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NI Vision

NI PCI-1410 User Manual

High-Quality Monochrome Image Acquisition Device

February 2007
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Federal Communications Commission

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* The CE marking Declaration of Conformity contains important supplementary information and instructions for the user or installer.

Conventions

The following conventions are used in this manual:

<>	Angle brackets that contain numbers separated by an ellipsis represent a range of values associated with a bit or signal name—for example, AO <3..0>.
»	The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.
	This icon denotes a note, which alerts you to important information.
bold	Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.
italic	Italic text denotes variables, emphasis, a cross-reference, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.
`monospace`	Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.

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1

Introduction

This chapter describes the NI PCI-1410 (NI 1410) device and its software programming options.

About the NI 1410 Device

The NI 1410 is a high-accuracy, monochrome image acquisition device for PCI that supports RS-170, CCIR, NTSC, and PAL video standards, as well as nonstandard cameras from any of four input sources. The NI 1410 features a 10-bit analog-to-digital converter (ADC) that converts video signals to digital formats. The NI 1410 acquires images in real time and stores them in onboard frame memory or transfers them directly to system memory.

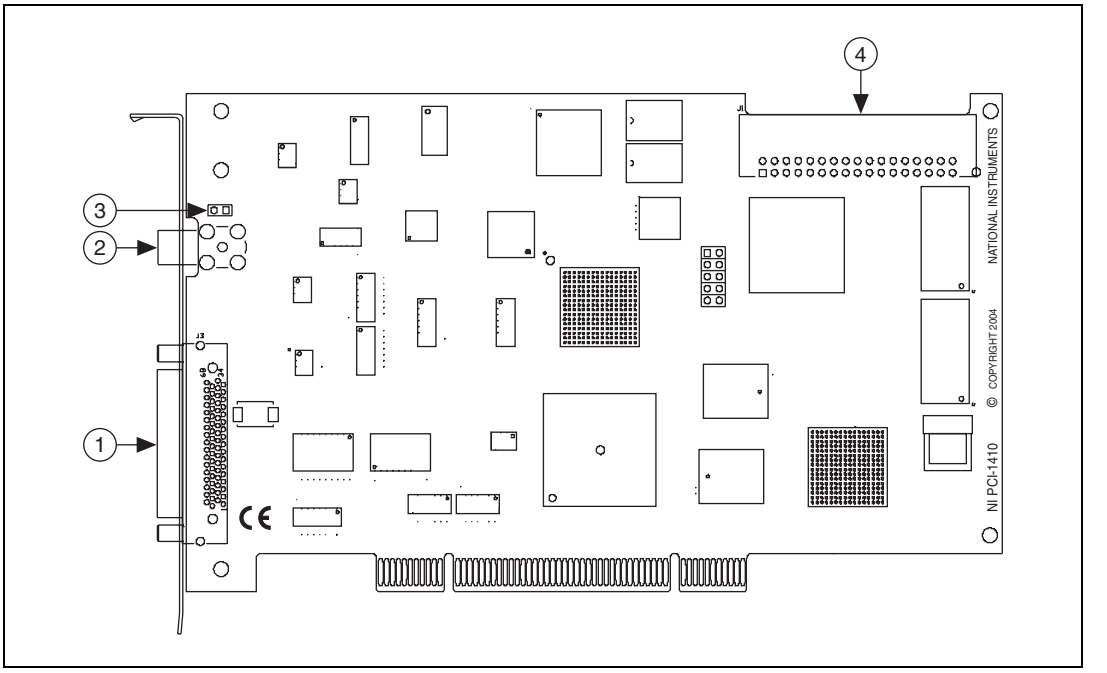
The NI 1410 is easy to install and configure. The NI 1410 ships with NI Vision Acquisition Software, which includes NI-IMAQ, the National Instruments driver software you can use to directly control the NI 1410 and other National Instruments image acquisition devices. With NI-IMAQ, you can quickly and easily start the applications without having to program the device at the register level.

As a stand-alone device, the NI 1410 supports four general-purpose control lines that are configurable to generate precise timing signals for controlling camera acquisition. The NI 1410 also supports four video sources and four external I/O lines to use as triggers or digital I/O lines.

Easily synchronizing several functions to a common trigger or timing event is a common challenge with image acquisition devices. The NI 1410 uses its Real-Time System Integration (RTSI) bus to solve this problem. The RTSI bus uses the National Instruments RTSI bus interface and ribbon cable to route additional timing and trigger signals between the NI 1410 and National Instruments DAQ, Motion Control, or other image acquisition devices. The RTSI bus can even synchronize multiple image acquisition hardware captures.

For detailed specifications of the NI 1410, refer to the *Specifications* section of *Getting Started with the NI PCI-1410*.

Refer to Figure 1-1 for the location of the NI 1410 W1 jumper and the connectors discussed in this manual.



1	68-Pin VHDCI Connector	3	W1 Jumper
2	BNC Connector	4	RTSI Bus Connector

Figure 1-1. NI PCI-1410 Parts Locator Diagram

Software Overview

Programming the NI 1410 requires the NI-IMAQ driver software for controlling the hardware. National Instruments also offers the following application software packages for analyzing and processing your acquired images.

- **Vision Builder for Automated Inspection (AI)**—Allows you to configure solutions to common inspection tasks.
- **National Instruments Vision Development Module**—Provides customized control over hardware and algorithms.

The following sections provide an overview of the driver software and the application software. For detailed information about individual software packages, refer to the documentation specific to each package.

NI-IMAQ Driver Software

The NI 1410 ships with NI Vision Acquisition Software, which includes the NI-IMAQ driver software. NI-IMAQ has an extensive library of functions—such as routines for video configuration, continuous and single shot image acquisition, memory buffer allocation, trigger control, and device configuration—you can call from the application development environment (ADE). NI-IMAQ handles many of the complex issues between the computer and the image acquisition device, such as programming interrupts and camera control.

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

NI-IMAQ also provides the interface path between the NI 1410 and LabVIEW, LabWindows™/CVI™, or a text-based programming environment. The NI-IMAQ software kit includes a series of libraries for image acquisition for LabVIEW, LabWindows/CVI, and Measurement Studio, which contains libraries for Microsoft Visual Basic.

NI-IMAQ features both high-level and low-level functions. Examples of high-level functions include the sequences to acquire images in multi-buffer, single-shot, or continuous mode. An example of a low-level function is configuring an image sequence, since it requires advanced understanding of the image acquisition device and image acquisition principles.

National Instruments Application Software

This section describes the National Instruments application software packages you can use to analyze and process the images you acquire with the NI 1410.

Vision Builder for Automated Inspection

NI Vision Builder for Automated Inspection (AI) is configurable machine vision software that you can use to prototype, benchmark, and deploy applications. Vision Builder AI does not require programming, but is scalable to powerful programming environments.

Vision Builder AI allows you to easily configure and benchmark a sequence of visual inspection steps, as well as deploy the visual inspection system for automated inspection. With Vision Builder AI, you can perform powerful visual inspection tasks and make decisions based on the results of

individual tasks. You also can migrate the configured inspection to LabVIEW, extending the capabilities of the applications if necessary.

Vision Development Module

The Vision Development Module is an image acquisition, processing, and analysis library of more than 270 functions for the following common machine vision tasks:

- Pattern matching
- Particle analysis
- Gauging
- Taking measurements
- Grayscale, color, and binary image display

You can use the Vision Development Module functions individually or in combination. With the Vision Development Module, you can acquire, display, and store images, as well as perform image analysis, and processing. Using the Vision Development Module, imaging novices and experts can program the most basic or complicated image applications without knowledge of particular algorithm implementations.

As a part of the Vision Development Module, NI Vision Assistant is an interactive prototyping tool for machine vision and scientific imaging developers. With Vision Assistant, you can prototype vision applications quickly and test how various vision image processing functions work.

Vision Assistant generates a Builder file, which is a text description containing a recipe of the machine vision and image processing functions. This Builder file provides a guide you can use for developing applications in any ADE, such as LabWindows/CVI or Visual Basic, using the Vision Assistant machine vision and image processing libraries. Using the LabVIEW VI creation wizard, Vision Assistant can create LabVIEW VI block diagrams that perform the prototype you created in Vision Assistant. You then can use LabVIEW to add functionality to the generated VI.

Integration with DAQ and Motion Control

Platforms that support NI-IMAQ also support NI-DAQ and a variety of National Instruments DAQ devices. This allows integration between image acquisition devices and National Instruments DAQ products.

Use National Instruments high-performance stepper and servo motion control products with pattern matching software in inspection and guidance applications, such as locating alignment markers on semiconductor wafers, guiding robotic arms, inspecting the quality of manufactured parts, and locating cells.

2

Hardware Overview

This chapter describes the features of the NI PCI-1410 device and includes information about acquisition modes, analog front-end considerations, and clamping.

Functional Overview

The NI 1410 features a flexible, high-speed data path optimized for the acquisition and formatting of video data from analog cameras. The NI 1410 can acquire from RS-170/NTSC, CCIR/PAL, VGA, and progressive scan cameras, as well as from non-standard cameras such as line scan cameras. The NI 1410 digitizes analog video signals to 8 or 10 bits of resolution at sampling frequencies up to 40 MHz.

The NI 1410 has a factory-calibrated gain circuit to improve measurement accuracy and board-to-board consistency. It uses a PCI interface for high-speed data transfer, 16 MB of SDRAM for data buffering, and region-of-interest control circuitry for optimizing the data transfer. The 16 MB of SDRAM also allows you to acquire entire images into onboard memory when necessary. The NI 1410 includes four external triggers, four camera control signals, seven RTSI bus triggers, and four video synchronization signals.

The block diagram in Figure 2-1 illustrates the key functional units of the NI 1410.

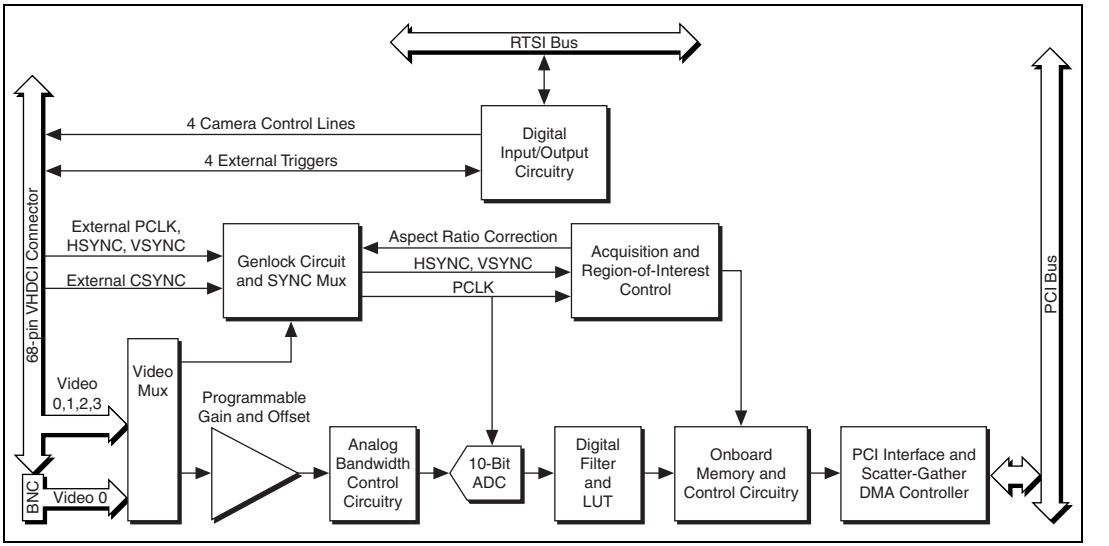


Figure 2-1. NI 1410 Block Diagram

Video Multiplexer

The video multiplexer routes one of the four AC-coupled video inputs to the 10-bit ADC circuitry. The input impedance is 75 Ω.

Programmable Gain and Offset

The NI 1410 uses programmable gain and offset circuitry to optimize the input signal range.

Analog Bandwidth Control Circuitry

You can select either the full bandwidth of 30 MHz or a reduced bandwidth of 9 MHz. The 9 MHz bandwidth setting is available using a 5th order Butterworth lowpass filter.

10-Bit ADC

The 10-bit ADC digitizes the conditioned video signal.

Digital Filter and LUT

The digital filter removes chrominance from a composite color video signal that conforms to either PAL or NTSC. The output of the digital filter passes through the 1,024 × 10-bit lookup table (LUT). You can configure the LUT to implement simple imaging operations such as contrast enhancement, data inversion, gamma correction, or other user-defined transfer functions.

Onboard Memory

The NI 1410 has 16 MB of SDRAM for temporarily storing image data being transferred to the system memory through the PCI bus. The memory can store multiple image buffers.

Scatter-Gather DMA Controllers

The NI 1410 uses three independent onboard direct memory access (DMA) controllers. The DMA controllers transfer data between the onboard SDRAM memory buffer and the PCI bus. Each of these controllers supports scatter-gather DMA, which allows the controllers to reconfigure on-the-fly. This functionality enables the NI 1410 to perform continuous image transfers directly to either contiguous or fragmented memory buffers.

PCI Interface

The NI 1410 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 MB/s in bus master mode.

Genlock Circuit and SYNC Mux

The genlock circuit receives the incoming video signal and generates PCLK, HSYNC, and VSYNC signals for use by the acquisition and control circuitry. The NI 1410 can lock to the standard RS-170/NTSC and CCIR/PAL video signals as well as progressive scan and VGA (640 × 480 resolution) signals. The genlock circuit on the NI 1410 also can lock to external HSYNC and VSYNC or CSYNC signals, as well as additional nonstandard formats.

Acquisition and Region-of-Interest Control

The acquisition and region-of-interest (ROI) control circuitry routes the active pixels from the 10-bit ADC to the onboard memory. The NI 1410 can perform ROI and scaling on all video lines. Pixel and line scaling transfers certain multiples (two, four, or eight) of pixels and lines to onboard memory.

RTSI Bus

The seven trigger lines on the RTSI bus provide a flexible interconnection scheme between multiple image acquisition devices, as well as between National Instruments DAQ or Motion Control devices.

Digital Input/Output Circuitry

The digital input/output (I/O) circuitry routes, monitors, and drives the external trigger lines, RTSI bus lines, and camera control lines. You can use the trigger lines to start or stop an acquisition on a rising or falling edge. You also can map onboard signals such as HSYNC, VSYNC, ACQUISTION_IN_PROGRESS, and ACQUISITION_DONE to these lines. The camera control lines provide a means to generate deterministic signals for triggering cameras, strobe lights, or other timing-critical applications.

Note The NI 1410 does not support pixel clock output on the trigger lines.

Acquisition Modes

The NI 1410 supports the following four video acquisition modes:

- **Standard Mode**—In standard mode, the NI 1410 receives an incoming composite video signal from the external BNC or 68-pin VHDCI connector and generates CSYNC, HSYNC, VSYNC, and PCLK signals. The VHDCI connector outputs the generated CSYNC signal to synchronize other image acquisition devices or cameras.
- **CSYNC External Mode**—In CYSNC external mode, the NI 1410 receives an incoming video signal (composite or luminance) and an external CSYNC signal from the external connector and generates HSYNC, VSYNC, and PCLK signals.
- **External Lock Mode**—In external lock mode, the NI 1410 receives HSYNC, VSYNC, and PCLK signals from the camera and uses these signals to acquire the video signals directly. You can use this mode to acquire from a line scan camera.

- **External HSYNC/VSYNC (HLOCK only) Mode**—In external HSYNC/VSYNC (HLOCK only) mode, the NI 1410 receives the external HSYNC and VSYNC signals and internally generates the PCLK signal. In this mode, the NI 1410 genlock circuitry uses only the HSYNC signal for locking. You can use this mode to acquire from asynchronously reset cameras that output a continuous HSYNC.

Analog Front End Considerations

The analog front end of the NI 1410 features a calibrated gain circuit, programmable DC-restore circuit, and 10-bit ADC as shown in Figure 2-2.

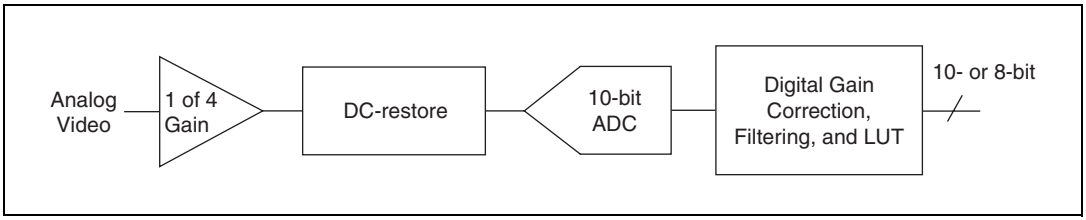


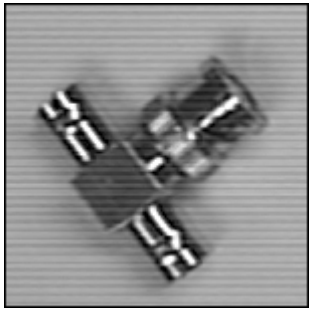
Figure 2-2. NI 1410 Analog Front End

10-Bit/8-Bit Mode

The NI 1410 always digitizes the incoming video signal to 10 bits of resolution. In 10-bit mode, the NI 1410 has four fixed, full-scale ranges for calibrating the gain for each range. Because the nominal full-scale ranges are 0.20, 0.35, 0.70, and 1.40 V, the gain is not continuously variable in this mode. To maintain compatibility with existing acquisition code and processing algorithms used with other analog image acquisition devices, the NI 1410 has an 8-bit mode that converts the 10-bit data from the ADC to 8-bit data in the LUT after gain correction and any digital filtering has occurred.

Clamping

The NTSC camera file sets the default values of Clamp Start and Clamp Stop to 106 and 116, respectively. These settings place the clamp pulse, which restores the DC level of the video signal, between the color burst signal and the beginning of active video. Because some cameras deviate from the exact timing required by the NTSC standard, the clamping pulse may intersect either the color burst or the active video portions of the signal. If this occurs, an acquired image may appear to have dark and light bands, as in the following image.



To prevent this problem, open Measurement & Automation Explorer (MAX) and navigate to the Advanced tab of the camera file property page. Use the following guidelines to adjust the Clamp Start and Clamp Stop values until the image is corrected:

- Minimum Clamp Start is 100
- Maximum Clamp Stop is 120
- Difference between Clamp Start and Clamp Stop is at least 10

3

Signal Connections

This chapter describes cable connections for the NI PCI-1410 device.

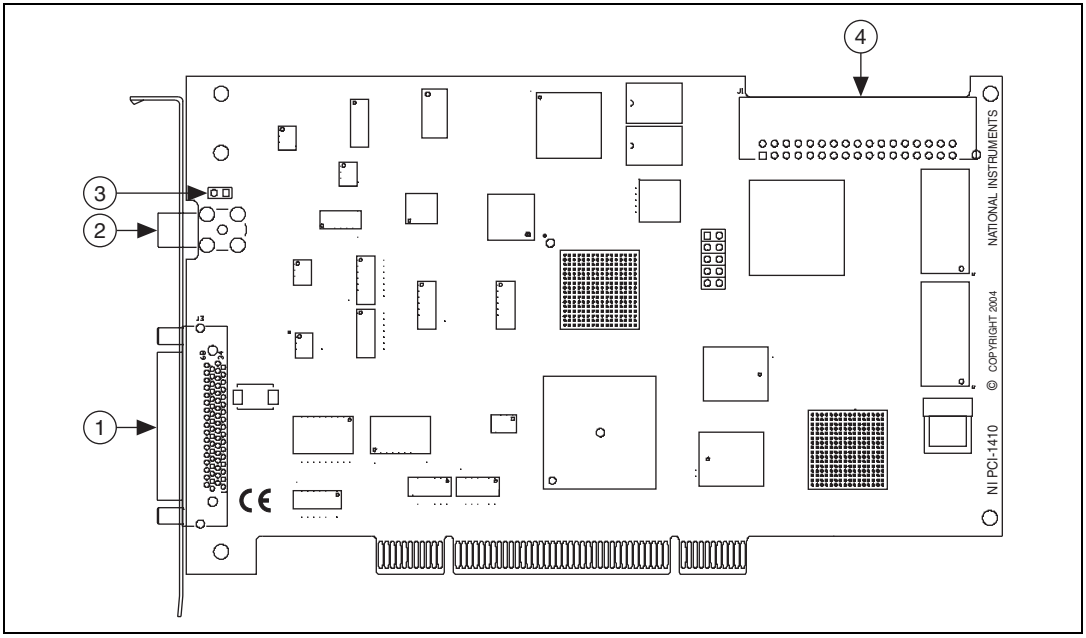
Video Input Channels

The video input channels for the NI 1410 support two input modes—referenced single-ended (RSE) and differential (DIFF). A channel configured in DIFF mode uses two inputs. One input connects to the positive terminal, and the other connects to the negative terminal. A channel configured in RSE mode uses one input, which connects to the positive terminal. The negative input is internally tied to ground.

BNC Connector

The BNC external connector supplies an immediate connection (RSE mode only) to the NI 1410 VIDEO0 input. To connect a camera to VIDEO0, first verify that the W1 jumper is in place. Next, use the 2 m BNC cable shipped with the NI 1410, or another 75 Ω BNC cable, to connect to the BNC connector. If you are using a BNC connection, the VIDEO0 connection on the 68-pin VHDCI I/O connector must be left open.

Refer to Figure 3-1 for the location of the NI 1410 W1 jumper and the connectors discussed in this chapter.



1	68-Pin VHDCI Connector	3	W1 Jumper
2	BNC Connector	4	RTSI Bus Connector

Figure 3-1. NI PCI-1410 Parts Locator Diagram

Figure 3-2 shows the BNC connector pin assignments.

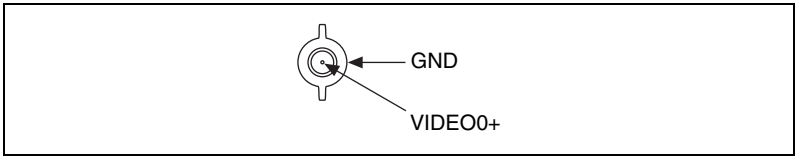


Figure 3-2. BNC Connector Pin Assignment

Digital I/O Connector

The 68-pin VHDCI connector connects to all video signals (VIDEO0, VIDEO1, VIDEO2, and VIDEO3), the external digital I/O lines, triggers, and external signals. To access these connections, you can build your own custom cable or use one of the optional National Instruments cables.

Note If you are using the VIDEO0 connection on the 68-pin VHDCI connector, you must unplug the BNC cable.

Figure 3-3 shows the pinout of the 68-pin VHDCI connector.

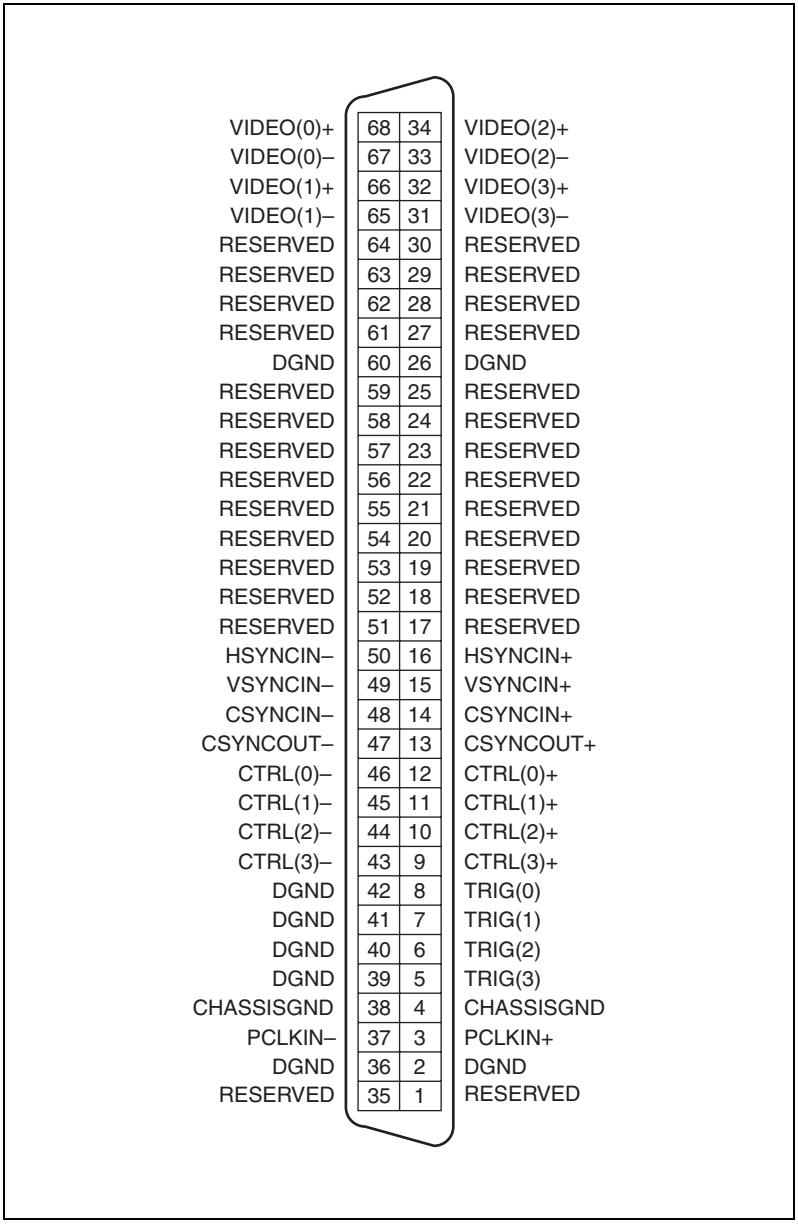


Figure 3-3. I/O Connector Pin Assignments

Digital I/O Connector Signal Connection Descriptions

Table 3-1 describes each signal connection on the 68-pin VHDCI connector.

Table 3-1. I/O Connector Signals

Signal Name	Description
VIDEO0±	VIDEO0± allows for a DIFF or RSE connection. To operate in RSE mode, you must connect VIDEO0– to DGND. When you use VIDEO0+ or VIDEO0–, you must disconnect the video signal from the BNC connector. To operate in DIFF mode, remove attached W1 jumper.
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<3..1>– to DGND.
PCLKIN±	Use PCLKIN± when the NI 1410 is in external lock mode. In this mode, PCLKIN represents the A/D sampling clock. You can select PCLKIN to be either TTL or RS-422 mode and program its polarity through software. In RS-422 mode, both PCLKIN+ and PCLKIN– receive the PCLK signal.
HSYNCIN±	Use HSYNCIN± when the NI 1410 is in external lock mode or external HSYNC/VSYNC (HLOCK only) mode. HSYNC is a synchronization pulse produced at the beginning of each video scan line that keeps the video monitor horizontal scan rate in step with the transmission of each new line. You can set HSYNCIN for either TTL or RS-422 mode and program its polarity through software. In RS-422 mode, both HSYNCIN+ and HSYNCIN– receive the HSYNC signal.
VSYNCIN±	Use VSYNCIN± when the NI 1410 is in external lock mode or external HSYNC/VSYNC (HLOCK only) 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 to be either TTL or RS-422 mode and program its polarity through software. In RS-422 mode, both VSYNCIN+ and VSYNCIN– receive the VSYNC signal.
CSYNCIN±	Use CSYNCIN± when the NI 1410 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 to be either TTL or RS-422 mode and program its polarity through software. In RS-422 mode, both CSYNCIN+ and CSYNCIN– receive the CSYNC signal.
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 NI 1410 generates CSYNCOUT.

Table 3-1. I/O Connector Signals (Continued)

Signal Name	Description
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 also can program the triggers to be programmatically asserted or unasserted, which is similar in function to a digital I/O line, or to contain specific pulse widths or internal status signals by using the onboard events.
CTRL<3..0>±	Use the control lines on the NI 1410 to control camera features and timing information, such as generating integration or shutter pulses. You can generate either static or dynamic signals and either TTL or differential signals on these lines.
DGND	DGND is a direct connection to digital GND on the NI 1410.
CHASSIS_GND	CHASSIS_GND is a direct connection to the computer's chassis, which is grounded through the power cord.

A

Custom Cables

This appendix lists specifications for building custom cables to use with the NI PCI-1410 device.

Cable Specification

National Instruments offers cables and accessories for you to connect to video sources, trigger sources, or synchronization sources. Use the following guidelines when developing your own cables:

- For the video inputs, use a 75 Ω shielded coaxial cable.
- For the digital triggers and synchronization signals, use twisted pairs for each signal.

For information about connector pin assignments, refer to the *Digital I/O Connector* section of Chapter 3, *Signal Connections*.

Connector Specifications

- Video and sync signals—75 Ω impedance
- Trigger signals—TTL
- Type—75 Ω BNC or 68-pin VHDCI receptacle

B

Technical Support and Professional Services

Visit the following sections of the National Instruments Web site at ni.com for technical support and professional services:

- **Support**—Online technical support resources at ni.com/support include the following:
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Glossary

A

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 value.
address	Value that identifies a specific location (or series of locations) in memory.
antichrominance filter	Removes the color information from the video signal.
ASIC	Application-Specific Integrated Circuit. A proprietary semiconductor component designed and manufactured to perform a set of specific functions for specific customer needs.
aspect ratio	The ratio of a picture or image's width to its height.

B

buffer	Temporary storage for acquired data.
bus	A group of conductors that interconnect individual circuitry in a computer, such as the PCI bus; typically the expansion vehicle to which I/O or other devices are connected.

C

CCIR	Comite Consultatif International des Radiocommunications. A committee that developed standards for video signals. Also used to describe signals, boards, and cameras that adhere to the CCIR standards.
chroma	The color information in a video signal.
chrominance	*See* chroma.
CSYNC	Composite synchronization signal. Signals in a color video system that multiplex all picture information into a single signal, such as NTSC, PAL, or SECAM.

D

DAQ	Data acquisition. (1) Collecting and measuring electrical signals from sensors, transducers, and test probes or fixtures and inputting them to a computer for processing. (2) Collecting and measuring the same kinds of electrical signals with A/D or DIO boards plugged into a computer, and possibly generating control signals with D/A and/or DIO boards in the same computer.
DMA	Direct memory access. A method by which data can be transferred between computer memory and 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.
driver	Software that controls a specific hardware device, such as an image acquisition or DAQ device.

E

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

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	The process of synchronizing a video source to the signal from a separate video source. The circuitry aligns the video timing signals by locking together the horizontal, vertical, and color subcarrier frequencies and phases and generates a pixel clock that clocks pixel data into memory for display or into another circuit for processing.

H

HSYNC	Horizontal synchronization signal. The synchronization pulse signal produced at the beginning of each video scan line that keeps a video monitor's horizontal scan rate in step with the transmission of each new line.

I

instrument driver	A set of high-level software functions, such as NI-IMAQ, that control specific plug-in computer boards. Instrument drivers are available in several forms, ranging from a function callable from a programming language to a virtual instrument (VI) in LabVIEW.
interlaced	A video frame composed of two interleaved fields. The number of lines in a field are half the number of lines in an interlaced frame.
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.

L

LSB	Least significant bit.
LUT	Lookup table. Table containing values used to transform the gray-level values of an image. For each gray-level value in the image, the corresponding new value is obtained from the lookup table.

M

memory buffer	*See* buffer.
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 image acquisition hardware.
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.

P

PAL	Phase Alternation Line. One of the European video color standards. PAL uses 625 lines per frame. *See also* NTSC.
PCI	Peripheral Component Interconnect. A high-performance expansion bus architecture originally developed by Intel to replace ISA and EISA. PCI offers a theoretical maximum transfer rate of 132 Mbytes/s.
PCLK	Pixel clock signal. Times the sampling of pixels on a video line.
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.

R

resolution	(1) The number of rows and columns of pixels. An image composed of m rows and n columns has a resolution of $m \times n$. This image has n pixels along its horizontal axis and m pixels along its vertical axis. (2) The smallest signal increment that can be detected by a measurement system. Resolution can be expressed in bits, proportions, or a percentage of full scale. For example, a system has 12-bit resolution, one part in 4,096 resolution, and 0.0244 percent of full scale.
ROI	Region of interest. (1) An area of the image that is graphically selected from a window displaying the image. This area can be used to focus further processing. (2) A hardware-programmable rectangular portion of the acquisition window.

RSE	Referenced single-ended. All measurements are made with respect to a common reference measurement system or a ground. Also called a grounded measurement system.
RTSI bus	Real-Time System Integration Bus. The National Instruments timing bus that connects image acquisition and DAQ boards directly by means of connectors on top of the boards for precise synchronization of functions.

S

scatter-gather DMA	A type of DMA that allows the DMA controller to reconfigure on-the-fly.
SDRAM	Synchronous DRAM is a form of dynamic RAM memory that is about 20% faster than EDO RAM. SDRAM interleaves two or more internal memory arrays so that while one array is being accessed, the next one is being prepared for access.
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.

T

trigger	Any event that causes or starts some form of data capture.
TTL	Transistor-transistor logic.

V

value	The grayscale intensity of a color pixel computed as the average of the maximum and minimum red, green, and blue values of that pixel.
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.
VSYNC	Vertical synchronization signal. The synchronization pulse generated at the beginning of each video field that tells the video monitor when to start a new field.

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