ratio errors of the camera. Given a standard video format with a default configuration, you can correct errors up to ±8% in steps of 1/**HCOUNT** or typically 0.15%. Note that using this function will affect most of the **Advanced** camera settings parameters. The function will automatically reposition and resize the picture by adjusting the region of interest offset and width parameters so that the visual region of interest stays unchanged. After you change the **Aspect Ratio Correction** and click the **OK** button, a warning message will appear that tells you the **Acquisition Window** width and X-offset under the **Basic** camera dialog box have changed. If necessary, you can manually readjust the ROI parameter.

StillColor Settings

The **StillColor** settings dialog box, shown in Figure 5-8, lets you adjust basic StillColor settings. See Appendix B, *StillColor*, for more information on StillColor and color image acquisition parameters.

Note: ***This dialog box is available only if you enable*** **StillColor Mode** ***on the*** **Operating Mode** ***tab. In*** **StillColor Composite** ***mode (PAL and NTSC cameras), you can adjust all settings in this dialog box. In*** **StillColor RGB** ***mode, you can adjust only the*** **Image Representation** ***and*** **Averaging** ***parameters.***

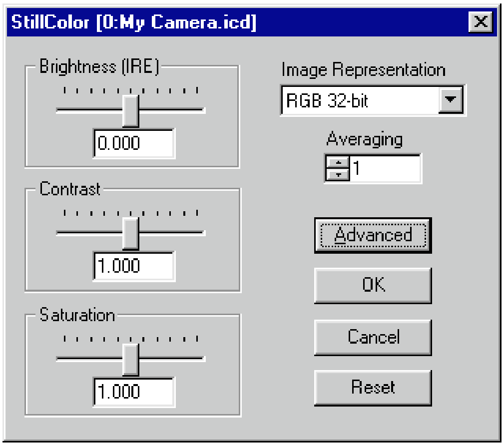


Figure 5-8. Basic StillColor Settings

Basic StillColor settings include:

- **Brightness (IRE)**—This parameter adjusts the brightness of the acquired picture. **Brightness** is valid only in composite mode. The unit is IRE, which is a percentage of the white level. The default value is 0, which corresponds to no correction.
- **Contrast**—This parameter adjusts the contrast of the acquired picture. **Contrast** is valid only in composite mode. The default value is 1.00, which corresponds to no correction. A value of 1.25 corresponds to an increase of the contrast by 25%.
- **Saturation**—This parameter adjusts the saturation of the acquired picture. **Saturation** is valid only in composite mode. The default value is 1.00 corresponding to no correction. A value of 1.25 corresponds to an increase of the saturation by 25%.

- **Image Representation**—This control selects the image representation. The different representation types are as follows:
  - RGB in 16-, 24-, 32-, 48-bit format
  - Red, green or blue plane in 8-bit format
  - Luminance, Hue, Saturation or Intensity in 8- or 16-bit format
  - HSL (Hue, Saturation, Luminance) in 32-bit format
  - HSI (Hue, Saturation, Intensity) in 32-bit format
- **Averaging**—This control specifies the number of color images to average for each image returned by NI-IMAQ.
- **Advanced**—This button brings up the Advanced color dialog box, as shown in Figure 5-9.

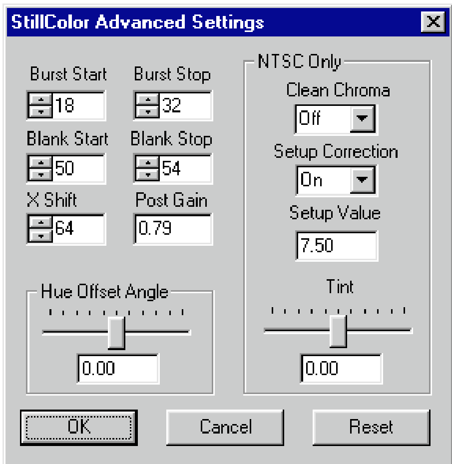


Figure 5-9. StillColor Advanced Settings

Advanced StillColor settings include:

- **Burst Start** and **Burst Stop**—These values define the position of the color burst in the composite video signal. The color burst is placed in the back porch after the horizontal synchronization and before the active video part of each line. Figure 5-5 illustrates the correct position of **Burst Start** and **Burst Stop**.
- **Blank Start** and **Blank Stop**—These values define the position of the blanking part in the composite video signal. The blanking is located on the back porch after the color burst and

before the active video part of each line. Figure 5-5 shows the correct position of **Blank Start** and **Blank Stop**.

- **X Shift**—The **X Shift** parameter defines the number of pixels before the X value of the acquisition window, where the physical acquisition of the picture must start in order to acquire the information needed by the StillColor algorithm. The acquisition of the picture should start just before the beginning of the color burst, as shown in Figure 5-5.
- **Post Gain—Post Gain** rescales the picture after StillColor processing so the white level appears white. You should not modify the default value of 0.79.
- **Hue Offset Angle**—When the selected **Image Representation** is Hue 8-bit (or Hue 16-bit), the hue value of a pixel is an angle where the value 0 corresponds to an angle of 0° and the value 255 (or 32,767 in Hue 16-bit) corresponds to 360°. The discontinuity point (0 modulo 360) corresponds, by default, to the color red. You can move this point to another hue value by adding or subtracting an offset angle. The **Hue Offset Angle** is expressed in degrees.
- **Clean Chroma** (NTSC only)—This parameter enables or disables the bandpass filter that cleans the chroma information before final demodulation. You can use this filter if the camera delivers a poor quality signal that results in vertical color bars in the image, especially for highly saturated colors.
- **Setup Correction** (NTSC only)—In NTSC**,** the black level of the image is not aligned with the blanking level. The black level is set up as 7.5% of the white level (7.5 IRE). To correct for this setup after StillColor decoding, enable the **Setup Correction** control. This control has no effect in PAL.
- **Setup Value** (NTSC only)—This parameter is the setup value to be corrected when **Setup Correction** is enabled. The default value is 7.5% of the white level (7.5 IRE).
- **Tint** (NTSC only)—In NTSC, inaccuracies in the coding, transmission, or decoding part of the system can cause tint errors. You can use **Tint** to correct for eventual tint inaccuracy in the resulting image. Tint corresponds to a rotation of the UV plane and is measured in degrees. This correction is not needed for PAL.

LUT Tab

You can configure the input look-up table (LUT) to implement simple imaging operations such as contrast enhancement, data inversion, gamma manipulation, or other nonlinear transfer function. Figure 5-10 shows the **LUT** tab settings.

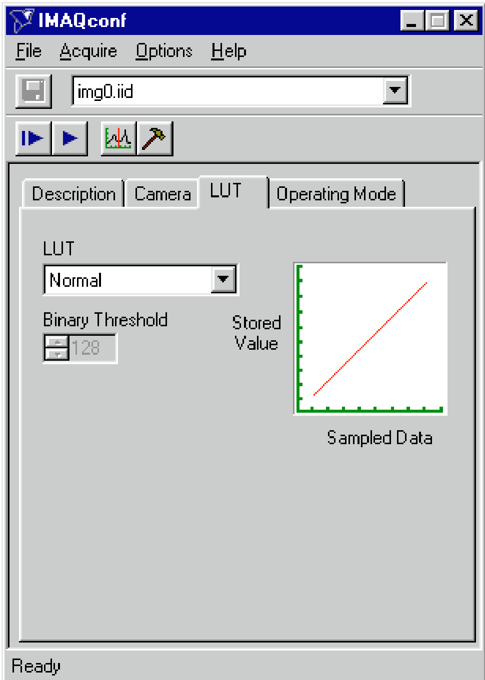


Figure 5-10. LUT Tab Settings

You can control the LUT through the NI-IMAQ software or you can select a predefined LUT in the `IMAQconf` configuration utility.

The predefined **LUT** selections are as follows:

- **Normal**—When you select this option, the LUT is effectively disabled, as shown in Figure 5-11.

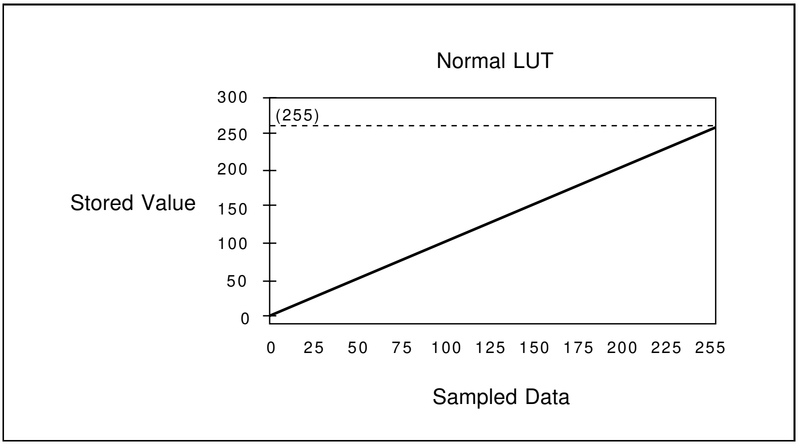


Figure 5-11. Normal LUT

- **Inverse**—When you select this option, the LUT inverts the gray levels, as shown in Figure 5-12.

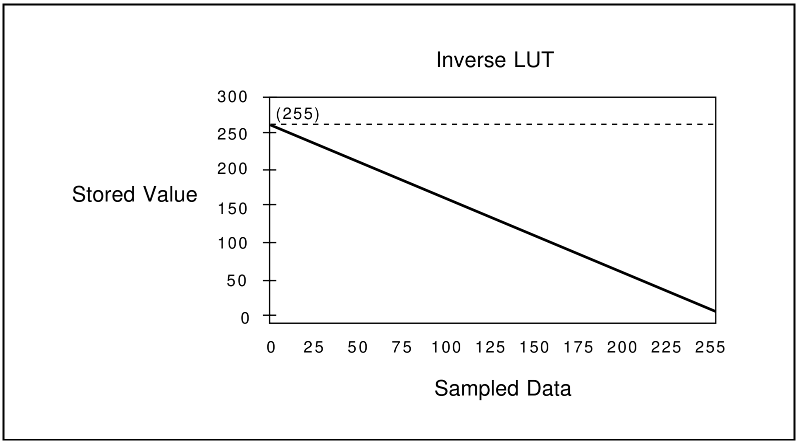


Figure 5-12. Inverse LUT

- **Log**—When you select this option, the LUT converts the sampled data to a logarithmic form that produces greater contrast in the *black* region, as shown in Figure 5-13.

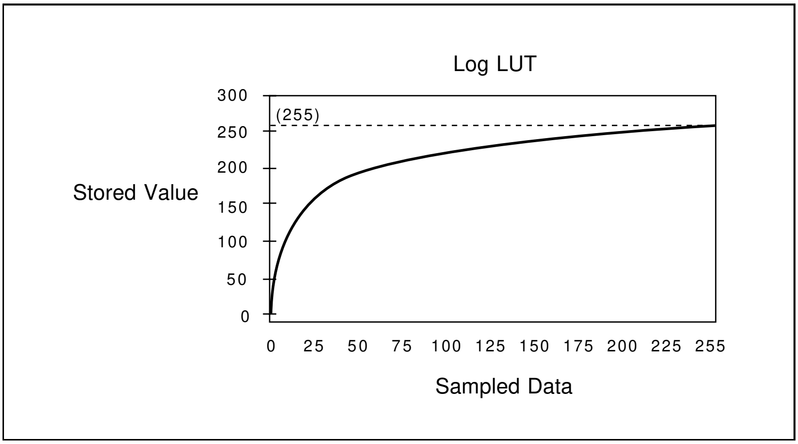


Figure 5-13. Log LUT

- **Exponential**—When you select this option, the LUT converts the sampled data to a logarithmic form that produces greater contrast in the *white* region, as shown in Figure 5-14.

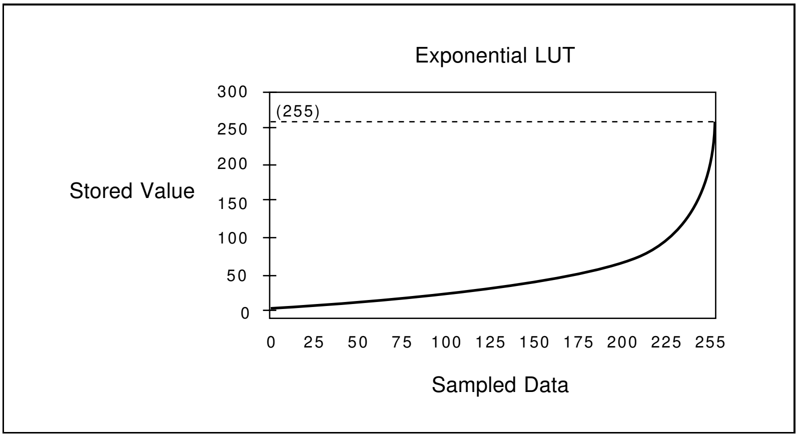


Figure 5-14. Exponential LUT

- **Binary**—When you select this option, the LUT converts the sampled data to a binary image of black or white, as shown in Figure 5-15. The threshold point is determined by the number you set in the **Binary Threshold** box.

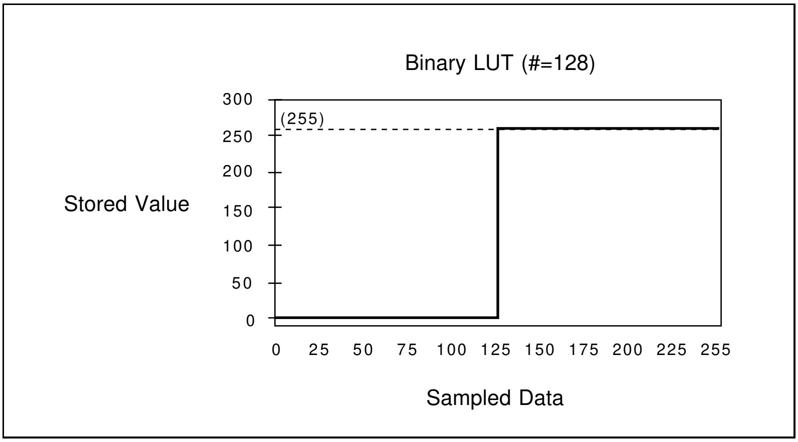


Figure 5-15. Binary LUT

- **Inverse Binary**—When you select this option, the LUT converts the sampled data to a binary image of black or white with the lighter areas becoming black and the darker areas white, as shown in Figure 5-16. The threshold point is determined by the number you set in the **Binary Threshold** box.

☞ **Note:** ***The* Binary Threshold *option specifies the threshold point for the binary and inverse binary LUTs. This option is disabled for the other LUTs.***

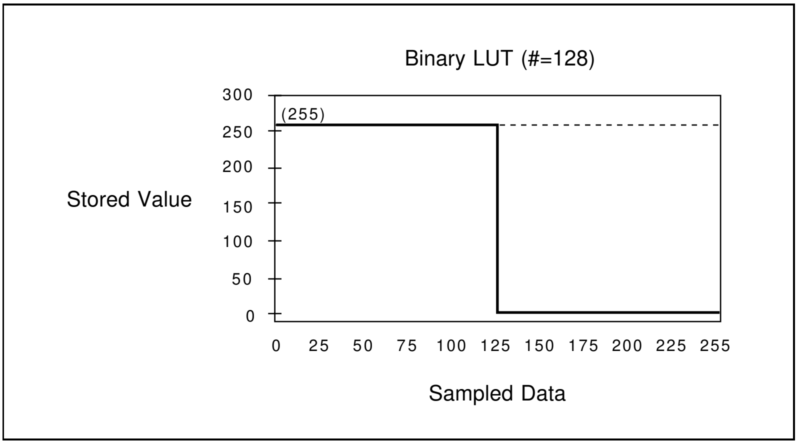


Figure 5-16. Inverse Binary LUT

Operating Mode Tab

The **Operating Mode** tab contains settings for video synchronization signals.

Figure 5-17 displays the **Operating Mode** tab.

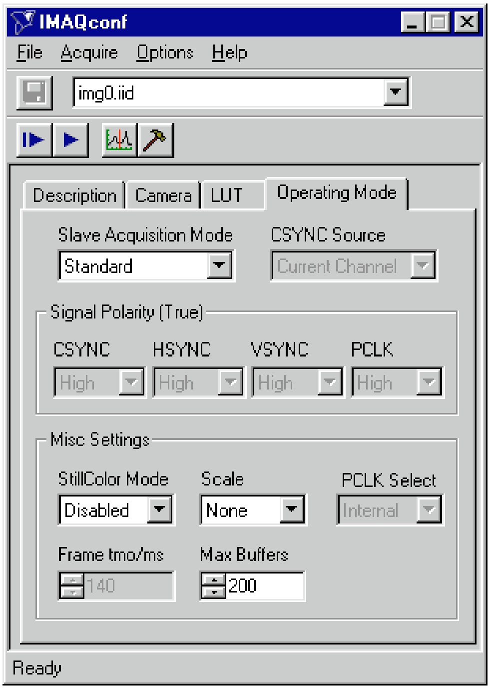


Figure 5-17. Operating Mode Tab

Operating Mode settings include:

- **Slave Acquisition Mode**—The 1408 device supports the following slave acquisition modes:
  - **Standard**—In standard mode, the 1408 device receives an incoming video signal and generates a CSYNC signal. The internal CSYNC signal generates the PCLK, HSYNC, and VSYNC signals. The 1408 device acquisition control circuitry uses these signals to store the acquired data in PCI memory. You can control each of these signals in software. The board parameters adjust the pixels per line (to generate PCLK), the horizontal start (to generate HSYNC), and the vertical start and lines (to generate VSYNC).

Note: ***The* Signal Polarity*,* CSYNC Source*, and* PCLK Select *options are disabled in this mode.***

- **CSYNC External Mode**—In CSYNC external mode, the PCI/PXI-1408 receives an incoming CSYNC to generate the PCLK, HSYNC, and VSYNC signals. The 1408 device acquisition control circuitry uses these signals to store the acquired data in PCI memory. You can control each of these signals in software. The board parameters adjust pixels per line (to generate PCLK), horizontal start (to generate HSYNC), and vertical start and lines (to generate VSYNC).

  When you select CSYNC external mode, the CSYNC polarity field also becomes valid. You can configure CSYNC to be active high or active low (rising or falling edge sensitive).

Note: ***The* Signal Polarity*,* CSYNC Source*, and* PCLK Select *options are active in this mode.***

- **External Lock Mode**—In external lock mode, the 1408 device receives PCLK, HSYNC, and VSYNC from the external connector. When you select external lock mode, the HSYNC polarity, VSYNC polarity, and PCLK polarity fields also become valid. You can configure each signal to be active high or active low (rising or falling edge sensitive).

Note: ***The* Signal Polarity *option is active and the* CSYNC Source *and* PCLK Select *options are disabled in this mode.***

- **CSYNC Source** —You can specify the input source for the CSYNC signal as either channel 0, channel 1, channel 2, channel 3, or external.
- **Signal Polarity**—You can control the signal polarity for the CSYNC, HSYNC, VSYNC, and PCLK signals. The default is True High.
- **Misc Settings**—The miscellaneous settings let you adjust the StillColor settings and include:
  - **StillColor Mode**—This control selects the acquisition mode. Settings include:
    - **Disabled**—Disables StillColor and enables monochrome mode.
    - **RGB**—Enables color mode with Tri-CCD cameras. This mode uses channels 1, 2, and 3, but you need to select a camera file only for channel 1.

- **Composite**—Enables color mode for PAL or NTSC cameras.

☞ **Note:** ***The* Grab *button is valid only in monochrome mode. The* Basic *and* Advanced *StillColor dialog boxes are only valid in* RGB *or* Composite *mode.***

- **Scale**—This parameter sets the horizontal and vertical hardware scaling factors.
- **PCLK Select**—When the PCI/PXI-1408 is in **CSYNC External Mode**, this parameter lets you chose whether the PCLK is internally generated by the board or external.
- **Frame tmo/ms**—This parameter sets the timeout value for a frame in milliseconds.
- **Max Buffers**—This parameter sets the maximum number of buffers for a ring or a sequence acquisition. You must restart your computer before this change takes effect.

Saving Your Configuration

When you complete the configuration, choose the **File»Save** option to save the resulting configuration so that the NI-IMAQ software can reference it.

Testing Your Configuration

After setup, use `IMAQconf` to test your configuration using the **Grab** and **Snap** functions, located either in the utility toolbar or under the **Acquire** menu (see Figure 5-2). You can use the resulting image and histograph to modify your configuration.

The functions for testing your configuration are as follows:

- **Grab**—Click the **Grab** button to make the 1408 device capture images in continuous mode at the maximum rate. If your display cannot keep up with the maximum rate acquisition, `IMAQconf` will continue to acquire images at the maximum rate but will display the images onscreen at the fastest allowable rate your system supports. The acquisition and display rates are shown in the title bar. Pressing the **Grab** button for the second time halts the grab function and displays the last acquired image on the screen. The **Grab** button is available only in monochrome mode.

Note: ***The* Grab *button becomes a* Multi-Snap *button in StillColor mode.***

- **Snap**—Clicking the **Snap** button will result in the 1408 device capturing and displaying a single video frame or field depending on the mode of the board.
- **Histograph**—The 1408 device displays the histograph of the captured image. You can use the histograph as an aid in setting the gain and offset values to receive the maximum input signal range.
- **Diagnostics**—The **Diagnostics** button lets you run diagnostic tests on the board. Pressing this button brings up the dialog box shown in Figure 5-18.

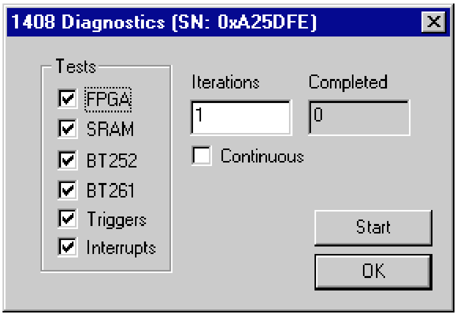


Figure 5-18. Diagnostics Settings

Select the tests you want to perform. Click the **Start** button to start the diagnostics. The diagnostics will run each test that has been specified by the appropriate checkbox. These tests will be executed the number of times specified in the **Iterations** box. To stop the diagnostics, press the **Stop** button. The **Completed** box displays the number of test iterations performed.

A camera *must* be connected to VIDEO0 when testing the interrupts.

Note: ***The* Start *button becomes a* Stop *button when you run the diagnostics.***

Image Storage

The 1408 device can store the captured image in bitmap (`bmp`) format if you select **File»Save** from the pull-down menu or right-click in the video window and select **File»Save**.

Storing the image serves two purposes. First, it saves a reference picture. Second, you can use the 1408 device to acquire images that you can later modify with virtually any image processing application without using NI-IMAQ.

Appendix 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 or DIFF (BNC or DSUB)
VIDEO<3..1>	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 (0–1.28 V in 64 20 mV steps at a gain of 1)
White reference	Programmable (0–1.28 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 .... 10.668 by 17.463 cm
(4.2 by 6.875 in.)

Weight .... 0.127 kg (0.028 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

Appendix B

StillColor

This appendix describes the different methods you can use to acquire a color image using the IMAQ PCI/ PXI-1408 and National Instruments StillColor technology, explains basic color theories, and describes the different output options supported by StillColor.

Introduction

You can use two basic video camera types for color acquisition—RGB cameras and composite color video cameras.

An RGB camera delivers the three basic color components—red, green and blue—on three different wires. This type of camera often uses three independent CCD sensors to acquire the three color signals. RGB cameras are used for very accurate color acquisition.

A composite color camera transmits the video signal on a single wire. The signal is composed of two components that are added together. These components are:

- A monochrome video signal that contains the gray level information from the image and the composite synchronization signals. This signal is the same as a standard monochrome video signal, such as RS-170 (NTSC) or CCIR-601 (PAL).
- A modulated signal that contains the color information from the image. The format of this signal depends on your camera. The three main color standards are as follows:
  - M-NTSC (also called NTSC), which is used mainly in the US and Japan
  - B/G-PAL (also called PAL), which is used mainly in Europe, India, and Australia
  - SECAM, which is used mainly in France and the former Soviet Republics. SECAM is only used for broadcasting, so SECAM countries often use PAL as the local color image format.

StillColor

StillColor is a technique you can use to acquire color images from composite color video or RGB cameras using the PCI/PXI-1408 monochrome device. Use StillColor Composite mode to acquire color images from a composite color video camera. Use StillColor RGB mode to acquire color images from an RGB camera. StillColor composite acquisition results in an image of much higher quality than the traditional color decoding that can be obtained with a color image acquisition board.

To acquire a color image, the PCI/PXI-1408 acquires multiple frames from the camera. Your computer CPU then processes the frames using the StillColor algorithm and creates a single color image. Because StillColor uses your computer CPU to process the image, the acquisition time for a single image depends on your system performance. You can acquire StillColor composite images at rates of up to 2 frames/s and StillColor RGB images at rates of up to 10 frames/s.

You can use StillColor in applications that require high-quality images of still or very slowly moving objects. StillColor supports many different image representations used in scientific or industrial applications, such as RGB bitmap and single plane hue, saturation, luminance, and intensity. StillColor also supports image averaging of up to 128 frames to increase the dynamic range of the StillColor image. See the *Introduction to Color* section later in this appendix for more information on image representations.

StillColor Composite

In a composite color video signal, the color information (chroma) is modulated in phase and amplitude around a sub-carrier frequency of 3.58 MHz (NTSC) or 4.43 MHz (PAL). The modulated signal is then added to the luminance information and the entire signal including synchronization pulses is transmitted on a single line.

Traditional Color Decoding

On the receiver side or in your IMAQ board, the luminance and the chroma signals must be separated before the color image can be decoded and rebuilt. However, the modulated color information and some of the high-frequency luminance information share the same frequency range around the sub-carrier frequency. This sharing makes it impossible to separate the two signals perfectly and, therefore, perfect reconstruction of the original color image is not possible.

All of the traditional ways to separate the two signals result in visual artifacts on the final picture. Techniques such as frequency-band filtering or comb filtering can minimize some of these artifacts, but most techniques are optimized to obtain the best picture for visualization of a continuous acquisition. The composite color formats are designed so that artifacts resulting from one frame are almost cancelled by artifacts in following frames. This system takes advantage of the slow response time of the human eye to obscure most of these problems.

The situation is different in a single frame acquisition where a single image is needed. A single image usually clearly shows the result of a bad color/luminance separation. Typical weakness of traditional separation techniques are:

- Reduced luminance bandwidth, resulting in a blurry image.
- Cross-color modulation where rapidly changing colors affect the luminance of the image, as shown on the edges of the parrot's head in Figure B-1.
- Cross-luminance modulation where rapidly changing luminance (stripes) results in irritating random color patterns, as shown on the black and white stripes around the parrot's eye in Figure B-1.

Figure B-1. Classical Decoding

Figure B-2. StillColor Decoding

☞ **Note:** ***You can find color versions of the illustrations in this appendix in the online version of this document included with your NI-IMAQ software kit.***

Both pictures are approximately 80 by 80 pixels in size and are acquired using an NTSC composite video signal. Figure B-1 uses classic decoding algorithms including bandpass/bandstop and comb filtering. Figure B-2 was acquired using the PCI/PXI-1408 and the StillColor algorithm.

Why StillColor?

StillColor is optimized for single-frame acquisition. A StillColor Composite acquisition acquires multiple consecutive frames. Assuming that all frames represent the same scene of still objects, the algorithm then uses knowledge about the composite color format to perfectly separate the color and the luminance information.

In an NTSC video signal, two consecutive frames representing the same object will contain the same luminance information but will have chroma signals that are opposite in phase. By adding the two frames together, the chroma information is cancelled, and by subtracting the two frames from each other, the luminance signal is cancelled. The resulting separation is now perfect, as shown in Figure B-2.

Color and luminance separation is more complex in a PAL video signal. The IMAQ device must acquire three consecutive frames, but the same perfect separation of the color and luminance information can be achieved after manipulation of these images.

After separating the color and luminance signals, the StillColor algorithm then decodes and rebuilds the color image. As shown in Figure B-2, the result does not show any of the artifacts encountered in traditional color decoding methods.

Composite Color Acquisition

The PCI/PXI-1408, in conjunction with NI-IMAQ, supports acquisition of color images from an NTSC or PAL composite color video camera.

NI-IMAQ can acquire the multiple frames, decode the color information, and rebuild the image automatically. The output image can be a simple RGB color image or one of many image representations supported by NI-IMAQ. See the *Introduction to Color* section later in this appendix for more information on image representations.

You can connect the composite video signal to any of the four input channels on the PCI/PXI-1408. Since StillColor is used for still scenes, you can perform only a snap (a single-image acquisition).

StillColor RGB

RGB cameras output a color image using three lines. StillColor RGB will acquire the three signals and construct a color image. The three lines are connected to three channels on the PCI/PXI-1408. One frame is acquired from each of the three channels, which represent the red, green, and blue planes of the image. StillColor combines these frames to construct the color image.

RGB Color Acquisition

The PCI/PXI-1408, in conjunction with NI-IMAQ, supports acquisition of color images from an RGB camera.

The NI-IMAQ driver can acquire the three frames and rebuild the image automatically. The output image can be a simple RGB color image or one of many image representations supported by the driver. See the *Introduction to Color* section later in this appendix for more information on image representations.

For a StillColor RGB snap, connect the three camera channels—red, green, and blue—to Video 1, Video 2, and Video 3, respectively, on the PCI/PXI-1408 device. Specify a channel for the video synchronization signal by selecting that channel as the sync source using the **Operating Mode** tab in `IMAQConf`. (See Chapter 5, *Configuration Utility*, for more information on the configuration utility.) A typical RGB camera includes the composite video synchronization signal in the green signal. You can also use other synchronization sources, such as an external composite video signal that can be connected to Video 0 or an external TTL composite synchronization signal that can be connected to the CSYNCIN pin of the DSUB connector. (See Chapter 4, *Signal Connections*, for signal connection information.)

Introduction to Color

Color is the wavelength of the light we receive in our eye when we look at an object. In theory, the color spectrum is infinite. Humans, however, can see only a small portion of this spectrum—the portion that goes from the red edge of infrared light (the longest wavelength) to the blue edge of ultraviolet light (the shortest wavelength). This continuous spectrum is called the visible spectrum, as shown in Figure B-3.

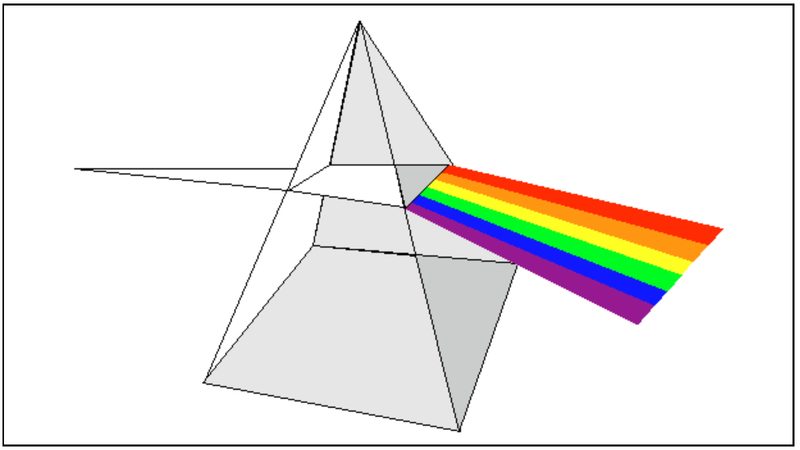


Figure B-3. White Light and the Visible Spectrum

White light is a combination of all colors at once. The spectrum of white light is continuous and goes from ultraviolet to infrared in a smooth transition. You can represent a good approximation of white light by selecting a few reference colors and weighting them appropriately. The most common way to represent white light is to use three reference components, such as red, green, and blue (R, G, and B primaries). You can simulate most colors of the visible spectrum using these primaries. For example, video projectors use red, green, and blue light generators, and an RGB camera uses red, green, and blue sensors.

The perception of a color depends on many factors, such as:

- *Hue*, which is the perceived dominant color. Hue depends directly on the wavelength of a color.
- *Saturation*, which is dependent on the amount of white light present in a color. Pastels typically have a low saturation while very rich colors have a high saturation. For example, pink typically has a red hue but has a low saturation.

- Luminance, which is the brightness information in the video picture. The luminance signal amplitude varies in proportion to the brightness of the video signal and corresponds exactly to the monochrome picture.
- Intensity, which is the brightness of a color and which is usually expressed as light or dark. For example, orange and brown may have the same hue and saturation; however, orange has a greater intensity than brown.

Image Representations

Color images can be represented in several different formats. These formats can contain all color information from the image or they can consist of just one aspect of the color information, such as hue or luminance. The following image representations can be produced using NI-IMAQ and StillColor.

RGB

The most common image representation is 32-bit RGB format. In this representation, the three 8-bit color planes—red, green and blue—are packed into an array of 32-bit integers. This representation is useful for displaying the image on your monitor. The 32-bit integer organized as:

0	RED	GREEN	BLUE

where the high-order byte is not used and blue is the low-order byte.

The system also supports a 24-bit and a 16-bit representation of the RGB image. The 24-bit representation is equivalent to the 32-bit representation; however, there is no unused byte. For the 16-bit representation, the image is packed into an array of 16-bit integers where each 16-bit pixel contains red, green, and blue, encoded with only five bits each. The most significant bit of the integer is always 0.

Color Planes

Each color plane can be returned individually. The red, green, or blue plane is extracted from the RGB image and represented as an array of 8-bit integers.

Hue, Saturation, Luminance, and Intensity Planes

The hue, saturation, luminance, and intensity planes can also be returned individually if you want to analyze the image. You can retrieve the data in 8-bit format to reduce the amount of data to be processed or in 16-bit format to take advantage of the higher precision available when using averaging.

The 16-bit image representation is scaled so that the pixel values are always positive. The value range is 0 to +32,767, so it is compatible with both 16-bit signed and 16-bit unsigned integers. On average, the 16-bit representation of a plane is equal to 128 times the 8-bit representation of the plane from the same image. The 16-bit representation is generally only used if you are performing averaging on your image. For example, averaging an image 16 times requires four extra bits ($16 = 2^4$) to represent the increased dynamic range. In this case, using the 16-bit representation may increase the dynamic range of your image.

Luminance, Intensity, Hue, or Saturation are defined using the Red, Green, and Blue values in the following formulas:

$$\text{Luminance} = 0.299 \times \text{Red} + 0.587 \times \text{Green} + 0.114 \times \text{Blue}$$

$$\text{Intensity} = (\text{Red} + \text{Green} + \text{Blue}) / 3$$

$$\text{Hue} = \text{ATN2}(Y, X)$$

where

$$Y = (\text{Green} - \text{Blue}) / \sqrt{2} \text{ and}$$

$$X = (2 \times \text{Red} - \text{Green} - \text{Blue}) / \sqrt{6}$$

$$\text{Saturation} = \sqrt{X^2 \times Y^2}$$

where

$$Y = (\text{Green} - \text{Blue}) / \sqrt{2} \text{ and}$$

$$X = (2 \times \text{Red} - \text{Green} - \text{Blue}) / \sqrt{6}$$

32-Bit HSL and HSI

You can also pack the three 8-bit Hue, Saturation, and Luminance planes (HSL) or the three Hue, Saturation, and Intensity planes (HSI) in one array of 32-bit integers, which is equivalent to the 32-bit RGB representation.

Appendix C

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 C-1)

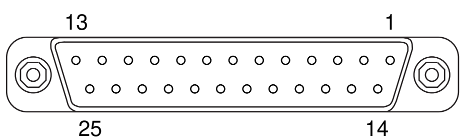


Figure C-1. 25-Pin DSUB Receptacle

Appendix D

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 U.S. 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.

	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 States	512 795 8248	512 794 5678
United Kingdom	01635 523545	01635 523154

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 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

IMAQ hardware ____

Interrupt level of hardware ____

DMA channels of hardware ____

Base I/O address of hardware ____

Programming choice ____

NI-IMAQ, IMAQ Vision, LabVIEW, or LabWindows/CVI version ____________________

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 ____

PCI chipset ____

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 ____

Documentation Comment Form

National Instruments encourages you to comment on the documentation supplied with our products. This information helps us provide quality products to meet your needs.

Title: *Getting Started with Your IMAQ PCI/PXI-1408 and the NI-IMAQ Software for Windows 95/NT*

Edition Date: October 1997

Part Number: 321325B-01

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

____

____

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

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Thank you for your help.

Name ____

Title ____

Company ____

Address ____

____

Phone (___)_____________________ Fax (___) _____________________

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National Instruments Corporation
6504 Bridge Point Parkway
Austin, TX 78730-5039

Fax to: Technical Publications
National Instruments Corporation
(512) 794-5678

Glossary

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

Numbers/Symbols

% percent

\+ positive of, or plus

+5V 5 V signal

– negative of, or minus

/ per

± plus or minus

Ω ohm

A

A	amperes
AC	alternating current
acquisition window	the image size specific to a video standard or camera resolution
active line region	the region of lines actively being stored; defined by a line start (relative to VSYNC) and a line count
active pixel region	the region of pixels actively being stored; defined by a pixel start (relative to HSYNC) and a pixel count
A/D	analog-to-digital
ADC	analog-to-digital converter—an electronic device, often an integrated circuit, that converts an analog voltage to a digital number
address	character code 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 a specific customer
aspect ratio	the ratio of a signal’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 sync 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	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
CCIR	Comite Consultatif International des Radiocommunications—a committee that developed standards for color video signals
chrominance	the color information in a video signal
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 sync signal; a combination of the horizontal and vertical sync 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=20log10 V1/V2, for signals in volts
DC	direct current
default setting	a default parameter value recorded in the driver; in many cases, the default input of a control is a certain value (often 0) that means *use the current default setting*.
DIN	Deutsche Industrie Norme
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
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 dB

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.
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 sync
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; examples of functions are: y = COS (x) **status** = `AO_config`(**board, channel, range**)

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 sync 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—the number of scans read or updates written per second

I

IC	integrated circuit
ID	identification
IEEE	Institute of Electrical and Electronics Engineers
IMAQconf	a configuration and diagnostic utility included with IMAQ devices
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 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 *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
I/O	input/output—the transfer of data to/from a computer system involving communications channels, operator interface devices, and/or data acquisition and control interfaces
IRQ	interrupt request

K

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

L

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
luminance	the brightness information in the video picture. The luminance signal amplitude varies in proportion to the brightness of the video signal and corresponds exactly to the monochrome picture.
LUT	look-up table—a selection in the `IMAQconf` configuration utility that contains formulas that let you implement simple imaging operations such as contrast enhancement, data inversion, gamma manipulation, or other nonlinear transfer functions

M

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

N

NI-IMAQ	driver software for National Instruments IMAQ hardware
noninterlaced	a video frame where all the lines are scanned sequentially, instead of divided into two frames as in an interlaced video frame
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; it is achieving widespread acceptance as a standard for PCs and workstations and 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 HYSNCs; the pixel count determines the frequency of the pixel clock

PLL	phase-locked loop—circuitry that provides a very stable pixel clock that is referenced to another signal, for example, an incoming HSYNC signal
protocol	the exact sequence of bits, characters, and control codes used to transfer data between computers and peripherals through a communications channel
pts	points
PXI	PCI eXtensions for Instrumentation. PXI is an open specification that builds off 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
region-of-interest	a hardware-programmable rectangular portion of the acquisition window
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
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 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

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 a HSYNC, back porch, active pixel region, and a front porch
VSYNC	vertical sync 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 luminance information is called Y, while the chrominance information is represented by two components, U and V representing the coordinates in a color plane.

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