

NI Vision

NI 17xx Smart Camera User Manual

Worldwide Technical Support and Product Information

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Depending on where it is operated, this Class A 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.

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

Consult the FCC Web site at 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 marking 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 NI 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 is required to correct the interference at their own expense.

Canadian Department of Communications

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

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

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

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About This Manual

This manual describes the electrical and mechanical aspects of the National Instruments 17xx smart camera.

Conventions



The following conventions appear in this manual:

This icon denotes a tip, which alerts you to advisory information.



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



This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash. When this symbol is marked on a product, refer to *Getting Started with the NI 17xx Smart Camera* for information about precautions to take.



When symbol is marked on a product, it denotes a warning advising you to take precautions to avoid electrical shock.

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.

Related Documentation

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

Hardware Documents

- *Getting Started with the NI 17xx Smart Camera*—Contains important safety information, specifications, and information about installing and configuring the NI 17xx smart camera.
- NI Developer Zone—Contains example programs, tutorials, technical presentations, the Instrument Driver Network, a measurement glossary, an online magazine, a product advisor, and a community area where you can share ideas, questions, and source code with developers around the world. The NI Developer Zone is located on the National Instruments Web site at ni.com/zone.

NI Vision Builder for Automated Inspection Documents

- *NI Vision Builder for Automated Inspection: Tutorial*—Describes Vision Builder for Automated Inspection and provides step-by-step instructions for solving common visual inspection tasks, such as inspection, gauging, part presence, guidance, and counting.
- *NI Vision Builder for Automated Inspection: Configuration Help*—Contains information about using the Vision Builder for Automated Inspection Configuration Interface to create a machine vision application.
- *NI Vision Builder for Automated Inspection: Inspection Help*—Contains information about running applications created with Vision Builder for Automated Inspection (Vision Builder AI) in the Vision Builder AI Interface.

LabVIEW and NI Vision Development Module Documents

- *LabVIEW Help*—Includes information about LabVIEW programming concepts, step-by-step instructions for using LabVIEW, and reference information about LabVIEW VIs, functions, palettes, menus, and tools.
- *Getting Started with LabVIEW*—Use this manual as a tutorial to familiarize yourself with the LabVIEW graphical programming environment and the basic LabVIEW features you use to build data acquisition and instrument control applications.

- *Getting Started with the LabVIEW Real-Time Module*—Use this manual as a tutorial to familiarize yourself with the LabVIEW Real-Time Module and the basic Real-Time Module features you use to build real-time applications.
- *NI Vision Concepts Manual*—Describes the basic concepts of image analysis, image processing, and machine vision. This document also contains in-depth discussions about imaging functions for advanced users.
- *NI Vision for LabVIEW Help*—Describes how to create machine vision and image processing applications in LabVIEW using the Vision Development Module. The help file guides you through tasks beginning with setting up your imaging system to taking measurements. It also describes how to create a real-time vision application using NI Vision with the LabVIEW Real-Time Module and contains reference information about NI Vision for LabVIEW palettes and VIs.

NI Vision Acquisition Software Documents

- *NI-IMAQ VI Reference Help*—Contains reference information about the LabVIEW VIs and properties for NI-IMAQ driver software.
- *Measurement & Automation Explorer Help for NI-IMAQ*—Describes how to configure NI-IMAQ driver software, NI frame grabbers, and NI smart cameras using Measurement & Automation Explorer.

NI 17xx Smart Camera Overview

This chapter provides an overview of the features and components of the National Instruments 17xx smart camera.

Hardware Overview

The NI 17xx smart camera incorporates an image sensor, a processor, and digital I/O in a compact, rugged housing.

The NI 17xx smart camera is available in multiple models. The smart camera will be referred to as the NI 17xx throughout this manual. When a feature pertains only to a specific model, it will be indicated.

Table 1-1 shows the supported features for each smart camera model.

Table 1-1. NI 17xx Smart Camera Models

Smart Camera Model	Processor	Sensor	Direct Drive Lighting Controller	Quadrature Encoder Interface
NI 1722	400 MHz	1/3 inch CCD Monochrome 640 × 480 pixels (VGA)	No	No
NI 1742	533 MHz	1/3 inch CCD Monochrome 640 × 480 pixels (VGA)	Yes	Yes

For more information about the NI 17xx sensor, refer to Chapter 3, [NI 17xx Image Sensor](#). For the complete specifications of the NI 17xx, refer to the *Specifications* section of *Getting Started with the NI 17xx Smart Camera*.

All NI 17xx smart cameras have an RS-232 serial port, two Gigabit Ethernet ports, and use a standard C-mount lens. The NI 1742 smart camera also includes support for the Direct Drive lighting controller and quadrature encoders. The Direct Drive lighting controller is an integrated controller that directly powers a variety of third-party current-controlled lights. Refer

to Chapter 4, *Lighting*, for more information about the Direct Drive lighting controller.

The NI 17xx also includes five LEDs for communicating system status, four DIP switches that specify startup options, two isolated inputs, and two isolated outputs for connecting to external devices. The NI 17xx also has one 5 V TTL strobe output and one 24 V strobe output for lighting control. Refer to Chapter 6, *LEDs and DIP Switches*, for more information about the LEDs and DIP switches. Refer to Chapter 2, *Power and I/O*, for more information about the digital I/O capabilities of the NI 17xx.

Figure 1-1 shows the NI 17xx smart camera.

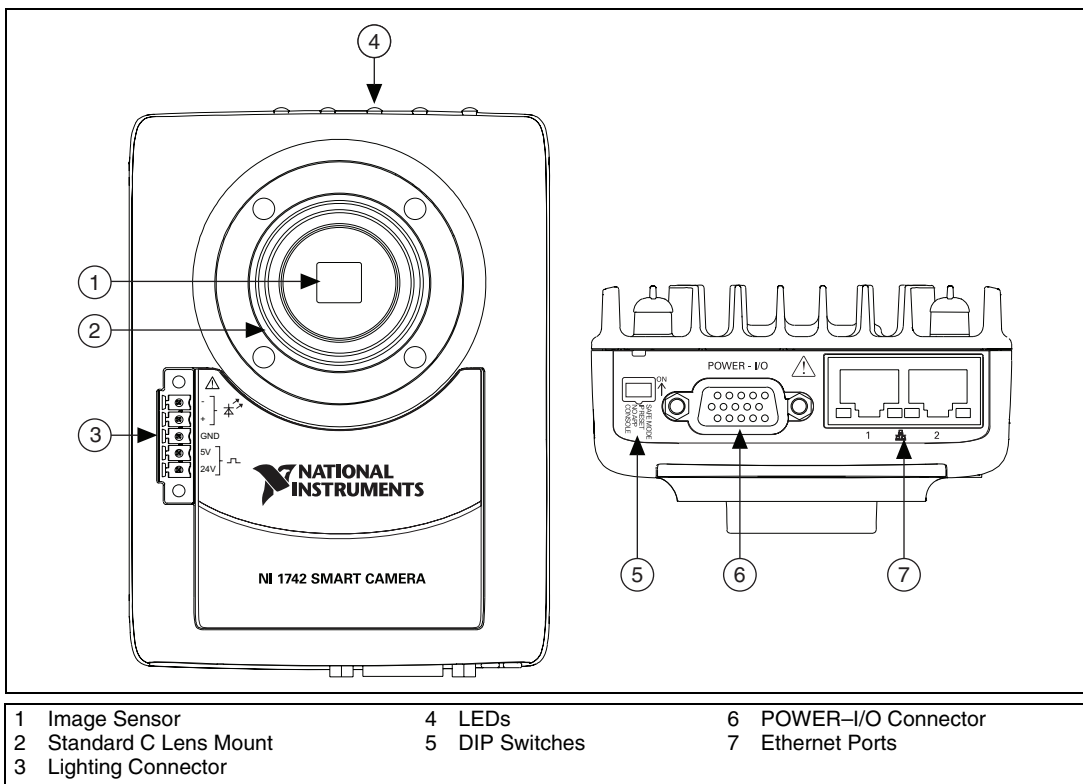
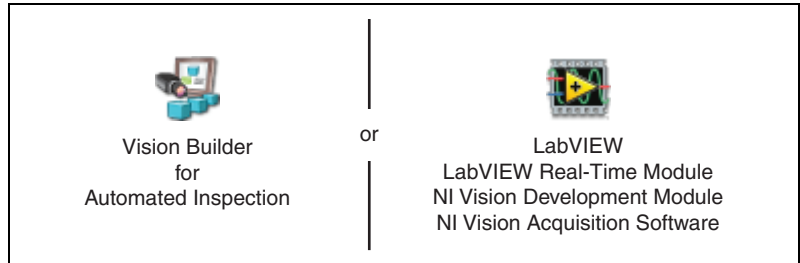


Figure 1-1. NI 17xx Smart Camera

Software Overview

Developing applications with the NI 17xx requires one of the following software options:



The installation and configuration process for each development environment is different. Refer to *Getting Started with the NI 17xx Smart Camera* for installation and configuration instructions.

The following sections describe the software options. For detailed information about individual software packages, refer to the documentation specific to the package.



Note Vision Builder for Automated Inspection and NI Vision Acquisition Software are included with the NI 17xx. LabVIEW, the LabVIEW Real-Time Module, and the NI Vision Development Module are sold separately.

NI Vision Builder for Automated Inspection

Vision Builder for Automated Inspection (Vision Builder AI) is configurable machine vision software you can use to configure the NI 17xx and prototype, benchmark, and deploy machine vision applications.

Creating applications in Vision Builder AI does not require programming. 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 can also migrate your configured inspection to LabVIEW, extending the capabilities of your applications if necessary.

LabVIEW

LabVIEW is a graphical programming environment for developing flexible and scalable applications. To develop machine vision applications with the NI 17xx and LabVIEW, you must have the following add-on modules: LabVIEW Real-Time Module, Vision Development Module, and Vision Acquisition Software.

LabVIEW Real-Time Module

The LabVIEW Real-Time Module combines LabVIEW graphical programming with the power of Real-Time (RT) hardware, enabling you to build deterministic, real-time systems. You develop VIs in LabVIEW and embed the VIs on RT targets, such as the NI 17xx smart camera. The RT target runs VIs without a user interface and offers a stable platform for real-time VIs. For more information about the LabVIEW Real-Time Module, refer to the *LabVIEW Help*.

NI Vision Development Module

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

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

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

For information about how to use the NI Vision Development Module with the LabVIEW Real-Time Module, refer to the *NI Vision for LabVIEW Help*.

NI Vision Acquisition Software

The NI Vision Acquisition Software CD contains Measurement & Automation Explorer (MAX) configuration software and NI-IMAQ driver software.

Use MAX to configure the NI 17xx. You can set the IP address, update software on the smart camera, configure triggering, and setup the lighting features. For more information about MAX, refer to the *Measurement & Automation Explorer Help for NI-IMAQ*.

NI-IMAQ is the interface path between the application software and the NI 17xx. NI-IMAQ controls the I/O and image acquisition on the NI 17xx smart camera.

NI-IMAQ includes an extensive library of VIs you can call from LabVIEW. These VIs include routines for video configuration, continuous and single-shot image acquisition, and trigger control.

The NI-IMAQ driver software performs all functions necessary for acquiring and saving images but does not perform image analysis. NI-IMAQ features both high-level and low-level functions. A function that acquires images in single-shot or continuous mode is an example of a high-level function. A function that requires advanced understanding of the NI 17xx device and image acquisition, such as configuring an image sequence, is an example of a low-level function.

For information about how to use NI-IMAQ, refer to the *NI-IMAQ VI Reference Help*.

Power and I/O

This chapter provides information about the NI 17xx POWER-I/O connector, connecting isolated inputs and isolated outputs, connecting to serial devices, and connecting to quadrature encoders.

POWER-I/O Connector

The POWER-I/O connector provides signal connections for power and I/O, including isolated inputs and outputs, quadrature encoders (NI 1742 only), and serial devices. The POWER-I/O connector is a standard female high-density 15-pin D-SUB connector. Figure 2-1 shows the POWER-I/O connector. The two pins used to connect to a power supply, pin 15 and pin 5, are also shown in Figure 2-1. Refer to *Getting Started with the NI 17xx Smart Camera* for information about connecting a power supply to the NI 17xx.

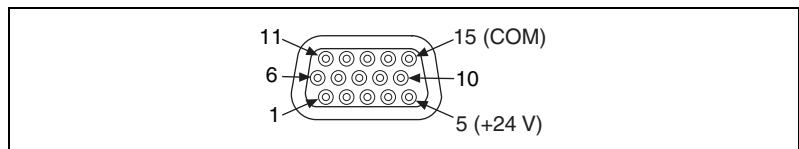


Figure 2-1. POWER-I/O Connector

Table 2-1 lists the signal names and pin numbers for the 15-pin POWER-I/O connector. The table also lists the wire colors for the 15-pin pigtail cable (part number 197818-05) is sold separately by National Instruments. Cables sold by other manufacturers could have different wire colors.

Table 2-1. POWER-I/O Signal Descriptions

Signal Name	Pin Number	Wire Color
+24 V	5	Red
COM	15	Black
RS232_TXD	10	Pink

Table 2-1. POWER-I/O Signal Descriptions (Continued)

Signal Name	Pin Number	Wire Color
RS232_RXD	14	Black/White
TrigIn+ IsoIn(0)+	2	Brown
IsoIn(1)+	8	Orange
TrigIn– IsoIn(0)– IsoIn(1)–	12	Light Green
IsoOut(0)+	6	Yellow
IsoOut(0)–	1	Green
IsoOut(1)+	11	Light Blue
IsoOut(1)–	7	Gray
PhaseA+	3	Blue
PhaseA–	13	Brown/White
PhaseB+	9	Purple
PhaseB–	4	White

NI 17xx Power Requirements



Caution Use the NI 17xx smart camera only with a 24 VDC, UL listed, limited power source (LPS) supply. The power supply should bear the UL listed mark, LPS. The power supply must meet any safety and compliance requirements for the country of use.

The NI 17xx uses a nominal 24 VDC power source. The NI 17xx accepts power within the range of the industry standard IEC 1311 input power specification (24 V +20%, –15% with an additional allowance for an AC peak of +5%).



Caution The 24 V external lighting strobe is an unregulated output dependent on the range of the power supply provided to the smart camera. If the power provided to the smart camera is +20%, –15% with +5% AC ripple, the output could be as high as 30 V. If the provided power exceeds the input voltage specifications of the third-party lighting controller, do *not* connect the 24 V lighting strobe output to the controller to prevent damage

to the controller. Use a power supply with tolerances that meet the requirements of the controller, or use the 5 V external lighting strobe.

If you are using the Direct Drive lighting controller, the power supply wattage must be sufficient to power both the camera and the light. The power required by the light can be significantly more than the power required by the smart camera.

Isolated Inputs



Caution Do not apply a voltage greater than 30 VDC to the isolated inputs. Voltages greater than 30 VDC may damage the NI 17xx.



Caution The isolated inputs and outputs on the NI 17xx provide an easy means for preventing ground loops that could degrade signal integrity. The isolation on the NI 17xx is *not* safety isolation.

You can wire an isolated input to both sourcing and sinking output devices. Refer to Figures 2-2 and 2-3 for wiring examples by output type. Refer the *Specifications* section in *Getting Started with the NI 17xx Smart Camera* for current requirements.

Isolated inputs are not compatible with 5 V logic.

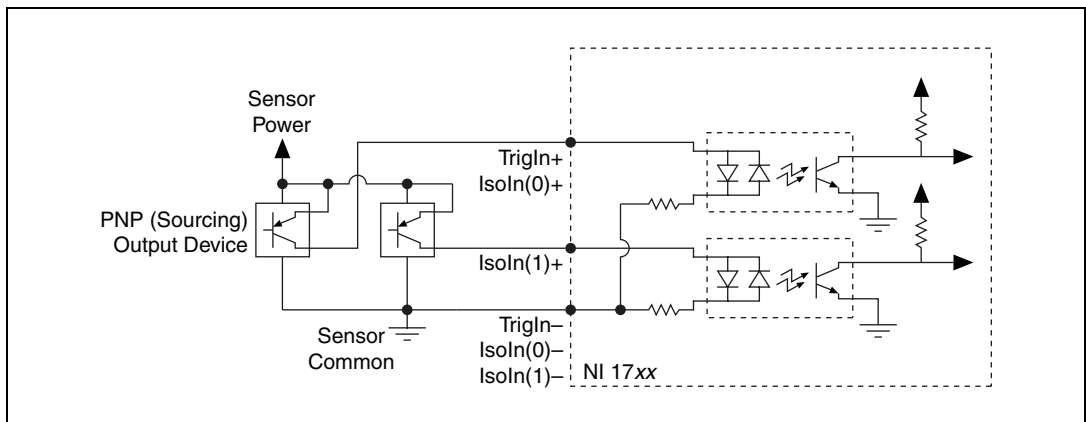


Figure 2-2. Connecting Sourcing Output Sensors to Isolated Inputs

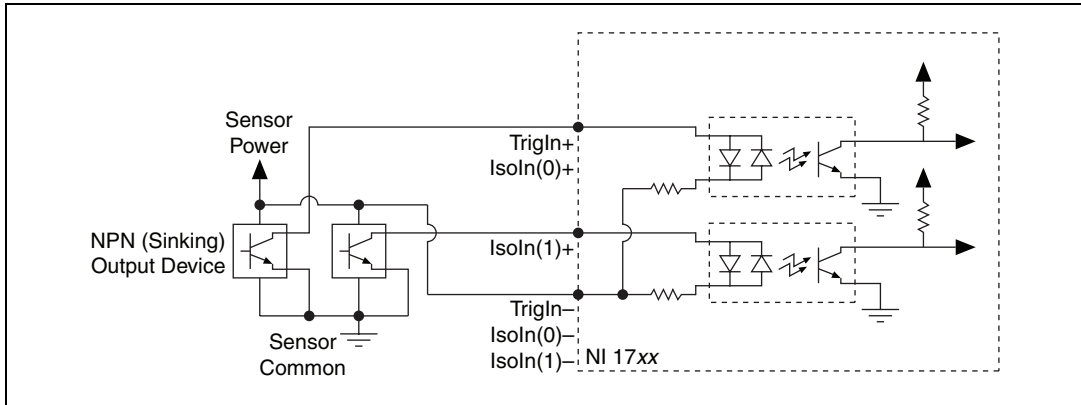


Figure 2-3. Connecting Sinking Output Sensors to Isolated Inputs

Isolated Outputs



Caution Do not power the load connected to the isolated outputs with any external power supply greater than 30 VDC. Voltages greater than 30 VDC may damage the NI 17xx.



Caution The isolated inputs and outputs on the NI 17xx provide an easy means for preventing ground loops that could degrade signal integrity. The isolation on the NI 17xx is *not* safety isolation.

The isolated outputs can be used to drive external loads, as shown in Figures 2-4 and 2-5.

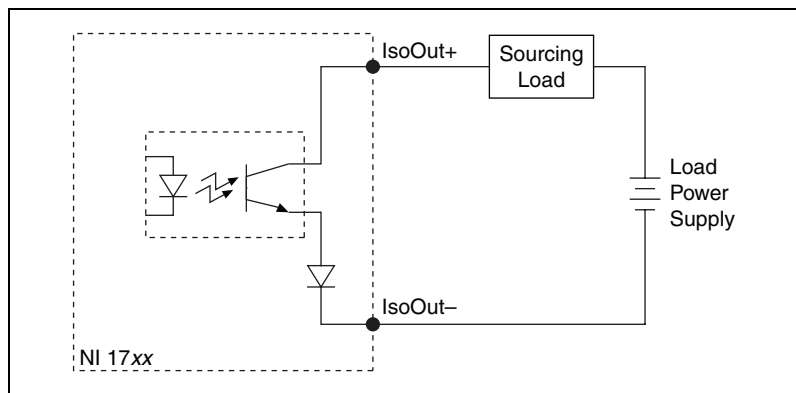


Figure 2-4. Connecting an Isolated Output to a Sourcing External Load

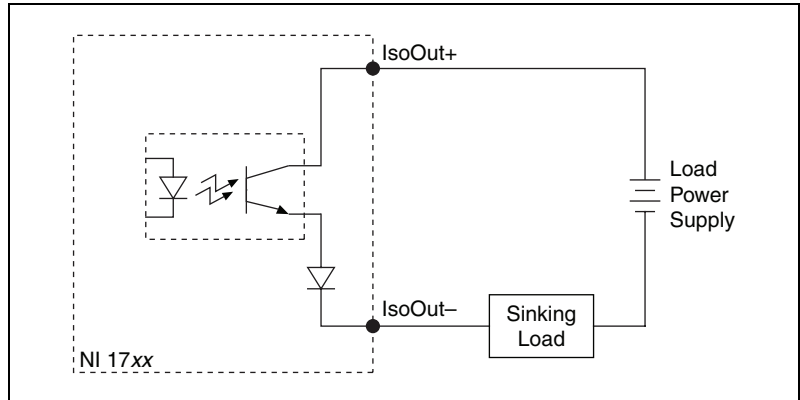


Figure 2-5. Connecting an Isolated Output to a Sinking External Load

Protecting Against Inductive Loads

When an inductive load, such as a relay or solenoid, is connected to an output, a large counter-electromotive force may occur at switching time due to energy stored in the inductive load. This flyback voltage can damage the outputs and the power supply.

To limit flyback voltages at the inductive load, install a flyback diode across the load. Mount the flyback diode as close to the load as possible. Use this protection method if you connect any of the isolated outputs to an inductive load.

Connecting to Serial Devices

Use the RS232_RXD and RS232_TXD signals on the POWER-I/O connector for serial communication. Connect the RS232_RXD signal on the NI 17xx to the Tx signal on your serial device. Connect the RS232_TXD signal on the NI 17xx to the Rx signal on your serial device.

When the CONSOLE DIP switch is in the OFF position, you can use the NI-Serial driver for serial communication. You must install the NI-Serial software on the NI 17xx. Refer to the *NI Serial Hardware and Software Help* for information about installing the NI-Serial software on LabVIEW Real-Time targets, such as the NI 17xx. To open this document, navigate to **Start»All Programs»National Instruments»NI-Serial»NI-Serial Help**.

Communicating with the Console

When the CONSOLE DIP switch is in the ON position, you can read device information from the NI 17xx during boot up, such as the IP address and firmware version, through a serial port terminal program. Ensure that the serial port terminal program is configured to the following settings:

- 9,600 bits per second
- Eight data bits
- No parity
- One stop bit
- No flow control

Connecting to a Quadrature Encoder

The NI 1742 supports RS-422 compatible differential quadrature encoders to provide positional information to the smart camera. A quadrature encoder uses two output channels, Phase A and Phase B, to track the position of a rotary shaft. Generally, the shaft is coupled to a motor drive that controls the movement of an object. By providing Phase A and Phase B signals to the NI 1742, you can obtain a precise measurement of the object position. Using a quadrature encoder gives you the ability to specify your trigger delay in terms of positional units—such as inches or centimeters, after applying the resolution information of your encoder—rather than time.

National Instruments does not recommend the use of single-ended encoders with the NI 1742. The ground for a single-ended encoder would need to be connected to the COM pin of the NI 1742, and the PhaseA– and PhaseB– signals would be left unconnected. In this configuration, the system is susceptible to significant noise that can be eliminated by using a differential encoder.

Shielded encoder cables are recommended for all applications. Unshielded cables are more susceptible to noise and can corrupt the encoder signals.

For information about using a quadrature encoder to delay a trigger, refer to the [External Trigger](#) section of Chapter 5, *Image Acquisition*.

Figure 2-6 shows an example of connecting differential line drivers.

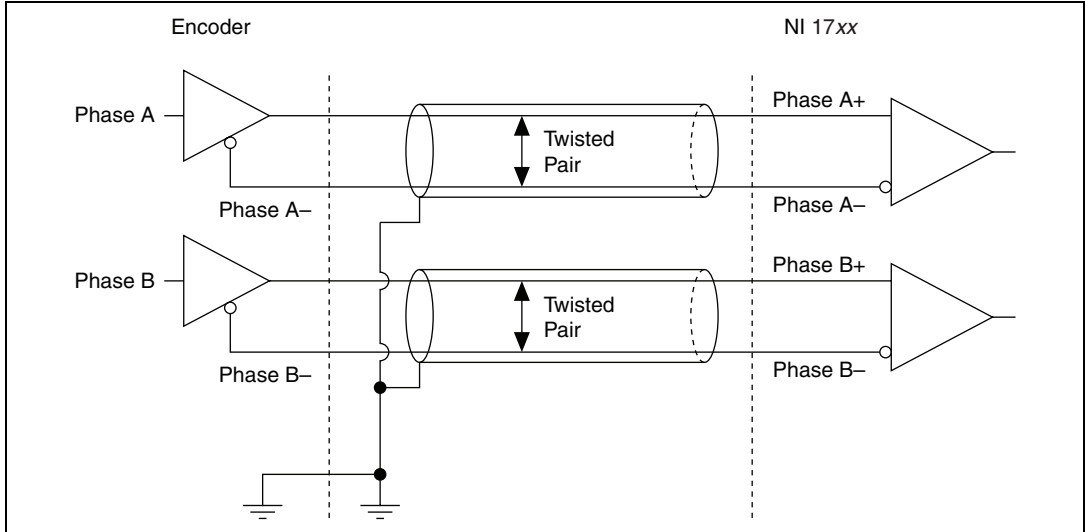


Figure 2-6. Connecting Differential Line Drivers

Figure 2-7 shows the internal quadrature encoder/RS-422 inputs circuit.

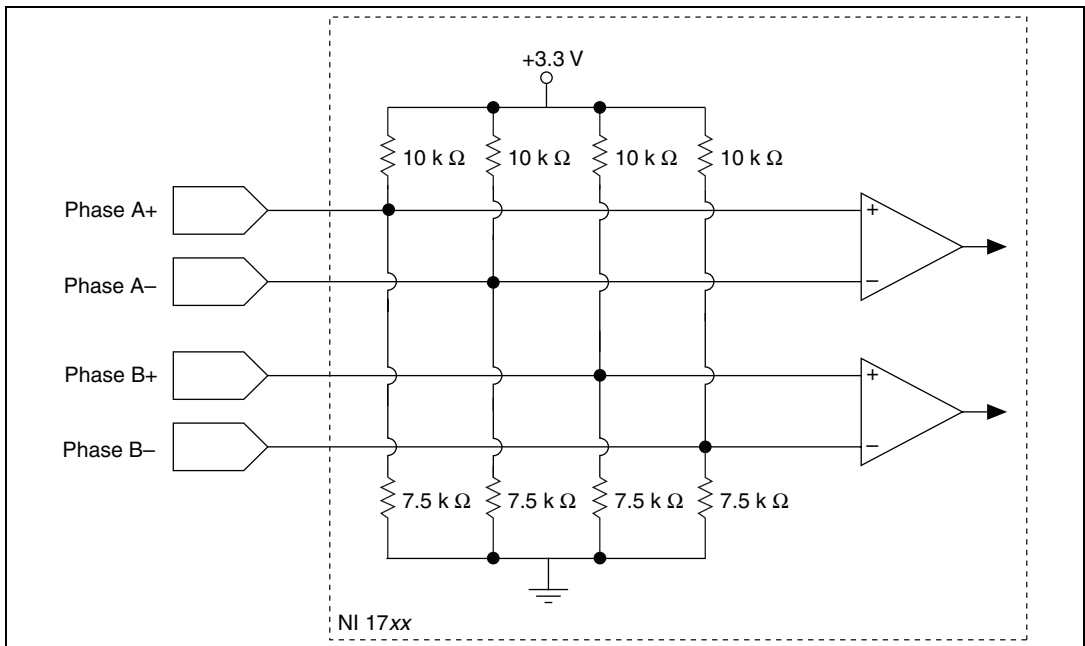


Figure 2-7. NI 1742 Quadrature Encoder/RS-422 Inputs Circuit

NI 17xx Image Sensor

This chapter provides an overview of the NI 17xx smart camera image sensor.

VGA Sensor

The NI 1722 and NI 1742 use a Sony ICX424AL 1/3 inch optical format, 640 × 480 pixel, monochrome CCD sensor. Each pixel is 7.4 μm × 7.4 μm. The dimensions of the light-sensitive portion of the sensor are 4.736 mm in the horizontal direction × 3.552 mm in the vertical direction.



Note The optical format, sometimes called sensor size, does not reflect the actual sensor dimensions, but is a historical naming convention.

Field of View

To calculate the horizontal and vertical field of view (FOV) necessary for your imaging system, use the Equation 3-1.

$$FOV = \frac{SD \times WD}{FL} \quad (3-1)$$

where FOV is the field of view,
 SD is the sensor dimension,
 WD is the working distance, and
 FL is the focal length of the lens

Figure 3-1 illustrates horizontal field of view and working distance.

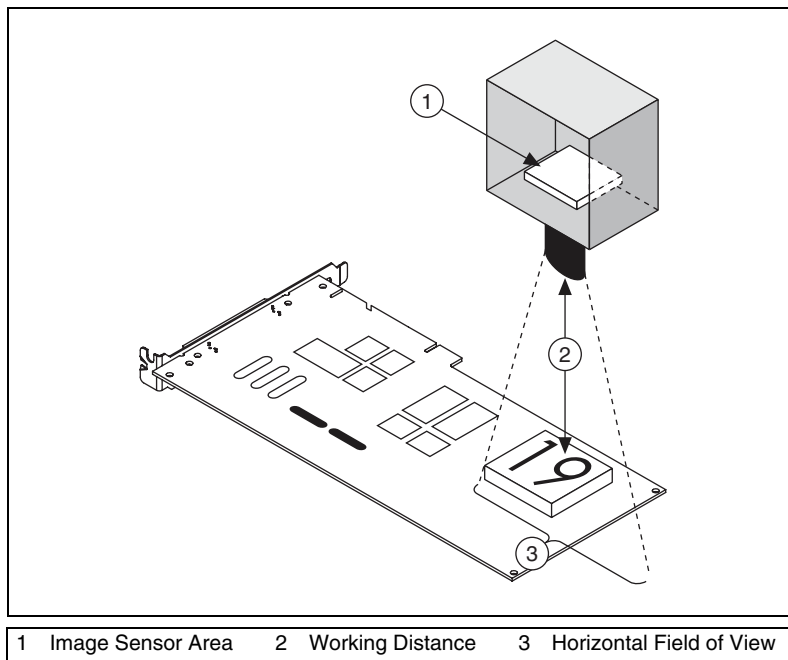


Figure 3-1. Parameters of an Imaging System

The field of view is the area under inspection that the smart camera can acquire. The horizontal and vertical dimensions of the inspection area determine the field of view. Make sure the field of view encloses the object you want to inspect. For example, if the working distance of your imaging setup is 100 mm, and the focal length of the lens is 8 mm, then the field of view in the horizontal direction is

$$FOV_{horizontal} = \frac{4.736 \text{ mm} \times 100 \text{ mm}}{8 \text{ mm}} = 59.2 \text{ mm}$$

Similarly, the field of view in the vertical direction is

$$FOV_{vertical} = \frac{3.552 \text{ mm} \times 100 \text{ mm}}{8 \text{ mm}} = 44.4 \text{ mm}$$

As you set up your system, you need to adjust the various parameters in the FOV equation until you achieve the right combination of components that match your inspection needs.

Spectral Response

The normalized spectral response for the sensor is shown in Figure 3-2. The spectral response curve describes the relative sensitivity of the sensor to different wavelengths of light. The peak responsivity of the sensor is to light with a wavelength of approximately 500 nm. This information is useful when selecting a light source to use in your application. It also helps determine what, if any, filters your application might require.

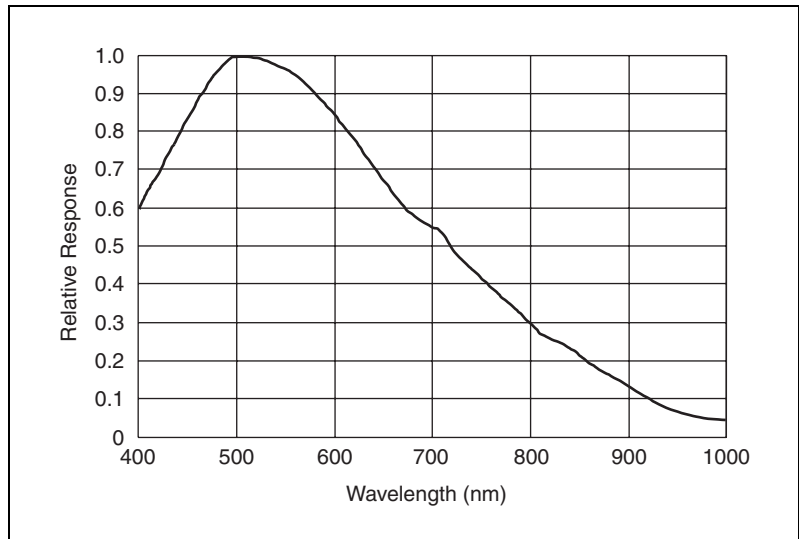


Figure 3-2. NI 1722 and NI 1742 Spectral Response Curve

Partial Scan Mode

Partial scan mode is a method of obtaining higher frame rates by reading out only a portion of the image from the sensor. Partial scan is frequently used when an application requires higher speed but less resolution than the sensor offers in full scan mode. The NI 17xx supports 1/2 scan and 1/4 scan. In 1/2 scan, one half of the image is read out from the center of the sensor and the rest of the image is discarded to enable a faster start of the next frame. In 1/4 scan, only one quarter of the image is read out. Figure 3-3 illustrates the portion of the sensor exposed during partial scanning.

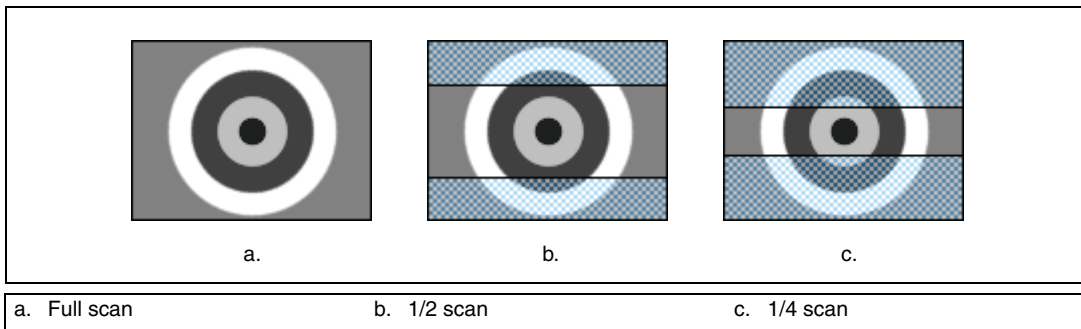


Figure 3-3. NI 17xx Partial Scan Modes

Binning

Binning can improve the light sensitivity of the sensor by treating adjacent pixels as a single pixel. Binning allows the image sensor to collect more electrons per pixel, which reduces the amount of required light and exposure time. Binning results in higher frame rates and lower resolution. The NI 17xx supports 1×2 binning. Figure 3-4 illustrates what happens to the sensor during binning.

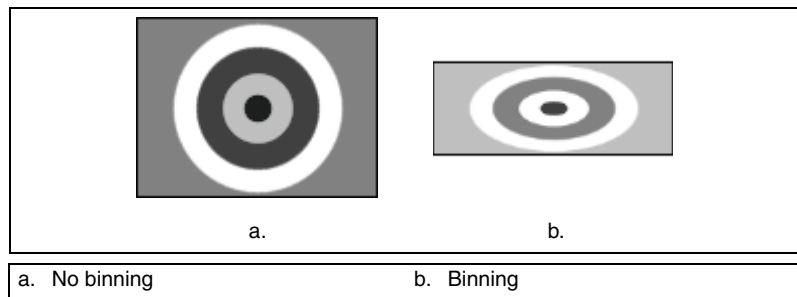


Figure 3-4. NI 17xx Binning

Gain

Gain is a multiplier applied to the analog signal prior to digitization. Increasing the gain increases the amplitude of the signal. Gain allows you to trade off between making smaller signals more visible at the cost of increased noise and no longer being able to differentiate between larger signals. The NI 17xx default gain setting optimizes the balance between small signals and large signals for most applications.

Figure 3-5 shows what happens when gain is applied to a signal.

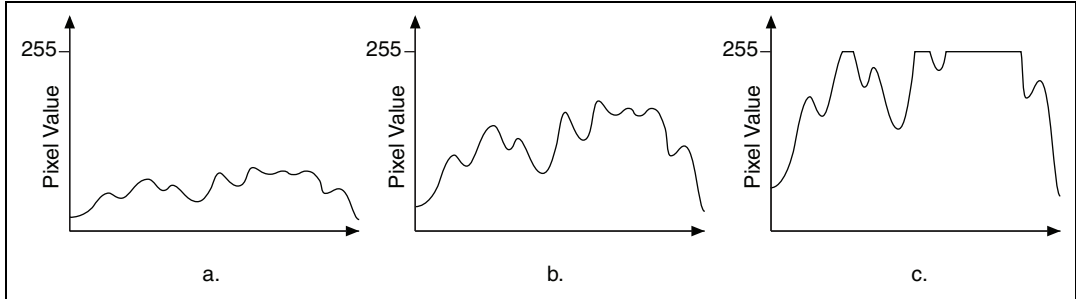


Figure 3-5. Affect of Gain on the Video Signal

In Figure 3-5a, no gain has been applied to the signal. The pixel values in the image are close. In Figure 3-5b, some gain has been applied to the signal. In Figure 3-5c, a high gain has been applied to the signal. At higher gain, mid-range and bright portions of the image might both be represented as white, pixel value 255. In Figure 3-5c, several bright areas of the image have been clipped to the maximum pixel value, 255, and you can no longer distinguish subtle shading in the brightest areas of the image.

Gain can be useful when there is not enough available light and you need to increase the brightness of your images. However, increasing gain multiplies both the signal and noise. When possible, it is preferable to add additional lighting.

Hardware Binarization

The NI 17xx supports binarization and inverse binarization. Binarization and inverse binarization segment an image into two regions: a particle region and a background region. Use binarization and inverse binarization to isolate objects of interest in an image.

To separate objects under consideration from the background, select a pixel value range. This pixel value range is known as the gray-level interval, or the threshold interval. Binarization works by setting all image pixels that fall within the threshold interval to the image white value and setting all other image pixels to 0. Pixels inside the threshold interval are considered part of the particle region. Pixels outside the threshold interval are considered part of the background region.

Inverse binarization reverses the assigned bit numbers of the particle region and the background region. All pixels that belong in the threshold interval, or the particle region, are set to 0, and all pixels outside the threshold interval, or the background region, are set to the image white value.

Figure 3-6 illustrates binarization and inverse binarization.

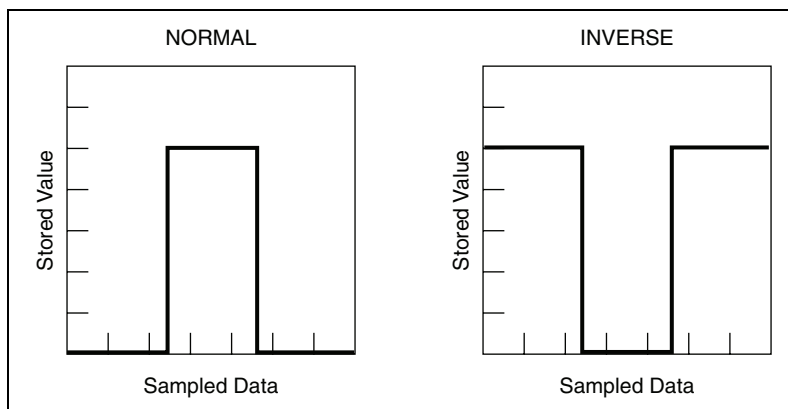


Figure 3-6. Binarization and Inverse Binarization

Enable hardware binarization as follows:

- In Vision Builder AI, configure the **Lookup Table** attribute on the **Advanced** tab of the **Acquire Image (Smart Camera)** step. Refer to the *Vision Builder for Automated Inspection: Configuration Help* for more information.
- In MAX, use the **Lookup Table** drop-down box on the **LUT** tab of the NI 17xx configuration page to enable hardware binarization. Refer to the *Measurement & Automation Explorer Help for NI-IMAQ* for more information.

Lighting

One of the most important aspects of setting up your imaging environment is proper illumination. Images acquired under proper lighting conditions make your image processing software development easier and overall processing time faster. The following sections describe how to use the Direct Drive lighting controller and the strobe outputs of the NI 17xx to control a light.

Lighting Connector

Figure 4-1 shows the lighting connector on the NI 1742. The NI 1722 does not have LED+ and LED– connections because it does not feature the Direct Drive lighting controller.



Caution All signals on the lighting connector are outputs from the smart camera. Do *not* connect any external voltage or current source to any pin on the lighting connector.

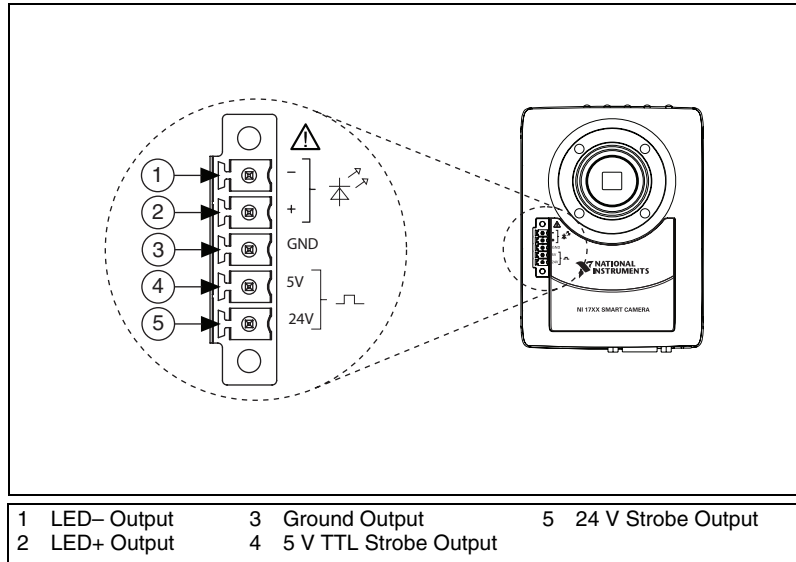


Figure 4-1. NI 1742 Lighting Connector

Direct Drive Lighting Controller (NI 1742 only)

The NI 1742 offers an innovative lighting controller that directly powers third-party current controlled lights. With other smart cameras, a lighting controller that drives a light must be purchased separately. The NI 1742 Direct Drive is capable of powering a variety of third-party lights.

For a current controlled light, higher current produces more light, up to the maximum current rating of the light. The maximum current rating of the light is specified by the manufacturer and based on the average amount of power that can be safely dissipated by the light.

The Direct Drive controller can operate in continuous or strobed mode. When operating in strobed mode, the controller can provide more current to the light than in continuous mode. The average power dissipated while strobing the light for a short period of time at a higher current is similar to the average power dissipated while running the light continuously at a lower current. Table 4-1 shows the maximum allowed current for continuous mode and strobed mode.

Table 4-1. Maximum Allowed Current for Direct Drive Lighting Controller

Maximum Strobed Current	Maximum Continuous Current
1 A	500 mA

For applications with a pause between exposures while new parts move into position, strobing the light allows the use of higher current and produces more light. With more light, you can reduce the exposure time. A shorter exposure time decreases the time it takes to acquire an image and potentially increases the total throughput of the system. Refer to the [Exposure](#) section of Chapter 5, [Image Acquisition](#), for more information about exposure control.

The NI 1742 automatically synchronizes the lighting strobe with the image sensor exposure. The NI 1742 always turns on the light before an exposure starts and turns the light off once the exposure completes. The duration of the light strobe is dictated by the exposure time. Refer to Chapter 5, [Image Acquisition](#), for more information.

When operating in strobed mode, it is important that the strobe duty cycle and strobe duration are within the specified limits of the light and the lighting controller. The strobe duration is the amount of time that the light remains on. Duration does not change based on current. The maximum strobe duration is the maximum amount of time that the light can remain on when being driven at the maximum current. The duty cycle is the ratio of the strobe duration to the frame period, expressed as a percentage. Refer to the [Maximum Frame Rate](#) section of Chapter 5, [Image Acquisition](#), for more information about the frame period.

Software allows you to set the exposure time to any setting within the hardware-supported range. However, if the NI 1742 is using the Direct Drive lighting controller in strobed mode, it verifies that the requested strobe duty cycle and strobe duration do not violate the limits of the Direct Drive lighting controller or the limits specified in the associated lighting file. Refer to the [Lighting Files](#) section for more information.

If the requested exposure time violates the limits of the Direct Drive lighting controller or the limits specified in the associated lighting file, the NI 1742 uses the requested exposure time, but requires the configured current to be less than or equal to the maximum continuous current.

Lighting Files

A lighting file is a text file that contains information about a light, such as the type and color of the light, maximum current limit, and maximum strobe duty cycle. Lighting files have the extension `.ild`. MAX and Vision Builder AI use lighting files to ensure that the current limits and duty cycle of your light are not exceeded when the light is used with the Direct Drive lighting controller. Lighting files exist in four levels of certification:

- **Digitally Signed by National Instruments**—The information contained within the lighting file has been verified as correct and safe by National Instruments. Contact National Instruments for support regarding this lighting data file or the light to which it refers.
- **Digitally Signed by a Third-Party Company**—The information contained within the lighting file has been verified as correct and safe by the specified third-party company. Contact the third-party company for support regarding this lighting data file or the light to which it refers.
- **Not Digitally Signed**—The information contained within the lighting file meets the requirements of Direct Drive lighting; however, it has not been verified that the information is safe to use with the specified light. Use this file at your own risk.
- **Invalid**—The information contained within the lighting file is unusable because the data does not meet the requirements of Direct Drive lighting, the data describing the light is not in the proper syntax, or the digital signature has been altered.

In digitally signed lighting files, the current limit and duty cycle limit are encoded as part of the signing process. The limits in signed lighting files are not human-readable. Modifying a signed lighting file will invalidate the signature and render the file unusable.

To use a light that does not have a lighting file, you can enter the lighting data manually in MAX or Vision Builder AI. In MAX, click on the **Lighting** tab of the NI 17xx configuration page. Click the **Configure Light** button and select **Enter Lighting Data Manually**. In Vision Builder AI, select the **Lighting** tab of the **Acquire Image (Smart Camera)** step. Click the **Configure Light Source** button and select **Enter Lighting Data Manually**.

Lighting files are installed to the following locations when you install NI-IMAQ:

- **Windows 2000/XP**—C:\Documents and Settings\All Users\Documents\National Instruments\NI-IMAQ\Data
- **Windows Vista**—C:\Users\Public\Documents\National Instruments\NI-IMAQ\Data

Selecting a Light

The NI 1742 software provides support for a variety of lights from major machine vision lighting companies. However, if your light is not in the list of supported lights, you may still be able to use your light with the Direct Drive lighting controller.

To determine if your light is compatible with the NI 1742, verify the following:

- The light is current controlled and not voltage controlled.
- The NI 1742 can provide enough current to obtain the desired illumination from the light.
- The maximum voltage drop specified for the light does not exceed the specified range of the NI 1742. Under some circumstances, some LEDs, particularly white and blue LEDs, require a higher voltage drop than usual to turn on or reach full brightness. Such lights may be incompatible with the NI 1742. The lights may need to be reconfigured by the manufacturer to bring the voltage drop within the specified range of the NI 1742.
- The minimum voltage drop specified for the light does not fall below the specified range of the NI 1742. Under some circumstances some LEDs, particularly infrared LEDs and lights with one LED per string, present a lower voltage drop than usual and may be incompatible with the NI 1742. These lights may need to be reconfigured by the manufacturer to bring the voltage drop within the specified range of the NI 1742.



Note The voltage drop of a light can vary significantly with environmental conditions, such as temperature, current, and strobe time.

Refer to the *Specifications* section of *Getting Started with the NI 17xx Smart Camera* for complete specifications for the Direct Drive lighting controller.

Connecting a Light to the Direct Drive Lighting Controller

Figure 4-2 illustrates how to connect a light to the Direct Drive lighting controller. Do not use the GND signal when connecting a light to the Direct Drive lighting controller.

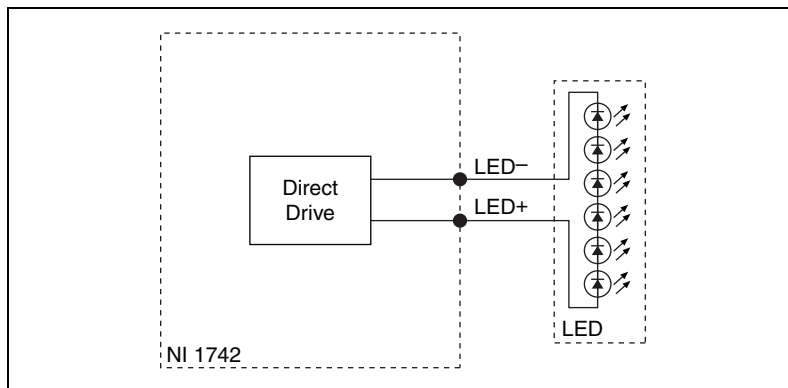


Figure 4-2. Connecting a Light to the Direct Drive Lighting Controller

The Direct Drive controller performs an initialization sequence to achieve the requested current output prior to acquiring the first image. You may notice a sequence of short flashes from the light when the application initializes or during shut down.

External Lighting Controllers

While the Direct Drive lighting controller is designed to handle common machine vision lighting requirements, some applications require the use of a light with current or voltage requirements beyond those supported by the Direct Drive. Other applications require more than one light. All models of the NI 17xx smart camera support connections to third-party lighting controllers to solve these applications.

The NI 17xx provides two types of external lighting outputs for synchronizing third-party controllers to the exposure of the smart camera: a 5 V TTL strobe output and a 24 V strobe output. The 5 V TTL strobe output is available for connecting to devices that require a 5 V signal. The 24 V strobe output is powered by the voltage from the smart camera power supply and is available for controllers that require higher voltage inputs. The 24 V strobe output is nominally a 24 V output if 24 V power is supplied to the smart camera.



Caution The 24 V external lighting strobe is an unregulated output dependent on the range of the power supply provided to the smart camera. If the power provided to the smart camera is +20%, -15% with +5% AC ripple, the output could be as high as 30 V. If the provided power exceeds the input voltage specifications of the third-party lighting controller, do *not* connect the 24 V lighting strobe output to the controller to prevent damage to the controller. Use a power supply with tolerances that meet the requirements of the controller, or use the 5 V external lighting strobe. When enabled, these outputs create a strobe pulse that can be used by the third-party controller to strobe the light simultaneously with the image exposure.

When enabled, these outputs create a strobe pulse that can be used by third-party controllers to strobe the light simultaneously with the image exposure.



Caution If you are using the 5 V strobe output or the 24 V strobe output, the software does not impose any limits on the duration or the duty cycle of the strobe output.

Alternatively, if the third-party lighting controller supports a programmable strobe time, the assertion edge of the NI 17xx output can start the strobe time, and the controller can be programmed for any arbitrary strobe duration.

Enable the 5 V and 24 V lighting outputs as follows:

- In Vision Builder AI, enable the **5 V TTL Strobe** and/or **24 V Strobe** controls on the **Lighting** tab of the **Acquire Image (Smart Camera)** step. Refer to the *Vision Builder for Automated Inspection: Configuration Help* for more information about configuring the 5 V TTL and 24 V strobe outputs..
- In LabVIEW, configure the **24V Strobe** and **5V Strobe** lighting properties. Refer to the *NI-IMAQ VI Reference Help* for more information about configuring the 5 V TTL and 24 V strobe outputs..
- In MAX, select the **5 V TTL Strobe** and/or **24 V Strobe** checkboxes on the **Lighting** tab of the NI 17xx configuration page. Refer to the *Measurement & Automation Explorer Help for NI-IMAQ* for more information about configuring the 5 V TTL and 24 V strobe outputs..

Connecting an External Lighting Controller to the NI 17xx

Figures 4-3 and 4-4 illustrate how to connect an external lighting controller to the 5 V TTL output and the 24 V output on the NI 17xx.

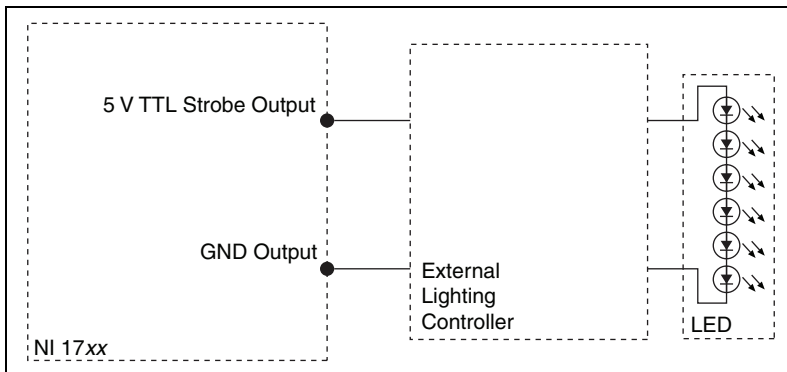


Figure 4-3. Connecting an External Lighting Controller to the 5 V TTL Strobe Output

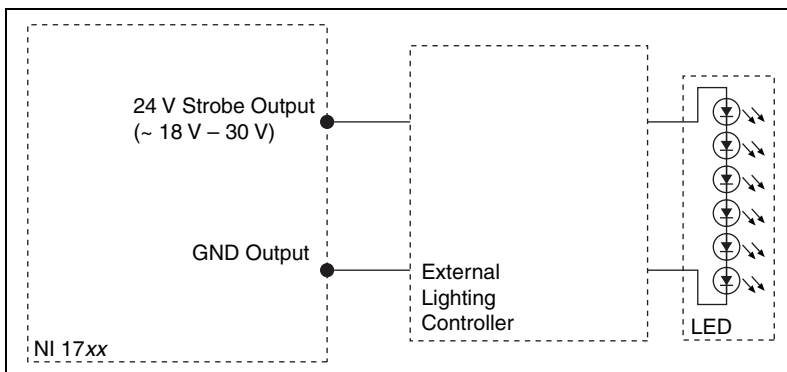


Figure 4-4. Connecting an External Lighting Controller to the 24 V Strobe Output

Image Acquisition

This chapter contains information about acquiring images with the NI 17xx smart camera and explains the relationships between triggering, lighting, and exposure.

Exposure

The NI 17xx smart camera provides control of the image sensor exposure time through software. The exposure time is the amount of time that light is allowed to strike the sensor to produce an image. When light strikes the surface of the sensor, it dislodges electrons. As more light strikes the sensor, more electrons are freed, creating a charge on the sensor.

For a given amount of light, the sensor collects more charge during a longer exposure time than a shorter exposure time. Because the charge is what is read out to produce the image, it is important to have an optimal amount of light and exposure time for your application.

Exposing the image sensor for too short of a time relative to the amount of light in the environment results in a dark, low contrast image. Exposing the image sensor for too long of a time relative to the amount of light in the environment results in a bright, low contrast image. When the image sensor is exposed for an appropriate amount of time relative to the light in the environment, acquired images will contain an appropriate amount of contrast to easily distinguish both dark and light features. Contrast is a key factor in obtaining good results from image processing algorithms.

In applications where the object under inspection is moving, the exposure time must be carefully considered. If the object moves significantly during the exposure, the resulting image is blurry and unsuitable for processing.

The maximum exposure time for imaging a moving object without blurring can be calculated by knowing the rate of motion, the field of view in the direction of the motion, and the number of pixels in the sensor. Assuming the object is moving horizontally across the field of view, Equation 5-1 calculates the maximum exposure time for a VGA sensor. The per pixel spatial resolution is the field of view divided by the number of pixels in the sensor.

$$E = \frac{R_{Horizontal} \times 2}{(FOV_{Horizontal}) / (N_{Horizontal})} \quad (5-1)$$

where E is the exposure time,
 R is the rate of motion in the horizontal direction,
 FOV is the field of view in the horizontal direction, and
 N is the number of sensor pixels in the horizontal direction

For many applications that include moving objects, additional lighting is necessary to achieve good image contrast because of the short exposure time needed to avoid motion blur.

Additionally, in many environments, the ambient light conditions vary too significantly to obtain consistent results without adding dedicated lighting. For example, in a building with windows, the ambient light can vary significantly with weather. Also, standard fluorescent lighting flickers at a rate that is perceivable by the NI 17xx. In these situations, the ambient light must be overridden with a dedicated light source to ensure reproducible results.

Acquiring Images

You can configure the NI 17xx to acquire images based on internal timing or an external trigger signal. In both cases, the NI 17xx can acquire full frame images at up to 60 frames per second (fps). If partial scanning or binning are enabled, the NI 17xx can acquire images faster than 60 fps. Refer to the [Maximum Frame Rate](#) section for information about factors that affect the maximum frame rate.

Internal Timing

The NI 17xx features two types of internally-timed modes: free-run mode and fixed-frame-rate mode.

In free-run mode, the NI 17xx acquires images at the maximum frame rate allowed by the configuration.

In fixed-frame-rate mode, you can specify a frame rate that is less than or equal to the maximum frame rate by setting the **Frame Rate** property in LabVIEW. Setting the **Frame Rate** property will implicitly take you out of free-run mode and into fixed-frame-rate mode. To return to free-run mode, set the **Fixed-Frame-Rate Mode** property in LabVIEW to FALSE.



Note Vision Builder AI and MAX do not support fixed-frame-rate mode.

External Trigger

Use the trigger input to synchronize the NI 17xx with an external event, such as the assertion of a signal generated by a proximity sensor. You can trigger the NI 17xx at rates up to the maximum frame rate. Refer to the [Maximum Frame Rate](#) section for information about factors that affect the maximum frame rate.

To use an external trigger, the trigger signal must be provided on the TrigIn/Iso(0) input to the camera and triggering must be enabled in the software. Refer to the [Isolated Inputs](#) section of Chapter 2, [Power and I/O](#), for information about connecting external signals.

Refer to the following documents for triggering information specific to each software:

Enable triggering as follows:

- **Vision Builder AI**—Select the **Triggered Acquisition** checkbox on the **Trigger** tab of the **Acquire Image (Smart Camera)** step.
- **LabVIEW**—Use the IMAQ Configure Trigger 3 VI.
- **MAX**—Select the **Enable Trigger** checkbox on the **Triggering** tab of the NI 17xx configuration page.

Figure 5-1 illustrates the relationship between an external trigger, a lighting strobe, and the exposure time.

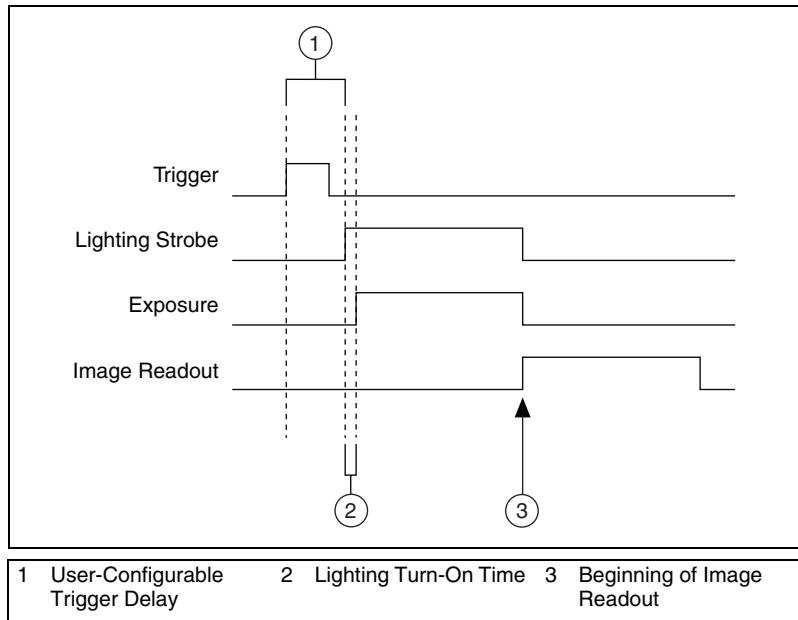


Figure 5-1. Externally Triggered Mode

The trigger shown in Figure 5-1 represents an external trigger, configured to use the rising edge as the active edge. The time between the active edge of the trigger and the assertion of the lighting strobe is a user-configurable trigger delay. The trigger delay can be measured in either milliseconds or quadrature encoder counts. The NI 1722 does not support quadrature encoders.

The incoming trigger is synchronized to the line rate of the smart camera. This adds an additional delay that can vary on a frame by frame basis. The maximum variability is shown in Table 5-1.

Table 5-1. Trigger Synchronization Variability

Smart Camera Model	Trigger Synchronization Variability
NI 1722 NI 1742	31.25 μ s

The amount of time required from the assertion of a trigger to the start of the light strobe and image exposure varies by application. For example, if a sensor that detects the presence of a part is positioned before the smart camera on a conveyor belt, a trigger delay will be necessary so that the smart camera waits until the part to be inspected passes in front of the smart camera to expose the image. In this case, specifying the trigger delay in terms of quadrature encoder counts allows the smart camera to expose the image when the part is positioned in front of the smart camera regardless of changes in speed of the conveyor belt. For other applications, a delay specified in milliseconds is sufficient.

If you are strobing a light, there is a short delay while the lighting controller turns on the light. This delay is represented by the lighting turn-on time in Figure 5-1. Table 5-2 lists the lighting turn-on times.

Table 5-2. Lighting Turn-on Time

Smart Camera Model	Lighting Turn-on Time
NI 1722 NI 1742	156 μ s

After the turn-on time, the exposure begins. The width of the exposure pulse determines how long the sensor is exposed. The exposure time can be adjusted by setting the **Exposure Time** control in Vision Builder AI, setting the **Exposure Time** property in LabVIEW, or by setting the **Exposure Time** control in MAX. The lighting strobe deasserts at the end of the exposure pulse. The end of an exposure starts the image readout from the sensor. The maximum trigger rate is determined by the maximum frame rate for your configuration. Refer to the [Maximum Frame Rate](#) section for information about the factors that affect the maximum frame rate.

Maximum Frame Rate

Frame rate is the inverse of the frame period. The frame period is the time from the start of exposure on one frame to the start of exposure on the next frame, as shown in Figure 5-2.

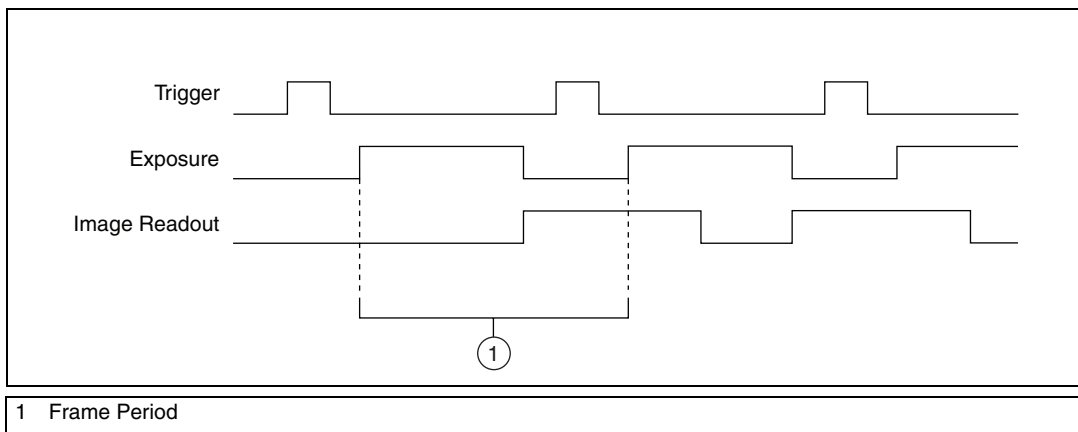


Figure 5-2. Frame Period

The frame period is affected by the following factors:

- Partial scan mode
- Binning mode
- Exposure time
- Lighting mode
- Trigger delay

The maximum frame rate ($1/\text{min frame period}$) for your configuration can be determined by reading the **Max Frame Rate** indicator in Vision Builder AI, reading the **Max Frame Rate** property in LabVIEW, or reading the **Max Frame Rate** indicator in MAX. When external triggering is enabled, do not trigger faster than the maximum frame rate.



Note Sending a trigger before the minimum frame period has expired will result in a missed trigger.

Use the following equation to determine the maximum frame rate:

$$\text{max frame rate} = \min\left(\text{absolute max frame rate}, \frac{1}{\text{min frame period}}\right)$$

The *absolute maximum frame rate* is determined by the partial scan mode and binning mode. Because the amount of data read out of the sensor is less in 1/2 or 1/4 scan mode, the readout takes less time, and you can achieve faster frame rates. The same is true of binning. When binning is enabled, the readout takes less time, and you can achieve faster frame rates. Refer to the [Partial Scan Mode](#) and [Binning](#) sections of Chapter 3, [Image Acquisition](#), for more information about partial scanning and binning.

Use Table 5-3 to determine the *absolute maximum frame rate*.

Table 5-3. Absolute Maximum Frame Rates

Smart Camera Model	Full Scan	1/2 Partial Scan	1/4 Partial Scan	1 × 2 Binning
NI 1722 NI 1742	60 fps	109 fps	175 fps	114 fps

The minimum frame period depends on exposure time, lighting mode, and trigger delay.

A longer exposure time results in a longer frame period, and a slower maximum frame rate. Refer to the [Exposure](#) section for more information about exposure time.

If you are not strobing a light using the Direct Drive or the external strobe outputs of the smart camera, the smart camera can expose one image while it is reading out the previous image, allowing for the highest possible frame rates. Figure 5-3 illustrates this relationship. The smart camera receives the trigger for the second image after the start of exposure for the first image. There must be enough time for the first image readout to finish before the the second image readout begins.

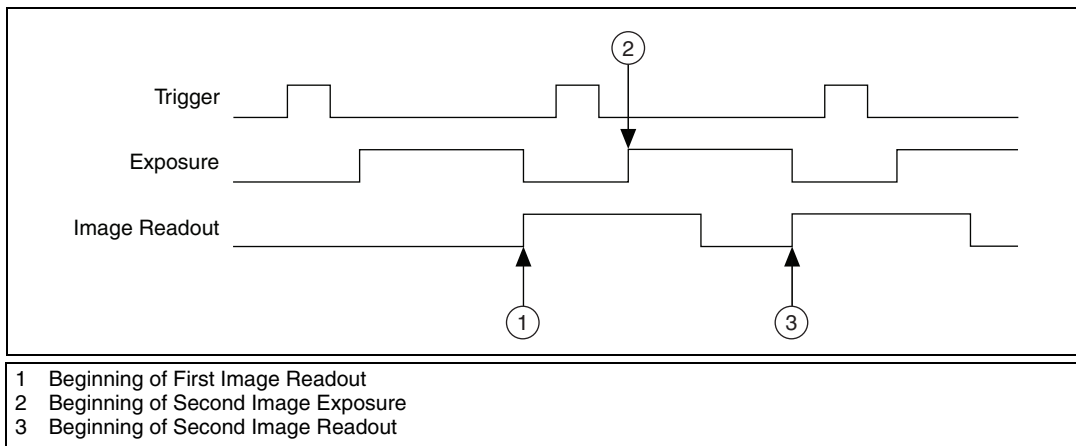


Figure 5-3. Image Acquisition Without Strobing

When strobing is enabled, the smart camera waits until the image readout is complete before turning on the light for the next frame, as shown in Figure 5-4.

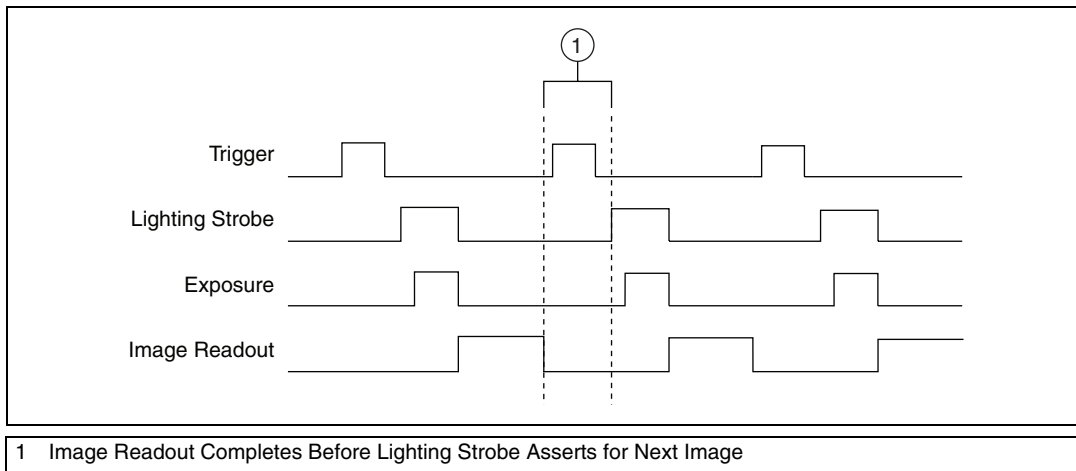


Figure 5-4. Image Acquisition With Strobing

If the trigger delay is specified in milliseconds and is set longer than the minimum frame period, as defined by the factors that affect the maximum frame rate, the smart camera uses the trigger delay value as the *min frame period*.

Refer to Figure 5-5 and Equations 5-2 and 5-3 to calculate the minimum frame period.

	No Strobe	Strobe
No Trigger	Equation 5-2	Equation 5-3
Trigger	Max(Equation 5-2, Trigger Delay)	Max(Equation 5-3, Trigger Delay)

Figure 5-5. Calculating Minimum Frame Period

$$\text{min frame period} = T + L + E \quad (5-2)$$

$$\text{min frame period} = T + L + E + R \quad (5-3)$$

where T is the trigger synchronization variability,
 L is the lighting turn-on time,
 E is the exposure time, and
 R is the image readout duration

Tables 5-1 and 5-2 list the values for the trigger synchronization variability and the lighting turn-on time, respectively.

The image readout duration varies depending on the smart camera configuration, as shown in Table 5-4.

Table 5-4. Image Readout Duration

Smart Camera Model	Full Scan	1/2 Scan	1/4 Scan	Binning
NI 1722 NI 1742	16.38 ms	8.17 ms	4.09 ms	8.17 ms

LEDs and DIP Switches

This chapter provides information about the location and functionality of the LED indicators and DIP switches on the NI 17xx smart camera.

Understanding the LED Indicators

Figure 6-1 shows the location of the LEDs on the NI 17xx.

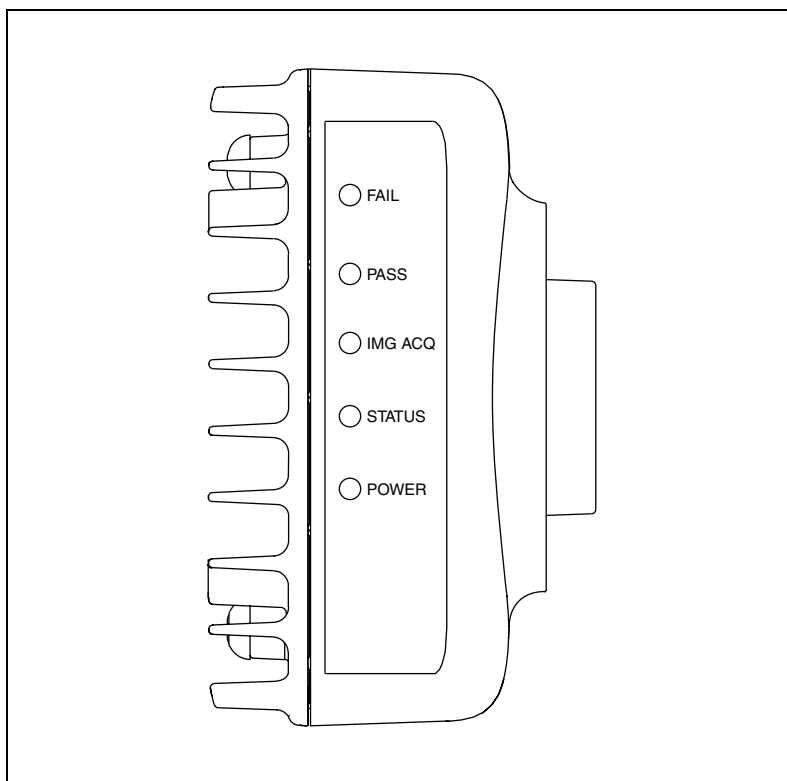


Figure 6-1. NI 17xx LEDs

Device Initialization

While the NI 17xx initializes, the POWER LED lights solid green and the STATUS, IMG ACQ, PASS, and FAIL LEDs exhibit a scrolling pattern. When the NI 17xx finishes initializing, the STATUS LED lights solid green. If the system does not initialize within the expected period of time, the STATUS LED flashes a status code. Refer to the *STATUS LED* section for information about the status codes.

The initialization scrolling pattern will last longer than usual if the NI 17xx is configured to acquire an IP address from a DHCP server but no DHCP server is available on the network. When acquiring an IP address from a DHCP server, the NI 17xx waits up to 60 seconds to acquire an IP address. If the NI 17xx does not receive an IP address within 60 seconds, the device will automatically restarts and tries again. The NI 17xx will attempt to acquire an IP address from a DHCP server up to three times. If after the third time the NI 17xx has not been assigned an IP address, the NI 17xx reverts to the unconfigured state and the IP address resets to 0 . 0 . 0 . 0. The STATUS LED flashes to indicate that the NI 17xx is in an unconfigured state.

POWER LED

The POWER LED indicates whether the power supplied to the camera is adequate. The POWER LED is green while the camera is properly powered on. When no power is being supplied to the camera, the POWER LED is unlit. When power is first applied to the NI 17xx, the POWER LED flashes red for one second while internal systems power up. If the POWER LED stays red for longer than one second, it indicates that the voltage is out of range.

STATUS LED

The STATUS LED is green during normal operation. The smart camera indicates specific conditions by flashing the STATUS LED, as shown in Table 6-1.

Table 6-1. STATUS LED Indications

LED Behavior	LED Color	Indication
Solid	Green	The smart camera initialized successfully and is ready for use.
1 Flash	Green	The smart camera IP address or software is unconfigured. The smart camera ships from the factory unconfigured. The smart camera also enters the unconfigured state if it is configured for DHCP and no DHCP server is available. Use MAX or Vision Builder AI to configure the smart camera. Refer to <i>Getting Started with the NI 17xx Smart Camera</i> for information about configuring the smart camera.
2 Flashes	Green	The smart camera detects an error in the software configuration. The camera has automatically booted into safe mode, regardless of the SAFE MODE DIP switch position. This usually occurs when an attempt to upgrade the software is interrupted or if system files are deleted from the smart camera. Reinstall software on the smart camera. Refer to <i>Getting Started with the NI 17xx Smart Camera</i> for information about installing software on the smart camera.
3 Flashes	Green	The smart camera is in safe mode because the SAFE MODE DIP switch is in the ON position. Refer to the Configuring DIP Switches section for information about the SAFE MODE DIP switch.
4 Flashes	Green	The smart camera has experienced two consecutive software exceptions. The smart camera automatically restarts after an exception. After the second exception, the smart camera remains in the exception state, alerting you to resolve the problem. Reinstall software on the smart camera or contact National Instruments for assistance. Refer to <i>Getting Started with the NI 17xx Smart Camera</i> for information about installing software on the smart camera.
5 Flashes	Green	The smart camera detects a critical error. Reinstall software on the smart camera or contact National Instruments for assistance. Refer to <i>Getting Started with the NI 17xx Smart Camera</i> for information about installing software on the smart camera.

Table 6-1. STATUS LED Indications (Continued)

LED Behavior	LED Color	Indication
Flashing	Red	The smart camera detects a software crash or hang. Please contact National Instruments for assistance.
Solid	Red	The smart camera detects a critical boot ROM error. Please contact National Instruments for assistance.

IMG ACQ LED

The IMG ACQ LED briefly lights green when an image is captured and ready for analysis. Fast frame rates can give this LED the appearance of being continuously lit.

If the IMG ACQ LED and the FAIL LED both flash red, it indicates that the NI 17xx has shut down because the maximum internal temperature was exceeded. Refer to the *Thermal Considerations* section of Chapter 8, *Thermal Considerations and Mounting Information*, for information about measuring the temperature of the NI 17xx. Refer to the *Specifications* section of *Getting Started with the NI 17xx Smart Camera* for complete specifications.

PASS LED

The PASS LED is a green LED that is user-configurable through the IMAQ property node in LabVIEW or the **Smart Camera I/O** step in Vision Builder AI.

FAIL LED

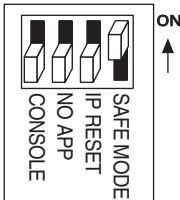
The FAIL LED is a red LED that is user-configurable through the IMAQ property node in LabVIEW or the **Smart Camera I/O** step in Vision Builder AI.

If the IMG ACQ LED and the FAIL LED both flash red, it indicates that the NI 17xx has shut down because the maximum internal temperature was exceeded. Refer to the *Thermal Considerations* section of Chapter 8, *Thermal Considerations and Mounting Information*, for information about measuring the temperature of the NI 17xx. Refer to the *Specifications* section of *Getting Started with the NI 17xx Smart Camera* for complete temperature specifications.

Configuring DIP Switches

This section describes the SAFE MODE, IP RESET, NO APP, and CONSOLE DIP switches on the NI 17xx. To turn on a DIP switch, lift the DIP switch cover and move the switch to the ON position.

SAFE MODE Switch

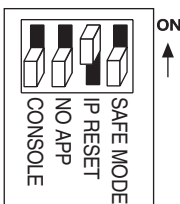


To start the NI 17xx in safe mode, move the SAFE MODE switch to the ON position and reapply power or restart the NI 17xx. If the switch is in the ON position when the NI 17xx starts, the NI 17xx launches only the essential services required for updating configuration information and installing software. The LabVIEW Real-Time engine does not launch. Use safe mode to reconfigure the NI 17xx TCP/IP settings, update firmware, and to install or update the software on the NI 17xx.

If the software on the NI 17xx is corrupted, start the NI 17xx in safe mode and update the software. To resume normal operations, move the SAFE MODE switch to the OFF position and reapply power or restart the NI 17xx. Refer to *Getting Started with the NI 17xx Smart Camera* for information about updating the software on the NI 17xx.

The STATUS LED flashes green three times when the NI 17xx is in safe mode. Keep the SAFE MODE switch in the OFF position during normal operation.

IP RESET Switch

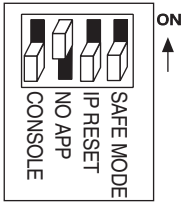


To clear the NI 17xx IP settings, move the IP RESET switch to the ON position and reapply power or restart the NI 17xx. Use the IP RESET switch to reset the TCP/IP settings when moving the camera from one subnet to another or when the current TCP/IP settings are otherwise invalid.

Starting the NI 17xx with the IP RESET switch in the ON position resets the IP address to 0 . 0 . 0 . 0. Once you have reset the IP address, you can set up a new network configuration for the NI 17xx from a development machine on the same subnet, or you can use an Ethernet cable to connect the NI 17xx directly to the development computer. Refer to *Getting Started with the NI 17xx Smart Camera* for information about assigning an IP address to the NI 17xx.

To resume normal operations, move the IP RESET switch to the OFF position and reapply power or restart the NI 17xx. Keep the IP RESET switch in the OFF position during normal operation.

NO APP Switch

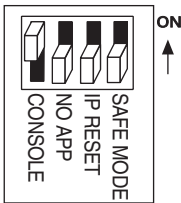


Move the NO APP switch to the ON position to prevent a startup application from running when the NI 17xx powers on. If you want to permanently disable the application from running when the NI 17xx powers on, you can disable the startup application in software.

To automatically run an application when the NI 17xx powers on, keep the NO APP switch in the OFF position. You must configure the application in software to automatically run when the NI 17xx powers on. Refer to the *LabVIEW Real-Time Module User Manual* for more information about automatically launching VIs when the NI 17xx powers on. Refer to the *NI Vision Builder for Automated Inspection: Configuration Help* for more information about configuring remote target options.

Keep the NO APP switch in the OFF position during normal operation.

CONSOLE Switch



With a serial port terminal program, you can use the CONSOLE switch to read device information from the NI 17xx during start up, such as the IP address and firmware version. When the CONSOLE switch is in the ON position, the serial port outputs device information and is not available for applications. The NI 17xx reads this switch only when powering up or restarting and will only display device information during start up.

When the CONSOLE switch is in the OFF position, you can use the NIK 17xx serial port and NI-Serial driver software to send and receive serial data. The NI-Serial software is installed when you install NI-IMAQ. When using the NI-Serial driver, keep the CONSOLE switch in the OFF position during normal operation.

Refer to the [Connecting to Serial Devices](#) section of Chapter 2, *Power and I/O*, for more information about using serial communication with the NI 17xx.

Ethernet Ports

This chapter provides information about the Ethernet ports and Ethernet LEDs on the NI 17xx smart camera and considerations for assigning an IP address.

The Ethernet ports on the NI 17xx provide a connection between the NI 17xx and the development computer or other network devices. The NI 17xx provides two 10/100/1,000 Mbps Ethernet ports. Figure 7-2 shows the Ethernet ports on the NI 17xx.

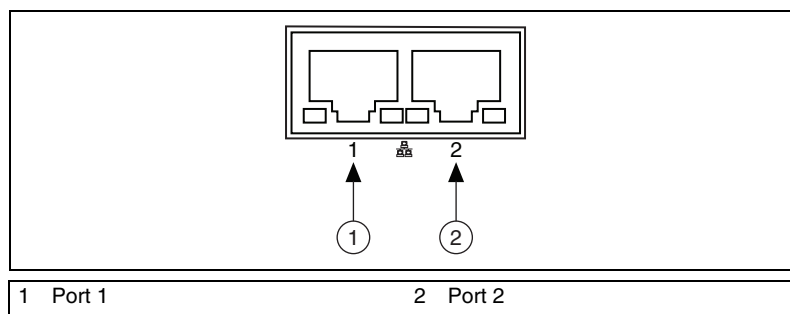


Figure 7-1. NI 17xx Ethernet Ports

Port 1 is the primary port and port 2 is the secondary port. The primary port can be configured to acquire an IP address from a DHCP server. The secondary port can only be configured for a static IP address.

Both Ethernet ports of the NI 17xx can connect to a 10, 100, or 1,000 Mbps (1 Gbps) Ethernet network at either full or half duplex. The NI 17xx automatically detects the speed and duplex capabilities of its link partner and configures for the fastest common interface. The NI 17xx can also perform auto-crossover, allowing the use of straight or crossover Ethernet cables, independent of the connection configuration.

When shielded Ethernet cables are being used, ensure that the shields on the Ethernet cables and the POWER-I/O cable do not contact each other to maintain full Ethernet signal integrity.



Note A CAT 5e or CAT 6 1000Base-T Ethernet cable is required to achieve maximum 1,000 Mbps (1 Gigabit) Ethernet performance. CAT 5e and CAT 6 Ethernet cables adhere to higher electrical standards required for Gigabit Ethernet communication. CAT 5 cables are not guaranteed to meet necessary electrical requirements. While CAT 5 cables may appear to work in some installations at 1,000 Mbps, CAT 5 cables are likely to cause increased bit errors resulting in degraded or unreliable network performance.

Ethernet LEDs

Figure 7-2 shows the Ethernet LEDs on the NI 17xx.

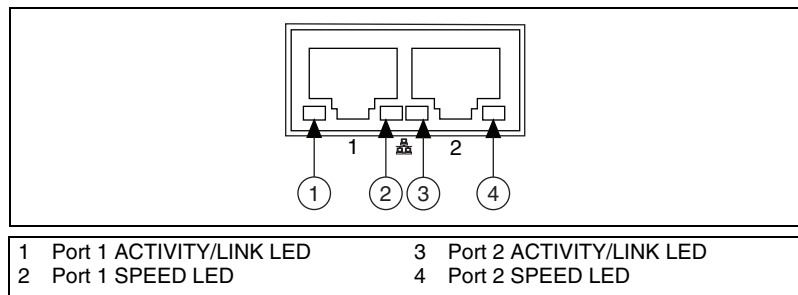


Figure 7-2. NI 17xx Ethernet LEDs

ACTIVITY/LINK LED

The ACTIVITY/LINK LED indicates whether a link is established between the NI 17xx and the device connected at the other end of the Ethernet cable. The LED is off when no cable is connected or if the NI 17xx or the device connected at the other end of the cable are powered down. The LED is solid green when a link is established, but there is no traffic activity on the link. The LED will flash green when there is traffic activity on the link. If the NI 17xx is connected to a corporate network, traffic that is not related to the NI 17xx traffic will often be present on the link. In dedicated links between a computer and the NI 17xx, typically the only traffic on the link will be the communication between the computer and the NI 17xx.

SPEED LED

The SPEED LED indicates the speed of the negotiated link. The NI 17xx supports 10 Mbps, 100 Mbps, and 1,000 Mbps (1 Gbps) links, and will automatically select the highest speed shared by the NI 17xx and the device it is connected to. The SPEED LED follows the behavior specified in Table 7-1.

Table 7-1. SPEED LED Behavior

LED Behavior	Indication
Off	No link or a 10 Mbps link is negotiated
Solid Green	A 100 Mbps link is negotiated
Solid Amber	A 1,000 Mbps link is negotiated

DHCP and Static IP Address Assignment

You must configure the IP settings for the NI 17xx prior to use. You can assign a static IP address or, if your network has a DHCP server, you can use a DHCP server to assign an IP address. If you do not know whether you should assign a static IP address or use a DHCP server to assign an IP address, assign a static IP address.

DCHP IP address assignment is only available for port 1. Static IP address assignment is available on both ports.

For information about assigning an IP address to the NI 17xx, refer to *Getting Started with NI 17xx Smart Camera*.

The advantage of using a DHCP server to assign an IP address is that the DHCP server manages the IP addresses of the network. You do not need to know the IP address of the smart camera. Also, the DHCP server does not allow other devices to use the IP address that is already assigned to your smart camera.

Although using a DHCP server makes configuring an IP address easy, configuring a static IP address can be more reliable. Consider the following potential issues before using a DHCP server to assign an IP address to the smart camera:

- If the network has both static IP addresses and IP addresses managed by a DHCP server, the DHCP server must be configured to not use reserved static IP addresses. If the DHCP server is not configured this way, the DHCP server can assign a reserved IP address to another device, causing address conflicts on the network, which results in some devices being unreachable.

- When an NI 17xx configured for DHCP starts, it must be able to connect to the DHCP server. If an NI 17xx was previously configured to use a DHCP server and the NI 17xx cannot connect to the DHCP server, the NI 17xx does not appear in MAX or Vision Builder AI. The IP address must be reconfigured before you can use the smart camera.

Subnet Considerations

To configure the NI 17xx, it must reside on the same subnet as the development computer. If you want to use the NI 17xx on a subnet other than the one the development computer is on, first connect and configure the smart camera on the same subnet as the host computer.

The first time you configure the smart camera, you must also install software on it. After configuring the smart camera, use DHCP to assign an IP address or reassign a static IP address for the subnet where you want the smart camera to reside, then physically move the smart camera to the other subnet. Refer to the *Getting Started with the NI 17xx Smart Camera* for more information about configuring the smart camera.

Contact your network administrator if you need assistance configuring the host computer and smart camera on the same subnet.

Thermal Considerations and Mounting Information

This chapter contains information about the operating temperature of the NI 17xx smart camera and provides the information necessary to create a custom mount for the NI 17xx.

Thermal Considerations

The NI 17xx smart camera can operate in environments with ambient temperatures ranging from 0–45 °C. The maximum housing temperature of the NI 17xx is 65 °C. Refer to the *Specifications* section of *Getting Started with the NI 17xx Smart Camera* for complete specifications. Figure 8-1 shows the location to take temperature measurements on the NI 17xx.

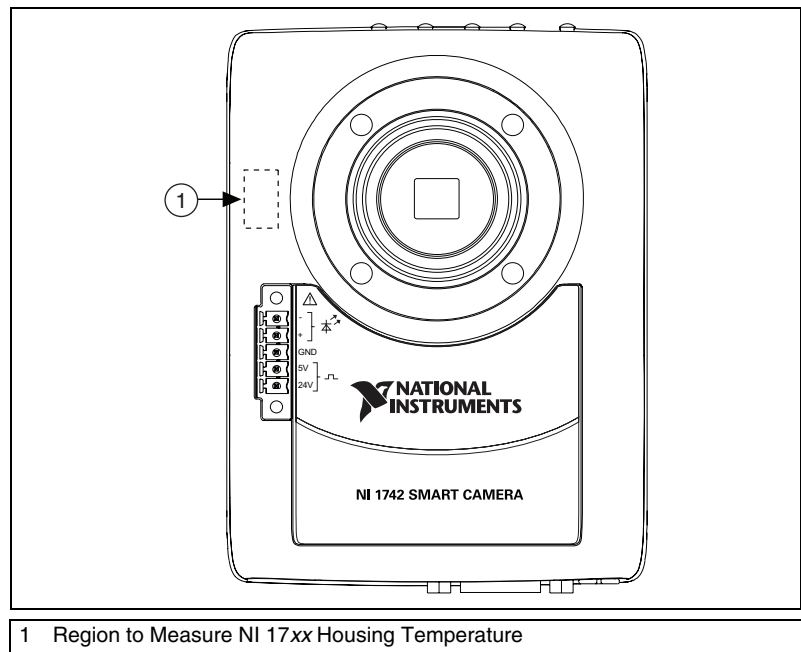


Figure 8-1. Measuring the NI 17xx Housing Temperature

Operating the NI 17xx above the specified ambient temperature or above the specified case temperature will degrade image quality and can cause permanent damage to the device.

The NI 17xx also has an internal temperature sensor that provides an internal temperature measurement. You can monitor the temperature sensor from LabVIEW using the **Status Information** > **Temperature** property from the IMAQ property node.

If the internal temperature sensor ever reads 70 °C or more, the NI 17xx immediately halts operation and becomes unresponsive. The IMG ACQ LED and the FAIL LED flash red. You must remove and reapply power to the NI 17xx to recover from this condition.

To maximize the cooling efficiency of the NI 17xx, mount it to a thermally conductive structure.

Mounting the NI 17xx



Caution If you choose not to mount the NI 17xx to a thermally conductive structure, do not position the NI 17xx with the heat sinks resting on any surface. Doing so may violate the thermal requirements of the NI 17xx and cause the NI 17xx to overheat. Refer to the *Specifications* section of *Getting Started with the NI 17xx Smart Camera* for temperature specifications.

Figures 8-2 through 8-5 provide the dimensional drawings necessary to create a custom mount for the NI 17xx.

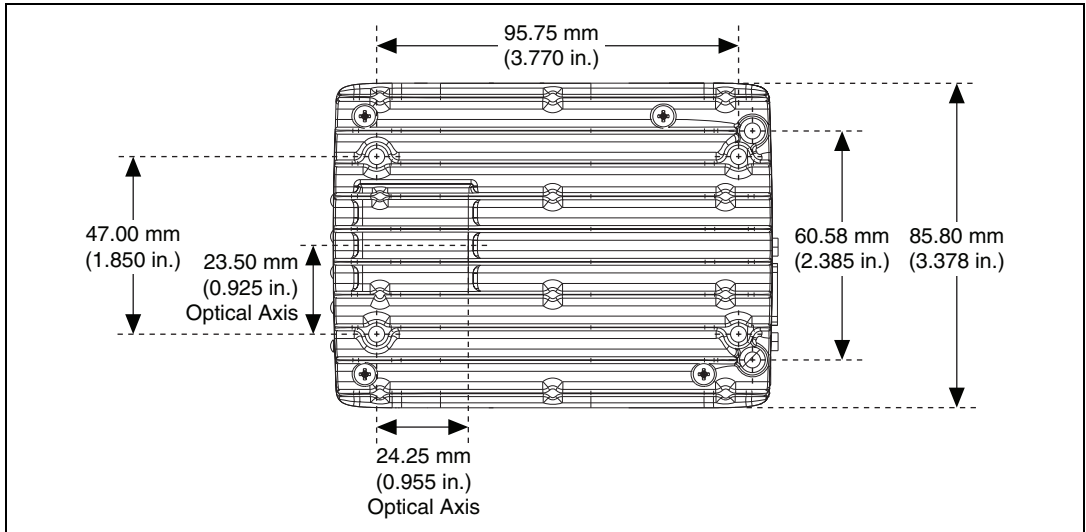


Figure 8-2. Back View of the NI 17xx with Dimensions

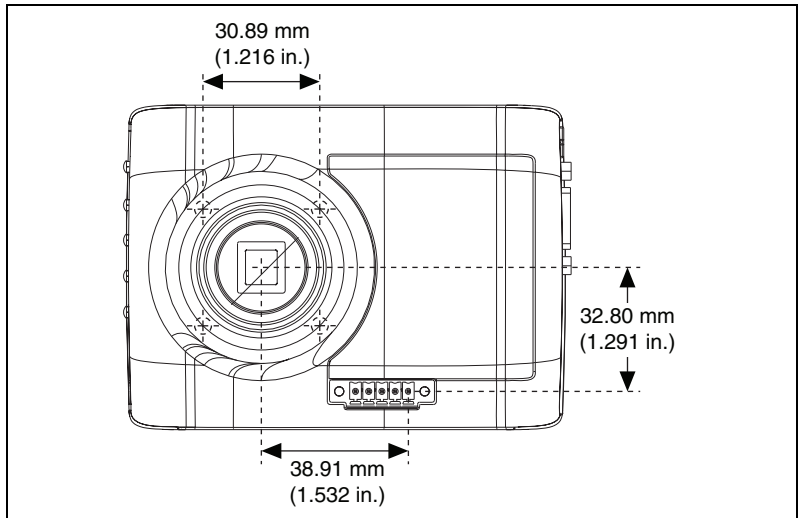


Figure 8-3. Front View of the NI 17xx with Dimensions

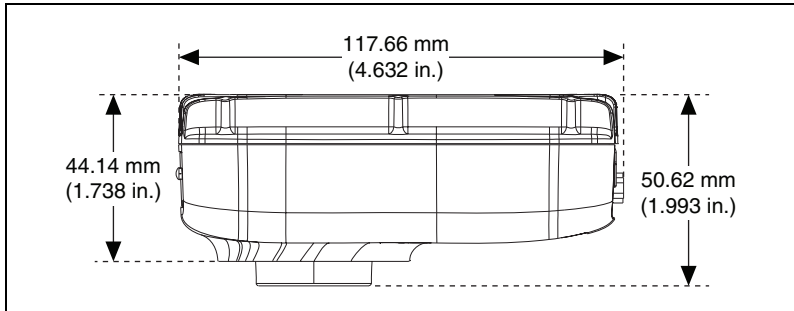


Figure 8-4. Side View of the NI 17xx with Dimensions

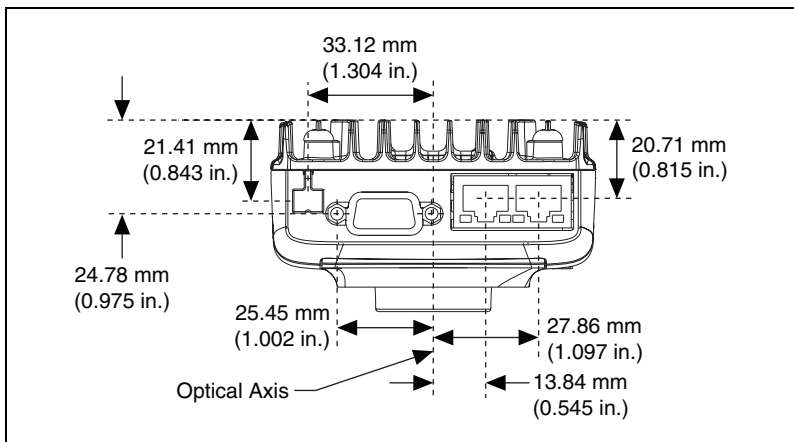


Figure 8-5. Bottom View of the NI 17xx with Dimensions

Troubleshooting

This appendix provides instructions for troubleshooting the NI 17xx smart camera.

Configuration Problems

The NI 17xx Does Not Appear in MAX or Vision Builder AI

Possible causes and solutions:

- Verify that there is power to the NI 17xx and that both the NI 17xx and the development computer are properly connected to the network. The POWER LED should be lit green and the ACTIVITY/LINK LED should flash green when refreshing the list of devices in MAX or Vision Builder AI.
- The NI 17xx may have been configured on another network subnet and then moved to the current network subnet. Reconfigure the NI 17xx on the current network. Refer to the [Subnet Considerations](#) section of Chapter 7, [Ethernet Ports](#) for more information.
- The cable you are using may be inappropriate for the speed of your network, causing network communication dropout. While 1,000 Mbps communication over short cables lengths can be achieved with the CAT5 cable commonly used for 10 and 100 Mbps, CAT5e and CAT6 cables are more reliable and recommended for 1,000 Mbps links. The NI 17xx has the ability to perform auto-crossover, allowing the use of straight or crossover Ethernet cables, independent of the connection configuration.
- Another device on the network is using the IP address assigned to the NI 17xx. Either remove or reconfigure the other device, or reconfigure the NI 17xx IP address by moving the IP RESET DIP switch to the ON position and reapplying power or restarting the NI 17xx. Refer to the [IP RESET Switch](#) section of Chapter 6, [LEDs and DIP Switches](#), for more information.

The NI 17xx Restarts Unexpectedly

Possible causes and solutions:

- The NI 17xx is configured to acquire an IP address from a DHCP server, but no DHCP server is available on the network. When the NI 17xx is configured to acquire an IP address from a DHCP server, it waits for up to 60 seconds for the IP address to be acquired successfully. If the NI 17xx does not receive an IP address within 60 seconds, it restarts and attempts to acquire an IP address again. After three unsuccessful attempts to acquire an IP address from a DHCP server, the NI 17xx restarts and enters an unconfigured state. In the unconfigured state, the NI 17xx has an IP address of 0.0.0.0 and only limited software loads.

In the unconfigured state, the NI 17xx has network connectivity. If the NI 17xx is on the same subnet as the host computer, then refreshing the list of remote devices in MAX or Vision Builder AI will cause the NI 17xx to appear with an IP address of 0.0.0.0. Use MAX or Vision Builder AI to reconfigure the NI 17xx IP address. Then restart the NI 17xx.

Refer to *Getting Started with the NI 17xx Smart Camera* for more information about assigning an IP address to the NI 17xx.

- The NI 17xx has detected an error in the software configuration and automatically restarted into safe mode, independent of the state of the SAFE MODE DIP switch. This usually occurs when an attempt to upgrade the software is interrupted or if system files are deleted from the smart camera by the user. Reinstall software on the smart camera. Refer to *Getting Started with the NI 17xx Smart Camera* for information about installing software on the smart camera.
- The NI 17xx experienced two consecutive software exceptions. The smart camera automatically restarts after an exception. After the second exception, the smart camera remains in the exception state, alerting you to resolve the problem. To correct this issue, reinstall software on the smart camera. Refer to *Getting Started with the NI 17xx Smart Camera* for information about installing software on the smart camera or contact National Instruments for assistance.
- In the event that the Direct Drive lighting controller detects an abnormal load condition, such as a short circuit on the LED+ output, the NI 1742 stops image acquisition and returns an error. The Direct Drive stops providing current to the light, and the smart camera may restart. Ensure that your lighting wire connections are correct and/or reconfigure your lighting settings in MAX or Vision Builder AI.

- The voltage drop of the light may have exceeded the maximum voltage or minimum voltage requirements of the NI 1742. The voltage drop of a light can vary significantly with environmental conditions, such as temperature, current, and strobe time. Verify that the voltage drop across the LED+ and LED– terminals is within the specified range of the NI 1742. Your light may need to be reconfigured by the manufacturer to bring the voltage drop within the specified range of the NI 1742. Refer to the *Specifications* section of *Getting Started with the NI 17xx Smart Camera* for more information.
- The NI 17xx ran out of memory. The reason may be that acquired images are still in memory. When developing applications with LabVIEW, use the IMAQ Dispose VI to destroy an image and free the space it occupied in memory. This VI is required for each image created in an application to free the memory allocated to the IMAQ Create VI. Execute the IMAQ Dispose VI only when the image is no longer needed in your application. You can configure the IMAQ Dispose VI to free memory for each call to the IMAQ Create VI or just once for all images created using the IMAQ Create VI.

Run-time Problems

The NI 17xx is Unresponsive and Blinks the IMG ACQ LED and the FAIL LED

The NI 17xx maximum internal temperature was exceeded. You must remove and reapply power to the NI 17xx to recover from this condition. Refer to the *Thermal Considerations* section of Chapter 8, *Thermal Considerations and Mounting Information*, for information about measuring the temperature of the NI 17xx. Refer to the *Specifications* section of *Getting Started with the NI 17xx Smart Camera* for complete temperature specifications.

Lighting Problems

The Light Does Not Illuminate When Using the Direct Drive Lighting Controller

In the event that your light does not illuminate, verify the following:

- The smart camera supports the Direct Drive lighting controller. The NI 1742 supports the Direct Drive. The NI 1722 does not support the Direct Drive.
- The light is wired with the correct polarity, LED+ pin to the anode and LED– pin to cathode.
- You have properly configured the maximum light settings in MAX or Vision Builder AI. For safety reasons, the default configuration of the smart camera does not enable lighting until you configure the maximum lighting current settings that are appropriate for your light.
- You have enabled the Direct Drive lighting controller in MAX or Vision Builder AI.
- The smart camera is receiving a trigger if you have configured the smart camera for triggering in MAX or Vision Builder AI. This can be verified by checking that the IMG ACQ LED on the smart camera illuminates when a trigger is provided on the TrigIn+/IsoIn(0)+ and TrigIn–/IsoIn(0)– pins. If you are not receiving a trigger, refer to the [No Trigger is Received](#) troubleshooting section.
- There is not a short circuit wiring condition. If the smart camera detects a short circuit wiring condition, it will disable the Direct Drive until the condition is cleared and the acquisition is reinitialized.

In the event that the Direct Drive lighting controller detects an abnormal load condition, such as a short circuit on the LED+ output, the NI 17xx stops image acquisition and returns an error. The Direct Drive stops providing current to the light, and the smart camera may restarts. Ensure that your lighting wire connections are correct and/or reconfigure your lighting settings in MAX or Vision Builder AI.

- You have requested an amount of current within the specified range of the NI 1742 and within the maximum lighting current settings you configured in MAX or Vision Builder AI. If your application requests more current than either of these two options, the NI 1742 disables the Direct Drive until an allowable current level is requested and the acquisition is reinitialized.

- If you are strobing, the on time required to illuminate for your requested exposure time plus the lighting turn-on time does not exceed the maximum allowed strobe duration. Refer to Chapter 5, *Image Acquisition*, for more information.
- If you are strobing, the duty cycle does not exceed the maximum allowed duty cycle at your requested frame rate. Refer to Chapter 5, *Image Acquisition*, for more information.
- The on voltage of the light is within the specifications of the Direct Drive lighting controller. Refer to the *Specifications* section of *Getting Started with the NI 17xx Smart Camera* for more information.
- The voltage drop of the light may have exceeded the maximum voltage or minimum voltage requirements of the NI 1742. The voltage drop of a light can vary significantly with environmental conditions, such as temperature, current, and strobe time. Verify that the voltage drop across the LED+ and LED– terminals is within the specified range of the NI 1742. Your light may need to be reconfigured by the manufacturer to bring the voltage drop within the specified range of the NI 1742. Refer to the *Specifications* section of *Getting Started with the NI 17xx Smart Camera* for more information.

There is No External Lighting Strobe

Possible causes and solutions:

- If you have configured the smart camera for triggering in MAX or Vision Builder AI, verify that the smart camera is receiving a trigger. This can be verified by checking that the IMG ACQ LED on the smart camera illuminates when a trigger is provided on the TrigIn+/IsoIn(0)+ and TrigIn–/IsoIn(0)– pins. If you are not receiving a trigger, refer to the *No Trigger is Received* troubleshooting section.
- If you are using the 24 V strobe output, verify that there is enough time between frames for the strobe output to fully turn off before being re-enabled. The required time will vary with the load conditions, but is typically a few milliseconds. If a faster response is necessary, use the 5 V strobe output.
- Make sure that you have enabled the corresponding external lighting strobe in MAX or Vision Builder AI. Complete one of the following procedures to enable the correct lighting strobe:

MAX

1. Launch MAX.
2. In the Configuration tree, expand **Devices and Interfaces**.
3. Expand **NI-IMAQ Devices**.
4. Expand the smart camera you are using.
5. Select the channel you are using.
6. Select the **Lighting** tab.
7. Select the appropriate strobe from the **External Strobe Generation** control.

Vision Builder AI

1. Launch Vision Builder AI.
2. In the **Acquire Image (Smart Camera)** step, select the **Lighting** tab.
3. Select the appropriate strobe from the **External Strobe Generation** control.

Triggering Problems

No Trigger is Received

If you are not receiving a trigger, verify the following:

- The trigger is wired to the TrigIn+/IsoIn(0)+ and TrigIn-/IsoIn(0)- signals.
- If TrigIn/IsoIn(0) and IsoIn(1) are both being used, that the devices they are connected to are either both sinking (NPN) or both sourcing (PNP).
- The trigger is connected correctly based on the type of sensor it is—sourcing or sinking. Refer to the *Isolated Inputs* section of Chapter 2, *Power and I/O* for information about connecting isolated inputs.
- The sensor power supply is of appropriate voltage for interfacing to NI 17xx isolated inputs. Refer to the *Isolated Inputs* section of Chapter 2, *Power and I/O* for information about isolated inputs. Refer to the *Specifications* section of *Getting Started with the NI 17xx Smart Camera* for complete specifications.
- You configured the device in MAX or Vision Builder AI to expect a trigger. Refer to the *External Trigger* section of Chapter 5, *Image Acquisition* for information about configuring an external trigger.

LED Error Indications

STATUS LED Error Conditions

The NI 17xx indicates specific error conditions by flashing the STATUS LED a specific number of times. Refer to the [STATUS LED](#) section of Chapter 6, [LEDs and DIP Switches](#) for the STATUS LED flashing sequences and the corresponding error condition.

POWER LED is Not Lit When the NI 17xx is Powered on

If the power supply is properly connected to the NI 17xx, but the POWER LED does not light up, check that the power supply is 24 V $\pm 20\%$ / -15% and within the specifications outlined in the *Specifications* section of *Getting Started with the NI 17xx Smart Camera*. Verify that the power supply can supply enough current for the NI 17xx model in use. Using a power supply that is not within these specifications might result in an unresponsive or unstable system and could damage the NI 17xx.



Caution The 24 V external lighting strobe is an unregulated output dependent on the range of the power supply provided to the smart camera. If the power provided to the smart camera is $\pm 20\%$, -15% with $\pm 5\%$ AC ripple, the output could be as high as 30 V. If the provided power exceeds the input voltage specifications of the third-party lighting controller, do *not* connect the 24 V lighting strobe output to the controller to prevent damage to the controller. Use a power supply with tolerances that meet the requirements of the controller, or use the 5 V external lighting strobe.

Maintenance

Do not touch the CCD sensor by hand or with other objects. The sensor can be damaged by electrostatic discharge (ESD), body oils, and particulate matter.

Use a lens mount cover whenever a lens is not mounted on the camera to protect the sensor from dust and dirt.

Avoid drastic temperature changes to prevent dew condensation.

When necessary, use the following procedure to clean the sensor at a workstation equipped with anti-ESD facilities. If dust sticks to the CCD, first attempt to blow it off from the side of the sensor using ionized air. If oils are present on the sensor, clean the sensor with a cotton bud and ethyl alcohol. Be careful not to scratch the glass. Use only one pass over the glass per cotton bud to minimize the risk of recontamination and scratching.



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:
 - **Self-Help Resources**—For answers and solutions, visit the award-winning National Instruments Web site for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on.
 - **Free Technical Support**—All registered users receive free Basic Service, which includes access to hundreds of Application Engineers worldwide in the NI Discussion Forums at ni.com/forums. National Instruments Application Engineers make sure every question receives an answer.

For information about other technical support options in your area, visit ni.com/services or contact your local office at ni.com/contact.

- **Training and Certification**—Visit ni.com/training for self-paced training, eLearning virtual classrooms, interactive CDs, and Certification program information. You also can register for instructor-led, hands-on courses at locations around the world.
- **System Integration**—If you have time constraints, limited in-house technical resources, or other project challenges, National Instruments Alliance Partner members can help. To learn more, call your local NI office or visit ni.com/alliance.
- **Declaration of Conformity (DoC)**—A DoC is our claim of compliance with the Council of the European Communities using the manufacturer's declaration of conformity. This system affords the user protection for electronic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting ni.com/certification.

If you searched ni.com and could not find the answers you need, contact your local office or NI corporate headquarters. Phone numbers for our worldwide offices are listed at the front of this manual. You also can visit the Worldwide Offices section of ni.com/niglobal to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

Glossary

Symbol	Prefix	Value
p	pico	10^{-12}
n	nano	10^{-9}
μ	micro	10^{-6}
m	milli	10^{-3}

B

binary image An image in which the pixels have only one of two intensity values. Objects in the image usually have a pixel intensity of 1 (or 255), and the background has a pixel intensity of 0.

C

CCD Charge Coupled Device. A chip that converts light into electronic signals.

D

DIP switch Dual Inline Package switch.

Direct Drive lighting controller A lighting controller integrated into some models of the National Instruments smart camera that can directly power current-controlled lights.

E

Ethernet cable, standard CAT-5, CAT-5e, or CAT-6 Ethernet cable used to connect a Real-Time target to a network port or between the development computer and the Real-Time target.

exposure time The amount of time that light is allowed to strike the imaging sensor to produce an image.

F

falling edge	The digital signal transition from the high state to the low state.
field of view	The area of inspection that the camera can acquire.
fps	Frames per second.

G

gain	The amount of increase in signal power, voltage, or current expressed as the ratio of output to input.
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I

IEC	International Electrotechnical Commission. A standard-setting body.
IEEE	Institute of Electrical and Electronics Engineers. A standard-setting body.
I/O	Input/output. The transfer of data to/from a computer system involving communications channels, operator interface devices, or data acquisition and control interfaces.

L

LED	Light-emitting diode.
-----	-----------------------

M

MAC	Media access control. The MAC address uniquely identifies each unit connected to a network.
MAX	Measurement & Automation Explorer. A controlled, centralized configuration environment that allows you to configure all of your NI devices.

N

NI-IMAQ Driver software for National Instruments frame grabbers and smart cameras.

P

PLC Programmable Logic Controller. An industrial computer used for factory automation, process control, and manufacturing systems.

pulse train A signal consisting of a series of continuous pulses.

Q

quadrature encoder An encoding technique for a rotating device where two tracks of information are placed on the device, with the signals on the tracks offset by 90 degrees from each other. The phase difference indicates the position and direction of rotation.

R

rising edge The digital signal transition from the low state to the high state.

RS-232 Standard electrical interface for serial data communications.

S

sensor resolution The number of columns and rows of CCD pixels in the camera sensor.

sensor size The size of a sensor's active area.

subnet A set of systems whose IP addresses are configured such that they can communicate directly with one another. Data will not flow through an intermediate router.

syntax Set of rules to which statements must conform in a particular programming language.

T

TCP Transmission Control Protocol. A set of standard protocols for communicating across a single network or interconnected set of networks. TCP is for high-reliability transmissions.

trigger Any event that causes or starts some form of data capture.

V

VDC Volts direct current.

VI Virtual Instrument. A combination of hardware and/or software elements, typically used with a PC, that has the functionality of a classic stand-alone instrument.

W

working distance The distance from the front of the camera lens to the object under inspection.

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