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IMAQ™

IMAQ PCI/PXI™-1409 User Manual

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

NATIONAL INSTRUMENTS™

November 2000 Edition
Part Number 322811A-01

Worldwide Technical Support and Product Information

ni.com

National Instruments Corporate Headquarters

11500 North Mopac Expressway Austin, Texas 78759-3504 USA Tel: 512 794 0100

Worldwide Offices

Australia 03 9879 5166, Austria 0662 45 79 90 0, Belgium 02 757 00 20, Brazil 011 284 5011,
Canada (Calgary) 403 274 9391, Canada (Ontario) 905 785 0085, Canada (Québec) 514 694 8521,
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FCC/Canada Radio Frequency Interference Compliance*

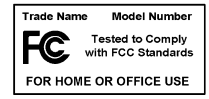
Determining FCC Class

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

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

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

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



Consult the FCC web site `http://www.fcc.gov` for more information.

FCC/DOC Warnings

This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual and the CE Mark Declaration of Conformity**, may cause interference to radio and television reception. Classification requirements are the same for the Federal Communications Commission (FCC) and the Canadian Department of Communications (DOC).

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

Class A

Federal Communications Commission

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

Canadian Department of Communications

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

Class B

Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Canadian Department of Communications

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

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

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

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

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

Conventions

The following conventions are used in this manual:

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

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

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

italic Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. This font also denotes text that is a placeholder for a word or value that you must supply.

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1

Introduction

This chapter describes the PCI-1409 and PXI-1409 devices and describes your software programming choices.

About Your 1409 Device

The PCI-1409 and PXI-1409 devices are high-accuracy, monochrome, IMAQ boards for PCI, PXI, or CompactPCI chassis that support RS-170, CCIR, NTSC, and PAL video standards as well as some nonstandard cameras from any of four input sources. The boards feature a 10-bit analog-to-digital converter (ADC) that converts video signals to digital formats. The PCI-1409 acquires images in real time and can store these images in onboard frame memory or transfer these images directly to system memory.

The 1409 device is simple to configure so that you can easily install the board and begin your image acquisition. The 1409 device ships with NI-IMAQ, the National Instruments complete image acquisition driver software you can use to directly control your 1409 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 1409 device is ideal for both industrial and scientific environments. As a standalone board, the 1409 device supports four general purpose control lines that you can configure to generate precise timing signals for controlling camera acquisition. The 1409 device also 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 1409 device and NI-IMAQ with the National Instruments data acquisition (DAQ) product line.

A common problem with many image acquisition boards is that you cannot easily synchronize several functions to a common trigger or timing event. The 1409 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 1409 device and up to four National Instruments DAQ, Motion Control, or other IMAQ boards in your computer.

Detailed specifications of the PCI-1409 and PXI-1409 are in Appendix A, *Specifications*.

Using PXI with CompactPCI

Using PXI-compatible products with standard CompactPCI products is an important feature provided by the *PXI Specification*, Revision 1.0. If you use a PXI-compatible plug-in device in a standard CompactPCI chassis, you will be unable to use PXI-specific functions, but you can still use the basic plug-in device functions. For example, the RTSI bus on your PXI-1409 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-1409 device will work in any standard CompactPCI chassis adhering to the *PICMG 2.0 R2.1 CompactPCI* core specification using the 64-bit definition for J2.

PXI specific features are implemented on the J2 connector of the CompactPCI bus. Table 1-1 lists the J2 pins your PXI-1409 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-1409 Device

PXI-1409 Signal	PXI Pin Name	PXI J2 Pin Number
RTSI Trigger <0..6>	PXI Trigger <0..6>	B16, A16, A17, A18, B18, C18, E18

Software Programming Choices

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

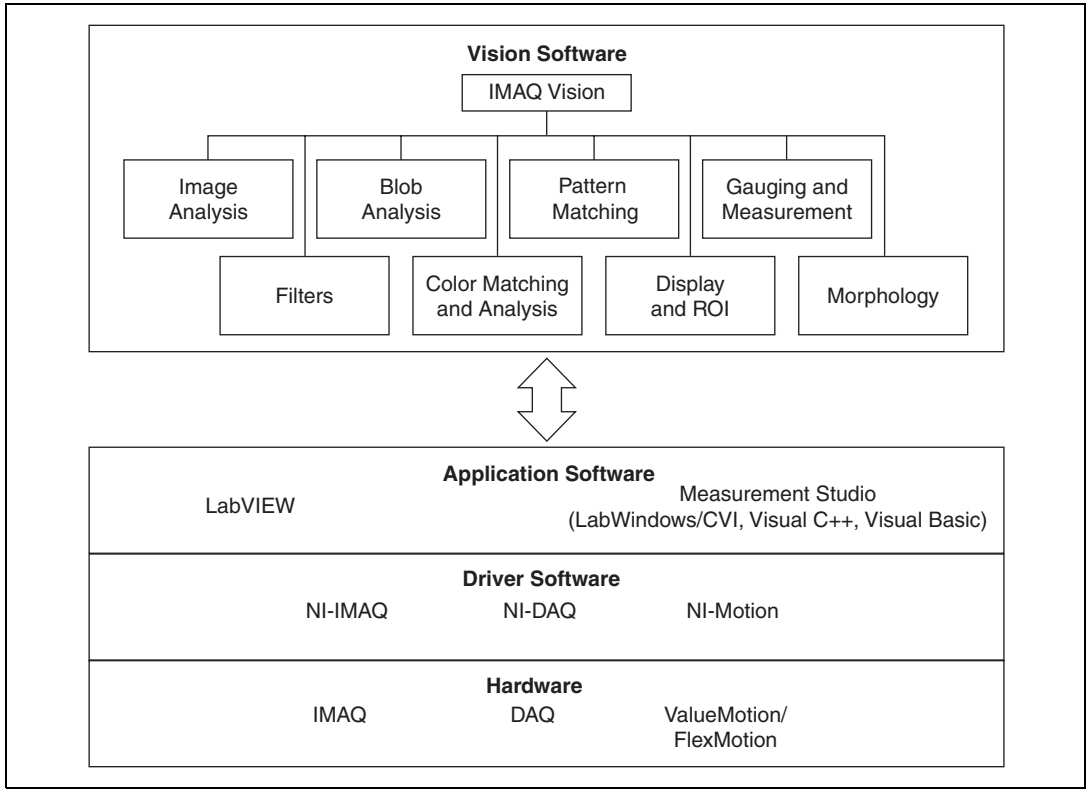


Figure 1-1. The Relationship between the Programming Environment, NI-IMAQ, and Your Hardware

NI-IMAQ Driver Software

The NI-IMAQ driver software is included with your IMAQ device. NI-IMAQ has an extensive library of functions that you can call from your application programming environment. These functions include routines for video configuration, image acquisition (continuous and single-shot), memory buffer allocation, trigger control, and board configuration, as shown in Figure 1-2.

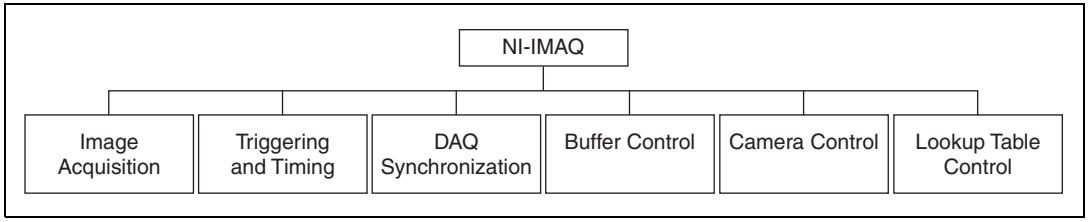


Figure 1-2. NI-IMAQ Functions

The NI-IMAQ driver software performs all of the functions required for acquiring and saving images. The NI-IMAQ software does not perform any image analysis. For image analysis functionality, refer to the *National Instruments IMAQ Vision* section in this chapter.

NI-IMAQ has both high-level and low-level functions for maximum flexibility and performance. Examples of high-level functions include the functions to acquire images in single-shot or continuous mode. An example of a low-level function is configuring an image sequence, since it requires advanced understanding of your IMAQ device and image acquisition.

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

NI-IMAQ is also the interface path between LabVIEW, LabWindows/CVI, or a conventional programming environment and your IMAQ device. The NI-IMAQ software kit includes a series of libraries for image acquisition for LabVIEW and Measurement Studio, which contains libraries for LabWindows/CVI, Visual C++, and Visual Basic. These libraries are functionally equivalent to the NI-IMAQ software.

National Instruments IMAQ Vision

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

You can use IMAQ Vision functions directly or in combination for unique image processing. With IMAQ Vision you can acquire, display, manipulate, and store images as well as perform image analysis, processing, and interpretation. Using IMAQ Vision, an imaging novice or expert can perform graphical programming of the most basic or complicated image applications without knowledge of any algorithm implementations.

IMAQ Vision is available for LabVIEW and Measurement Studio, which includes support for LabWindows/CVI, Visual C++, and Visual Basic.

IMAQ Vision Builder

IMAQ Vision Builder is an interactive prototyping tool for machine vision and scientific imaging developers. With IMAQ Vision Builder, you can prototype vision software quickly or test how various vision image processing functions work.

As shown in Figure 1-3, IMAQ Vision Builder generates a Builder file, which is a text description that contains a recipe of the machine vision and image processing functions. This Builder file provides a guide you can use for developing applications with IMAQ Vision in LabVIEW or Measurement Studio.

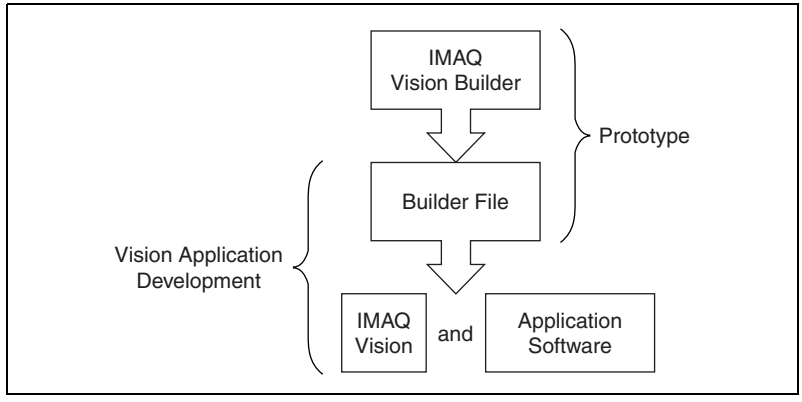


Figure 1-3. IMAQ Vision Builder and Application Development Tools

Integration with DAQ

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

Vision and Motion

With National Instruments IMAQ hardware and IMAQ Vision pattern matching software you can quickly and accurately locate objects in instances where objects vary in size, orientation, focus, and even when the part is poorly illuminated. Use National Instruments high-performance stepper and servo motion control products with pattern matching software in inspection and guidance applications such as locating alignment markers on semiconductor wafers, guiding robotic arms, inspecting the quality of manufactured parts, and locating cells.

2

Configuration and Installation

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

What You Need to Get Started

To set up and use your 1409 device, you will need the following:

- ❑ One of the following 1409 devices:
  - PCI-1409
  - PXI-1409
- ❑ *Getting Started with Your IMAQ System*
- ❑ NI-IMAQ release notes
- ❑ *IMAQ PCI/PXI-1409 User Manual*
- ❑ NI-IMAQ for Windows 2000/NT/Me/9*x* and online documentation
- ❑ Optional software packages and documentation:
  - IMAQ Vision for LabVIEW or Measurement Studio (LabWindows/CVI, Visual C++, Visual Basic)
  - IMAQ Vision Builder
  - LabVIEW
  - Measurement Studio (LabWindows/CVI, Tools for Visual Basic)
- ❑ IMAQ BNC-1 shielded, 75 Ω BNC cable for VIDEO0 (included with the 1409 device)
- ❑ BNC-to-RCA adapter (included with your 1409 device)

- ❑ Your Pentium-based PCI, PXI, or CompactPCI computer running Windows 2000, Windows NT, Windows Me, Windows 98, or Windows 95
- ❑ A video camera or other video source

Note The IMAQ PCI-1409 and PXI-1409 devices rely on your computer's PCI interface chipset for the highest throughput to system memory. For the best results, your computer should have a Pentium or better processor and an Intel 430 or 440 series or compatible PCI interface chipset.

Optional Equipment

National Instruments offers a variety of products for use with your PCI/PXI-1409 board, including the following cables and other National Instruments products:

- IMAQ 6822 BNC breakout box and cable for trigger and additional camera support
- RTSI bus cables for connecting the 1409 device to other IMAQ or DAQ hardware
- Other National Instruments DAQ devices for enhanced triggering, timing, or input/output

For more specific information about these products, refer to your National Instruments catalog or Web site, or call the office nearest you.

How to Set up Your IMAQ System

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

Follow the instructions in the *Getting Started with Your IMAQ System* document to install your NI-IMAQ software and IMAQ hardware.

If you will be accessing the NI-IMAQ device drivers through LabVIEW, you should read the NI-IMAQ release notes and the *NI-IMAQ User Manual* to help you get started.

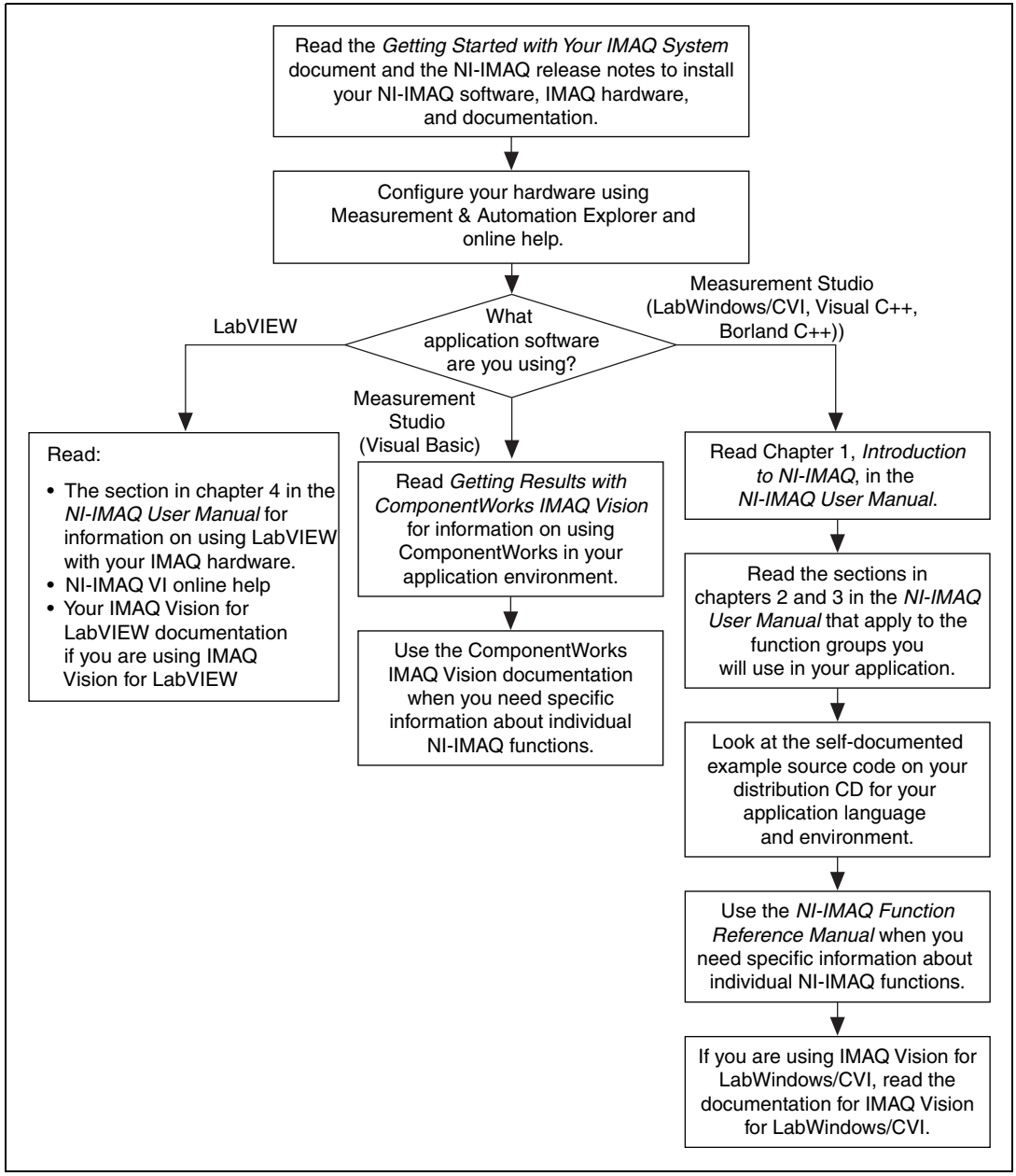


Figure 2-1. How to Set up Your IMAQ System

Unpacking

Your 1409 device is shipped in an antistatic package to prevent electrostatic damage to the board. Electrostatic discharge can damage several components on the board. To avoid such damage in handling the board, take the following precautions:

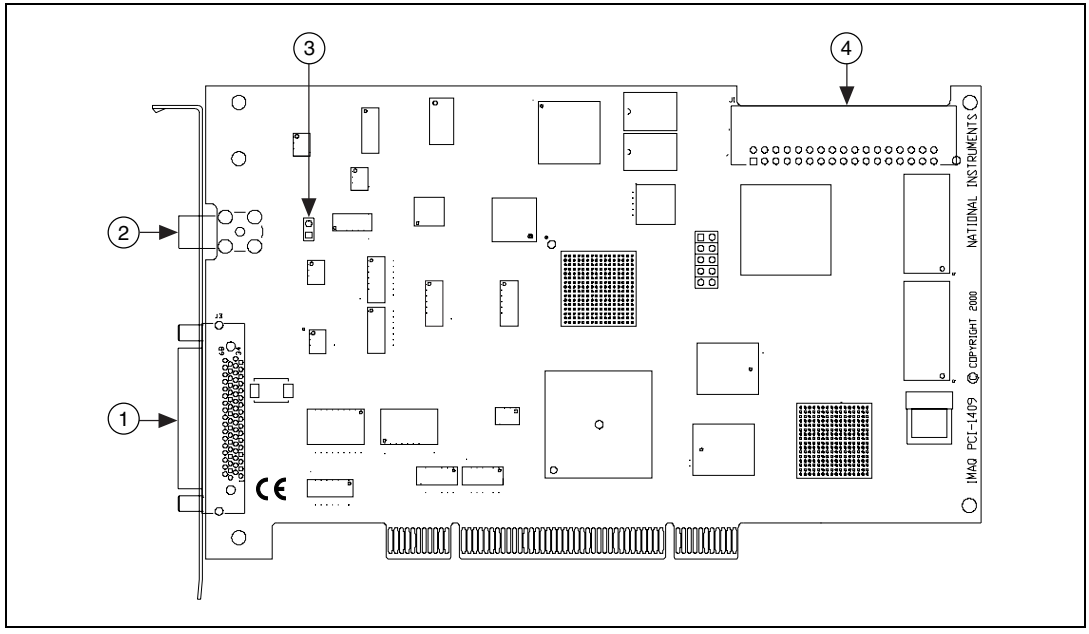
- Ground yourself via a grounding strap or by holding a grounded object.
- Touch the antistatic package to a metal part of your computer chassis before removing the board from the package.
- Remove the board from the package and inspect the board for loose components or any other signs of damage. Notify National Instruments if the board appears damaged in any way. Do *not* install a damaged board in your computer.
- *Never* touch the exposed pins of connectors.

Board Configuration

This section describes how to configure the VIDEO0 input mode on the 1409 device.

All other configuration options are software configurable.

Figure 2-2 shows the locations of user-configurable jumpers and switches as well as factory-default settings on the PCI-1409.



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

Figure 2-2. PCI-1409 Parts Locator Diagram

VIDEO0 Input Mode

VIDEO0 has two different input sources via a BNC connector or a 68-pin VHDCI 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 68-pin VHDCI 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.

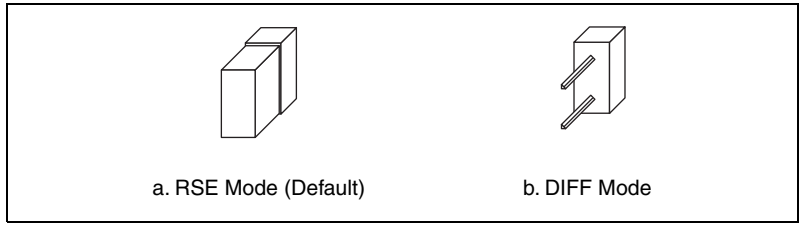


Figure 2-3. Configuring VIDEO0 with Jumper W1

Video channels 1, 2, and 3 are always in differential mode. To take an RSE measurement on these channels, tie the negative terminal of the connector to ground (Pins 26 or 60 on the 68-pin VHDCI connector). See Chapter 4, *Signal Connections*, for more information on pin assignments.

Installation

Note You must install the NI-IMAQ driver software before installing your 1409 device. For information on how to install NI-IMAQ, please see the *Getting Started with Your IMAQ System* document and your NI-IMAQ release notes.

- PCI-1409

  You can install the PCI-1409 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-1409 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. Turn off and unplug your computer.

Warning To protect both yourself and the computer from electrical hazards, the computer should remain off and unplugged until you finish installing the 1409 device.

2. Follow the electrostatic discharge guidelines in the *Unpacking* section of this chapter.
3. Remove the cover of your computer.
4. Make sure there are no lighted LEDs on your motherboard. If any are lit, wait until they go out before continuing your installation.
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. Select any available PCI expansion slot.
7. 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.
8. Line up the PCI-1409 with the 68-pin VHDCI and BNC connectors near the cut-out on the back panel. Slowly push down on the top of the PCI-1409 until its card-edge connector is resting on the expansion slot receptacle. Using slow, evenly distributed pressure, press the PCI-1409 straight down until it seats in the expansion slot.
9. Reinstall the bracket-retaining screw to secure the PCI-1409 to the back panel rail.
10. Check the installation.
11. Replace the computer cover.

Your PCI-1409 is now installed.

- PXI-1409

  You can install a PXI-1409 in any available 5 V peripheral slot in your PXI or CompactPCI chassis.

Note The PXI-1409 has connections to several reserved lines on the CompactPCI J2 connector. Before installing a PXI-1409 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-1409 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-1409 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-1409 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-1409 is now installed.

3

Hardware Overview

This chapter presents an overview of the hardware functions on your PCI/PXI-1409 board and explains the operation of each functional unit making up the PCI/PXI-1409.

Functional Overview

The PCI/PXI-1409 features a flexible, high-speed data path optimized for the acquisition and formatting of video data from analog cameras. The 1409 device 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 1409 device digitizes analog video signals to 8 or 10 bits of resolution at sampling frequencies up to 40 MHz.

The 1409 device 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 on-board memory when necessary. The 1409 device includes four external triggers, four camera control signals, seven RTSI bus triggers, and six video synchronization signals.

The block diagram in Figure 3-1 illustrates the key functional units of the PCI/PXI-1409.

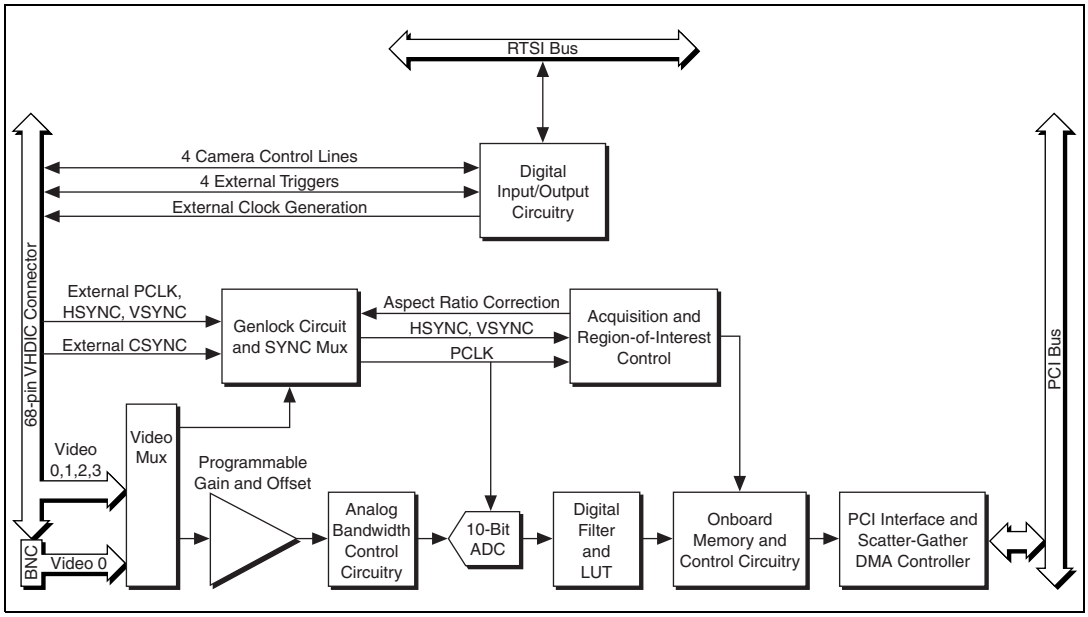


Figure 3-1. 1409 Device Block Diagram

Video Mux

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

Programmable Gain and Offset

The PCI/PXI-1409 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 1024 x 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 PCI/PXI-1409 comes with 16 MB of SDRAM for temporary storage of the image data being transferred to the system memory through the PCI bus. The memory can store multiple image buffers.

Scatter-Gather DMA Controllers

The PCI/PXI-1409 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. Therefore, the PCI/PXI-1409 can perform continuous image transfers directly to either contiguous or fragmented memory buffers.

PCI Interface

The PCI/PXI-1409 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 1409 device 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 1409 device can also lock to external HSYNC and VSYNC or CSYNC signals.

Acquisition and Region-of-Interest (ROI) Control

The acquisition and region-of-interest control circuitry routes the active pixels from the 10-bit ADC to the onboard memory. The PCI/PXI-1409 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 PCI/PXI-1409 boards as well as between any National Instruments DAQ or Motion device and the PCI/PXI-1409.

Digital Input/Output Circuitry

The digital input/output 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. In addition, you 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. This module also contains an external clock generation circuit. You can use this external clock as the source clock for a line scan camera.

Acquisition Modes

The 1409 device supports five video acquisition modes.

- Standard Mode—In standard mode, the 1409 device receives an incoming composite video signal from the external BNC or 68-pin VHDCI connector and generates CSYNC, HSYNC, VSYNC, and PCLK signals. The generated CSYNC signal is output on the VHDCI connector to synchronize other image acquisition boards or cameras.
- CSYNC External Mode—In CYSNC external mode, the 1409 device 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 1409 device receives HSYNC, VSYNC, and PCLK signals from the camera and uses these signals to acquire the video signals directly. You can also use this mode to acquire from a line scan camera.
- External HSYNC/VSYNC Mode—In external HSYNC/VSYNC mode, the 1409 device receives the external HSYNC and VSYNC from the connector and internally generates the PCLK signal. The device's genlock circuitry locks to the external HSYNC and VSYNC signals. You can use this mode to acquire from VGA monitors (640 x 480 resolution).
- External HSYNC/VSYNC (HLOCK only) mode—In external HSYNC/VSYNC (HLOCK only) mode, the 1409 device receives the external HSYNC and VSYNC signals and internally generates the PCLK signal. In this mode, the device's genlock circuitry uses only the HSYNC signal for locking. You can use this mode to acquire from asynchronously-reset cameras which output a continuous HSYNC.

Note Connect a FIELD signal to TRIG3 when the 1409 device is in external lock mode with an interlaced camera.

Analog Front End Considerations

The analog front end of the IMAQ PCI/PXI-1409 device features a calibrated gain circuit, programmable DC-restore circuit, and 10-bit ADC as shown in Figure 3-2.

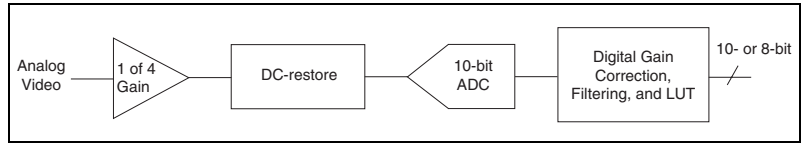


Figure 3-2. IMAQ PCI/PXI-1409 Analog Front End

10-bit/8-bit Mode

The 1409 device digitizes the incoming video signal to 10 bits of resolution at all times. In 10-bit mode, the 1409 device has four fixed, full-scale ranges where the gain for each range is calibrated. The nominal full-scale ranges are 0.20, 0.35, 0.70, and 1.40 V. As a result, the gain is not continuously variable in this mode. To maintain compatibility with other IMAQ analog devices, the 1409 device has an 8-bit mode, in which the 10-bit data from the ADC is converted to 8-bit data in the lookup table (LUT) after gain correction and any digital filtering has occurred.

4

Signal Connections

This chapter describes cable connections for the PCI-1409 and PXI-1409 devices.

BNC Connector

The BNC external connector supplies an immediate connection to the 1409 device VIDEO0 input. Use the 2 m BNC cable shipped with the PCI/PXI-1409 to connect a camera to VIDEO0. You cannot use this connection with VIDEO0 on the 68-pin VHDCI I/O connector. You can configure the BNC connector only for RSE mode.

Note Verify that Jumper W1 is installed when using the BNC input.

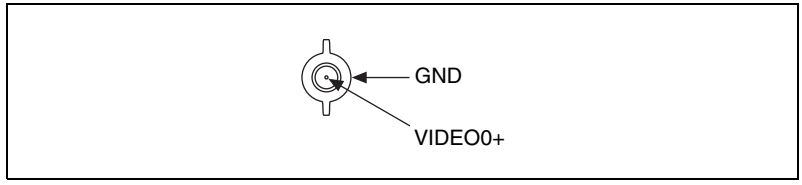


Figure 4-1. BNC Connector Pin Assignment

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 cables from National Instruments. Figure 4-2 shows the pinout of the 68-pin VHDCI connector.

Note Do *not* use the VIDEO0 connection on the 68-pin VHDCI connector when using the BNC connection.

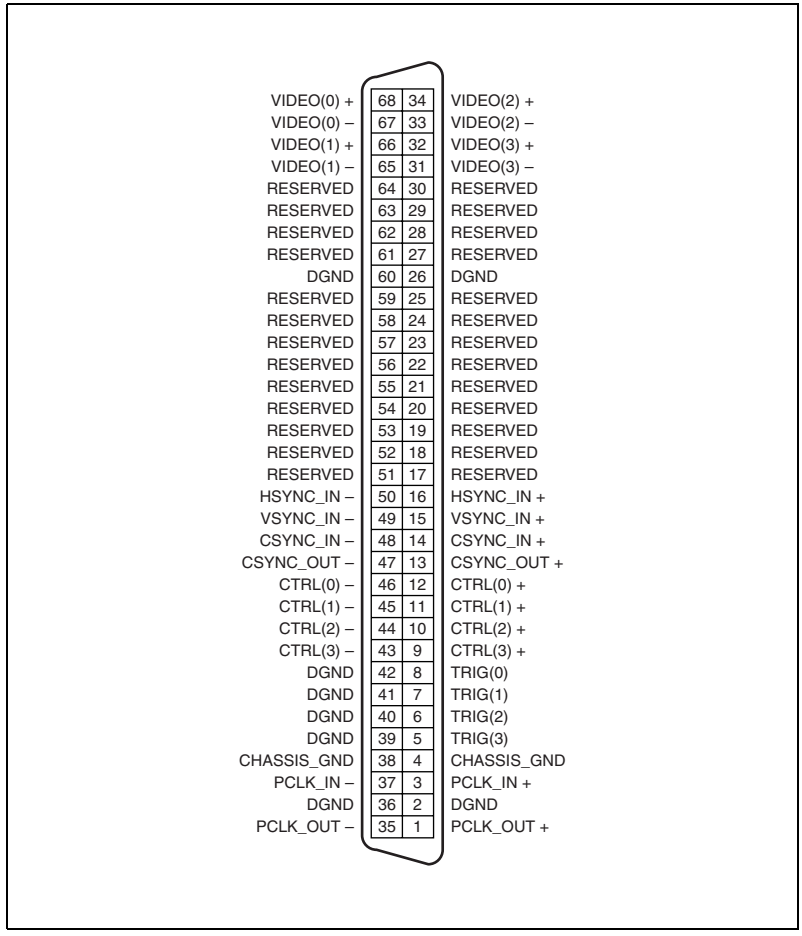


Figure 4-2. I/O Connector Pin Assignments

I/O Connector Signal Connection Descriptions

Table 4-1 describes each signal connection on the 68-pin VHDCI 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 1409 device 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.
PCLKOUT±	Use PCLKOUT± when your camera requires an external pixel clock source. The 1409 device can generate variable pixel clock frequencies between 500 kHz and 40 MHz. You can set PCLKOUT± through your software in TTL and RS-422 modes.
HSYNCIN±	Use HSYNCIN± when the 1409 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 to be 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 1409 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 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 1409 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 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 1409 device generates CSYNCOUT.

Table 4-1. 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 can also program the triggers to be programmatically asserted or unasserted similar in function to a digital I/O line or to contain internal status signals (by using the onboard events) or specific pulse widths.
CTRL<3..0>±	Use the control lines on the PCI-1409 to control camera features and timing information. Either static or dynamic, TTL or differential, signals can be generated on these lines to perform such functions as generating integration or shutter pulses to the cameras.
GND	GND is a direct connection to digital GND on the 1409 device.
CHASSIS_GND	CHASSIS_GND is a direct connection to the computer's chassis, which is grounded through the power cord.

A

Specifications

This appendix lists the specifications of the PCI-1409 and PXI-1409 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)
VGA	60 Hz, 640 × 480 resolution
Variable scan	Programmable

Video Input

Quantity	Four monochrome
Input impedance	75 Ω ±1%
VIDEO0	RSE (BNC), RSE or DIFF (VHDCI)
VIDEO<3..0>	RSE or DIFF (VHDCI)
Frequency response	30 MHz (–3 dB) typ
Digital Antichrominance filter	Programmable (disabled, 3.58 MHz notch filter, or 4.43 MHz notch filter)
Filter characteristics	Attenuation at notch frequency > 30 dB

Input range (black to white).....700 mV (calibrated)
200 mV to 1.40 V full scale

Accuracy.....±1.5% of reading

Temperature drift.....< 250 ppm/°C

A/D Conversion

Gray levels.....1024 (10-bit)

Differential nonlinearity .....±1 LSB max

RMS noise .....< 0.5 LSB rms

Signal-to-noise ratio .....56 dB typ

Sampling rate.....2 MHz to 40 MHz, externally clocked

Pixel aspect ratio.....Programmable ±5% of nominal

Internal Pixel Clock

Frequencies range .....11.6 to 25.8 MHz

Pixel ratio for
standard video sources.....±5%

Pixel jitter .....< 2 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 (1.5 A)
+12 V (100 mA)
–12 V (50 mA)

Physical

Dimensions

- PCI-1409 ..... 10.7 by 17.5 cm (4.2 by 6.9 in.)
- PXI-1409 ..... 10 by 16 cm (3.9 by 6.3 in.)

Weight

- PCI-1409 ..... 0.127 kg (0.28 lb)
- PXI-1409 ..... 0.172 kg (0.38 lb)

Environment

Operating temperature ..... 0 to 55 °C

Storage temperature ..... –20 to 70 °C

Relative humidity ..... 10 to 90%, noncondensing

Electromagnetic Compatibility

EMC/EMI.....CE, C-Tick, and FCC Part 15 (Class A) Compliant

Electrical Emissions .....EN 55011 Class A at 10 meters. FCC Part 15A above 1 GHz

Electrical Immunity .....Evaluated to EN 61326:1998, Table 1

Note This device should only be operated with shielded cable for full EMC and EMI compliance. See the *Compliance* section of this manual and the *Declaration of Conformity* included in your kit for any additional regulatory compliance information.

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

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

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

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

B

Custom Cables

This appendix lists specifications for building custom cables for your 1409 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 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 68-pin VHDCI receptacle

C

Technical Support Resources

Web Support

National Instruments Web support is your first stop for help in solving installation, configuration, and application problems and questions. Online problem-solving and diagnostic resources include frequently asked questions, knowledge bases, product-specific troubleshooting wizards, manuals, drivers, software updates, and more. Web support is available through the Technical Support section of `ni.com`

NI Developer Zone

The NI Developer Zone at `ni.com/zone` is the essential resource for building measurement and automation systems. At the NI Developer Zone, you can easily access the latest example programs, system configurators, tutorials, technical news, as well as a community of developers ready to share their own techniques.

Customer Education

National Instruments provides a number of alternatives to satisfy your training needs, from self-paced tutorials, videos, and interactive CDs to instructor-led hands-on courses at locations around the world. Visit the Customer Education section of `ni.com` for online course schedules, syllabi, training centers, and class registration.

System Integration

If you have time constraints, limited in-house technical resources, or other dilemmas, you may prefer to employ consulting or system integration services. You can rely on the expertise available through our worldwide network of Alliance Program members. To find out more about our Alliance system integration solutions, visit the System Integration section of `ni.com`

Worldwide Support

National Instruments has offices located around the world to help address your support needs. You can access our branch office Web sites from the Worldwide Offices section of `ni.com`. Branch office Web sites provide up-to-date contact information, support phone numbers, e-mail addresses, and current events.

If you have searched the technical support resources on our Web site and still cannot find the answers you need, contact your local office or National Instruments corporate. Phone numbers for our worldwide offices are listed at the front of this manual.

Glossary

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

Numbers/Symbols

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

A

A	Amperes.
A/D	Analog-to-digital.
AC	Alternating current.
acquisition window	The image size specific to a video standard or camera resolution.

active line region	The region of lines actively being stored. Defined by a line start (relative to the vertical synchronization signal (VSYNC)) and a line count.
active pixel region	The region of pixels actively being stored. Defined by a pixel start [relative to the horizontal synchronization signal(HSYNC)] and a pixel count.
ADC	Analog-to-digital converter. An electronic device, often an integrated circuit, that converts an analog voltage to a digital value.
address	Value that identifies a specific location (or series of locations) in memory.
ANSI	American National Standards Institute.
antichrominance filter	Removes the color information from the video signal.
API	Application programming interface.
area	A rectangular portion of an acquisition window or frame that is controlled and defined by software.
array	Ordered, indexed set of data elements of the same type.
ASIC	Application-Specific Integrated Circuit. A proprietary semiconductor component designed and manufactured to perform a set of specific functions for specific customer needs.
aspect ratio	The ratio of a picture or image's width to its height.

B

b	Bit. One binary digit, either 0 or 1.
B	Byte. Eight related bits of data, an eight-bit binary number. Also denotes the amount of memory required to store one byte of data.
back porch	The area of the video signal between the rising edge of the horizontal synchronization signal (HSYNC) and the active video information.
black reference level	The level that represents the darkest an image can get. *See also white reference level*.

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

C

C	Celsius.
cache	High-speed processor memory that buffers commonly used instructions or data to increase processing throughput.
CCIR	Comite Consultatif International des Radiocommunications. A committee that developed standards for video signals. Also used to describe signals, boards, and cameras that adhere to the CCIR standards.
chroma	The color information in a video signal.
chrominance	*See* chroma.
CMOS	Complementary metal-oxide semiconductor.
CompactPCI	Refers to the core specification defined by the PCI Industrial Computer Manufacturer's Group (PICMG).
conversion device	Device that transforms a signal from one form to another. For example, analog-to-digital converters (ADCs) for analog input and digital-to-analog converters (DACs) for analog output.
CPU	Central processing unit.
CSYNC	Composite synchronization signal. Signals in a color video system that multiplex all picture information into a single signal, such as NTSC, PAL, or SECAM.

D

D/A	Digital-to-analog.
DAC	Digital-to-analog converter. An electronic device, often an integrated circuit, that converts a digital number into a corresponding analog voltage or current.

DAQ	Data acquisition. (1) Collecting and measuring electrical signals from sensors, transducers, and test probes or fixtures and inputting them to a computer for processing. (2) Collecting and measuring the same kinds of electrical signals with A/D or DIO boards plugged into a computer, and possibly generating control signals with D/A and/or DIO boards in the same computer.
dB	Decibel. The unit for expressing a logarithmic measure of the ratio of two signal levels: $dB = 20\log_{10} V1/V2$, for signals in volts.
DC	Direct current.
default setting	A default parameter value recorded in the driver. In many cases, the default input of a control is a certain value (often 0).
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.
DRAM	Dynamic RAM.
driver	Software that controls a specific hardware device, such as an IMAQ or DAQ device.
dynamic range	The ratio of the largest signal level a circuit can handle to the smallest signal level it can handle (usually taken to be the noise level), normally expressed in decibels.

E

EEPROM	Electrically erasable programmable read-only memory. ROM that can be erased with an electrical signal and reprogrammed.
external trigger	A voltage pulse from an external source that triggers an event such as A/D conversion.

F

field	For an interlaced video signal, a field is half the number of horizontal lines needed to represent a frame of video. The first field of a frame contains all the odd-numbered lines, the second field contains all of the even-numbered lines.
FIFO	First-in first-out memory buffer. The first data stored is the first data sent to the acceptor. FIFOs are used on IMAQ devices to temporarily store incoming data until that data can be retrieved.
flash ADC	An ADC whose output code is determined in a single step by a bank of comparators and encoding logic.
frame	A complete image. In interlaced formats, a frame is composed of two fields.
front porch	The area of a video signal between the start of the horizontal blank and the start of the horizontal synchronization signal (HSYNC).
ft	Feet.
function	A set of software instructions executed by a single line of code that may have input and/or output parameters and returns a value when executed.

G

gamma	The nonlinear change in the difference between the video signal's brightness level and the voltage level needed to produce that brightness.
genlock	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.
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, and cables.
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.
hue	Represents the dominant color of a pixel. The hue function is a continuous function that covers all the possible colors generated using the R, G, and B primaries. *See also RGB*.
Hz	Hertz. Frequency in units of 1/second.

I

I/O	Input/output. The transfer of data to/from a computer system involving communications channels, operator interface devices, and/or data acquisition and control interfaces.
IC	Integrated circuit.
IEEE	Institute of Electrical and Electronics Engineers.
in.	Inches.
INL	Integral nonlinearity. A measure of LSB of the worst-case deviation from the ideal A/D or D/A transfer characteristic of the analog I/O circuitry.
instrument driver	A set of high-level software functions, such as NI-IMAQ, that control specific plug-in computer boards. Instrument drivers are available in several forms, ranging from a function callable from a programming language to a virtual instrument (VI) in LabVIEW.
interlaced	A video frame composed of two interleaved fields. The number of lines in a field are half the number of lines in an interlaced frame.
interpreter	A software utility that executes source code from a high-level language such as Basic, C or Pascal, by reading one line at a time and executing the specified operation.

interrupt	A computer signal indicating that the CPU should suspend its current task to service a designated activity.
interrupt level	The relative priority at which a device can interrupt.
IRQ	Interrupt request. *See interrupt*.

K

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

L

line count	The total number of horizontal lines in the picture.
LSB	Least significant bit.
luma	The brightness information in the video picture. The luma signal amplitude varies in proportion to the brightness of the video signal and corresponds exactly to the monochrome picture.
luminance	*See luma*.
LUT	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

m	Meters.
M	(1) Mega, the standard metric prefix for 1 million or 10^6, when used with units of measure such as volts and hertz (2) Mega, the prefix for 1,048,576, or 2^{20}, when used with B to quantify data or computer memory.

MB	Megabyte of memory.
Mbytes/s	A unit for data transfer that means 1 million or 10^6 bytes/s.
memory buffer	*See buffer*.
memory window	Continuous blocks of memory that can be accessed quickly by changing addresses on the local processor.
MSB	Most significant bit.
MTBF	Mean time between failure.
mux	Multiplexer. A switching device with multiple inputs that selectively connects one of its inputs to its output.

N

NI-IMAQ	Driver software for National Instruments IMAQ hardware.
noninterlaced	A video frame where all the lines are scanned sequentially, instead of divided into two frames as in an interlaced video frame.
NTSC	National Television Standards Committee. The committee that developed the color video standard used primarily in North America, which uses 525 lines per frame. *See also PAL*.
number of planes (in an image)	The number of arrays of pixels that compose the image. A gray-level or pseudo-color image is composed of one plane, while an RGB image is composed of three planes (one for the red component, one for the blue, and one for the green).
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. 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.
picture aspect ratio	The ratio of the active pixel region to the active line region. For standard video signals like RS-170 or CCIR, the full-size picture aspect ratio normally is 4/3 (1.33).
pixel	Picture element. The smallest division that makes up the video scan line. For display on a computer monitor, a pixel's optimum dimension is square (aspect ratio of 1:1, or the width equal to the height).
pixel aspect ratio	The ratio between the physical horizontal size and the vertical size of the region covered by the pixel. An acquired pixel should optimally be square, thus the optimal value is 1.0, but typically it falls between 0.95 and 1.05, depending on camera quality.
pixel clock	Divides the incoming horizontal video line into pixels.
pixel count	The total number of pixels between two horizontal synchronization signals (HSYNCs). 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, such as an incoming horizontal synchronization signal (HSYNC).
protocol	The exact sequence of bits, characters, and control codes used to transfer data between computers and peripherals through a communications channel.
pts	Points.
PXI	PCI eXtensions for Instrumentation. An open specification that builds on the CompactPCI specification by adding instrumentation-specific features.

R

RAM	Random-access memory.
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	(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.
RGB	Color encoding scheme using red, green, and blue (RGB) color information where each pixel in the color image is encoded using 32 bits: 8 bits for red, 8 bits for green, 8 bits for blue, and 8 bits for the alpha value (unused).
ribbon cable	A flat cable in which the conductors are side by side.
ROI	Region of interest. (1) An area of the image that is graphically selected from a window displaying the image. This area can be used focus further processing. (2) A hardware-programmable rectangular portion of the acquisition window.
ROM	Read-only memory.
RS-170	The U.S. standard used for black-and-white television.
RSE	Referenced single-ended. All measurements are made with respect to a common reference measurement system or a ground. Also called a grounded measurement system.
RTSI bus	Real-Time System Integration Bus. The National Instruments timing bus that connects IMAQ and DAQ boards directly by means of connectors on top of the boards for precise synchronization of functions.

S

s	Seconds.
saturation	The amount of white added to a pure color. Saturation relates to the richness of a color. A saturation of zero corresponds to a pure color with no white added. Pink is a red with low saturation.
scaling down circuitry	Circuitry that scales down the resolution of a video signal.
scatter-gather DMA	A type of DMA that allows the DMA controller to reconfigure on-the-fly.
SRAM	Static RAM.
StillColor	A post-processing algorithm that allows the acquisition of high-quality color images generated either by an RGB or composite (NTSC or PAL) camera using a monochrome video acquisition board.
sync	Tells the display where to put a video picture. The horizontal sync indicates the picture's left-to-right placement and the vertical sync indicates top-to-bottom placement.
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.
trigger	Any event that causes or starts some form of data capture.
trigger control and mapping circuitry	Circuitry that routes, monitors, and drives external and RTSI bus trigger lines. You can configure each of these lines to start or stop acquisition on a rising or falling edge.
TTL	Transistor-transistor logic.

U

UV plane	*See YUV.*

V

V	Volts.
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.
VCO	Voltage-controlled oscillator. An oscillator that changes frequency depending on a control signal. Use VCO in a phase-locked loop 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 horizontal synchronization signal, back porch, active pixel region, and a front porch.
VSYNC	Vertical synchronization signal. The synchronization pulse generated at the beginning of each video field that tells the video monitor when to start a new field.

W

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

Y

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

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