Getting Started with the NI 17xx Smart Camera

The National Instruments 17xx Smart Camera combines an image sensor and a high-performance processor to return either inspection results or images. While a typical industrial camera acquires and transmits images through a standard camera bus for processing on another device, the smart camera performs both acquisition and processing operations directly on the smart camera.

This document describes how to set up and configure the smart camera hardware, configure the IP address, install software, and acquire an initial image.

Refer to the *NI 17xx Smart Camera User Manual* for information about specific features and specifications of the smart camera. Select **Start»All Programs»National Instruments»Vision» Documentation»NI-IMAQ** to access the *NI 17xx Smart Camera User Manual* after configuring the smart camera using the procedures described in this document.

Unpack and Verify Components

Remove the NI Smart Camera from the package and inspect the device for any sign of damage. Notify National Instruments if the device appears damaged in any way. Do *not* use a damaged device.

For safety and compliance information, refer to the specifications in the *NI 17xx Smart Camera User Manual*.

Required Components

This section describes the hardware and software components necessary to set up and use the NI Smart Camera.

Hardware

The following hardware components are included in the NI Smart Camera kit:

❏ NI 17xx Smart Camera

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❑ 5-position lighting connector (additional/replacement plugs for use with the lighting connector are available from NI, part number 780260-01)

In addition to the items included in the smart camera kit, the following components are necessary to set up and configure the smart camera:

❑ One or two CAT 5 10/100Base-TX or CAT 5e or CAT 6 1000Base-T Ethernet cables. One Ethernet cable is required to connect the smart camera directly to the development computer. Two Ethernet cables are required to connect the smart camera to the development computer through a network.

> **Note** A CAT 5e or CAT 6 1000Base-T Ethernet cable is required to achieve maximum 1,000 Mbps (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 the necessary electrical requirements. While CAT 5 cables may appear to work at 1,000 Mbps in some installations, CAT 5 cables are likely to cause increased bit errors resulting in degraded or unreliable network performance.

❑ One of the following power supply options:

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

– NI desktop power supply (part number 780237-01) and power supply cord. Refer to ni.com for the power supply cord part number specific to your region and ordering information.

– Any 24 VDC, +20%/–15% (IEC 1311) power supply and one of the following cable options for connecting to the power supply and I/O:

  • 15-pin D-SUB pigtail cable, 5 m (part number 197818-05)

  • 15-pin D-SUB to 15-pin D-SUB cable, 2 m (part number 197817-02) or 5 m (part number 197817-05), and a 15-pin D-SUB terminal block

❑ Standard C-mount lens. Other lenses available from NI are listed in the *Optional Components* section.

❑ Development computer running Windows Vista/XP/2000

Software

Use one of the following application development environments to develop NI Smart Camera applications. Refer to Table 1 for the Vision Builder for Automated Inspection (Vision Builder AI) information or to Table 2 for LabVIEW and LabVIEW module information.

Table 1. NI Vision Builder AI Minimum Versions

NI Smart Camera	NI Vision Builder AI Version (Included)
NI 1722	3.5 or later
NI 1742	
NI 1744	3.6 or later
NI 1762	
NI 1764	

Table 2. LabVIEW and Necessary Modules Minimum Versions

Smart Camera	LabVIEW	LabVIEW Real-Time	Vision Development Module	Vision Acquisition Software
NI 1722	8.5 or later	8.5 or later	8.5 or later	8.6 or later
NI 1742				
NI 1744	8.5.1 or later	8.5.1 or later	8.6 or later	8.6 or later
NI 1762				
NI 1764				

Optional Components

National Instruments offers a variety of accessories for use with the NI Smart Camera, including the following items:

- Lenses
    - 8 mm (part number 780024-01)
    - 12 mm (part number 780025-01)

- 16 mm (part number 780026-01)
    - 25 mm (part number 780027-01)
- Current controlled lights
    - Back light (part number 780221-01)
    - Ring light (part number 780222-01)
    - Broad area linear light array (part number 780223-01)
    - Spot light (part number 780224-01)
- Mounting brackets
    - Tripod adapter plate (part number 780239-01)
    - Panel mount (part number 780240-01)
- Accessories
    - NI 17xx unshielded screw terminal breakout with 2 m cable (part number 780261-01)
    - NI Smart Camera I/O accessory (part number 780443-01)

Visit ni.com or contact the branch office nearest you for more information about these and other products.

Connect the Lens and Lighting

Complete the following steps to connect a standard C-mount lens and external lighting accessories to the NI Smart Camera.

1. Remove the lens cover from the smart camera.
2. Gently align the threads on the base of the lens with the threads on the sensor opening, and twist clockwise until the lens is securely attached.

Lighting

The NI Smart Camera offers two options for controlling a light—a Direct Drive internal lighting controller, or 5 V TTL or 24 V external strobe generation for use with a third-party lighting controller. Refer to the *NI 17xx Smart Camera User Manual* for information about using the smart camera with a light.

> **Note** The Direct Drive lighting controller is not available on NI 1722 smart cameras. NI 1722 smart cameras support only 5 V TTL or 24 V external strobe generation.

Connect the Power Supply and I/O

To connect a power supply to the NI Smart Camera, complete the steps listed in one of the following sections. Refer to the *Power Only* section to connect the NI desktop power supply directly to the smart camera with no additional I/O. Refer to the *Power with Additional I/O* section to connect a third-party power supply or if your application requires I/O, such as a trigger signal.

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

Power Only

Refer to Figure 1 while completing the following steps to connect the NI desktop power supply to the NI Smart Camera with no additional I/O.
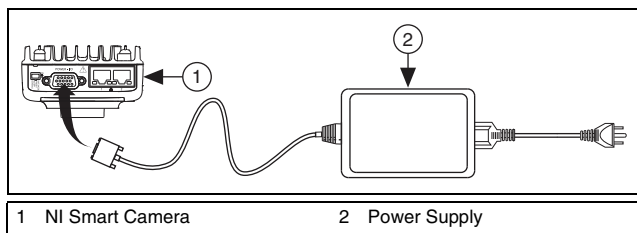

| 1 | NI Smart Camera | 2 | Power Supply |

Figure 1. Connecting the NI Smart Camera to the NI Desktop Power Supply

1. Connect and secure the 15-pin D-SUB connector on the NI desktop power supply to the POWER-I/O connector on the smart camera.

2. Plug the power supply power cord into the power supply.

3. Plug the power supply into an outlet.

When power is first applied to the smart camera, the POWER LED flashes red for one second while internal systems power up. The POWER LED then lights green when power is correctly wired to the smart camera.

Power with Additional I/O

National Instruments provides the following two cable options for connecting a third-party power supply and I/O to the NI Smart Camera.

- Terminal block with a 15-pin D-SUB connector, such as the NI Smart Camera I/O Accessory, and a 15-pin D-SUB to 15-pin D-SUB cable
- 15-pin D-SUB pigtail cable

Refer to Figure 2 while completing the following steps to connect a third-party power supply and I/O to the smart camera using either a terminal block or the pigtail cable.
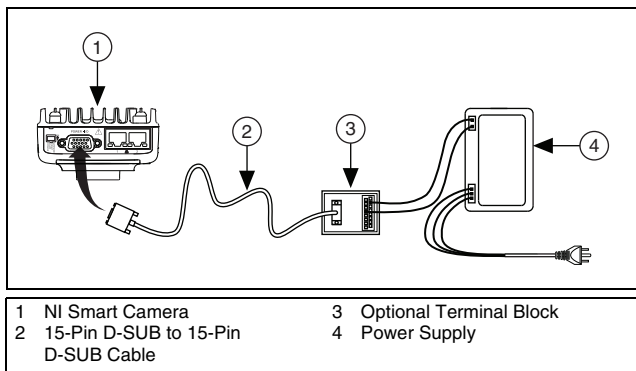

| 1 | NI Smart Camera | 3 | Optional Terminal Block |
| 2 | 15-Pin D-SUB to 15-Pin D-SUB Cable | 4 | Power Supply |

Figure 2. Connecting the NI Smart Camera to a Third-Party Power Supply

1. Connect and secure the 15-pin D-SUB connector on your cable to the POWER-I/O connector on the smart camera.

2. If you are using a terminal block, connect the cable to the terminal block.

3. Connect the +24 V signal from the cable or terminal block to the corresponding signal on the power supply.

   Table 3 shows the pin locations for the POWER-I/O connector and lists the signal names and pin numbers. The table also lists wire colors for the National Instruments 15-pin D-SUB pigtail cable. Cables from another vendor may have different wire colors.

Table 3. NI Smart Camera POWER-I/O Connector Signal Descriptions

Connector Diagram	Signal Name	Pin Number	Wire Color
	+24 V	5	Red
	COM	15	Black
	RS_232TXD	10	Pink
	RS_232RXD	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

Connector diagram labels:
11 15 (COM)
6 —10
1 5 (+24 V)

4. Connect the COM signal from the cable or terminal block to the corresponding signal on the power supply.

5. Connect any additional I/O signals necessary for your application to the appropriate signal on the cable or terminal block. Refer to Table 3 for pin information.

6. If necessary, connect the power cord to the power supply.

7. Plug the power supply into an outlet.

When power is first applied to the smart camera, the POWER LED flashes red for one second while internal systems power up. The POWER LED then lights green when power is correctly wired to the smart camera.

Connect to the Development Computer

The NI Smart Camera can connect to the development computer directly or through a network using an Ethernet cable. The smart camera provides automatic MDI/MDI-X correction, so you can use either a standard Ethernet cable or a crossover Ethernet cable to connect to the development computer. If the development computer is configured on a network, you must configure the smart camera on the same network subnet as the development computer to connect through the network.

> ⚠ **Caution** To prevent data loss and to maintain the integrity of your Ethernet installation, do not use a cable longer than 100 m. National Instruments recommends using a shielded twisted pair Ethernet cable for maximum signal integrity.

Firewall Configuration

If your firewall is controlled remotely or you are unsure about configuring the firewall, contact your network administrator. Refer to Appendix B, *Troubleshooting*, of the *NI 17xx Smart Camera User Manual* to troubleshoot network configuration issues.

Direct Connection

To connect the NI Smart Camera directly to the development computer, refer to Figure 3 and complete the following steps.
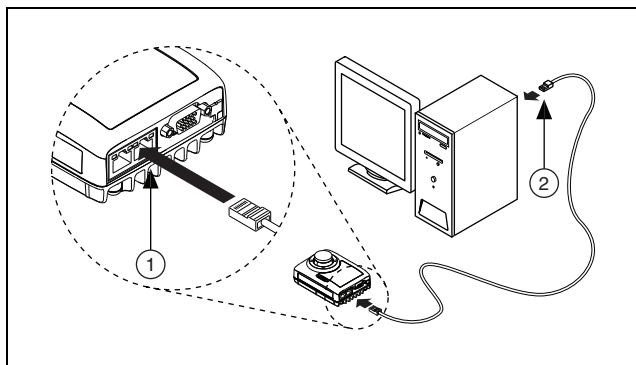
1 Connecting an Ethernet Cable to Port 1 on the NI Smart Camera
2 Connecting an Ethernet Cable to an Ethernet Port on the
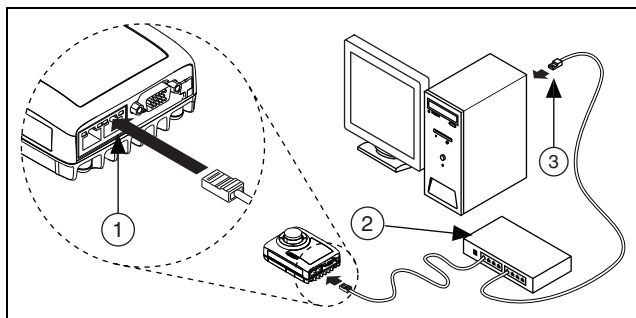 Development Computer

Figure 3. Connecting the NI Smart Camera Directly to the Development Computer

1. Use an Ethernet cable to connect from the Ethernet port on the development computer to Ethernet port 1 on the smart camera.

2. Configure the network card on the development computer to use a static IP address. Refer to your Windows networking documentation for information about configuring a static IP address.

The smart camera is now connected directly to the development computer.

Network Connection

To connect the NI Smart Camera to the development computer through a network, refer to Figure 4 and complete the following steps.

1 Connecting an Ethernet Cable to Port 1 on the NI Smart Camera
2 Ethernet Hub or Other Network Port
3 Connecting an Ethernet Cable to an Ethernet Port on the Development Computer

Figure 4. Connecting the NI Smart Camera to the Development Computer Through a Network

1. Verify that the development computer is connected to the network and powered on.

2. Using an Ethernet cable, connect from an Ethernet hub or other network port to Ethernet port 1 on the smart camera.

The smart camera is now connected to the development computer through a network.
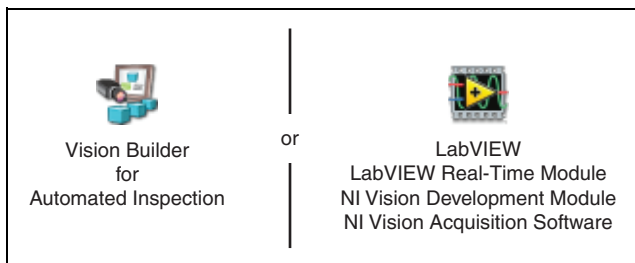
Subnet Considerations

To configure the NI Smart Camera, it must reside on the same subnet as the development computer. Once the smart camera is configured, as described in the *Configuring the NI Smart Camera with Vision Builder AI* section and the *Configuring the NI Smart Camera with LabVIEW* section, other subnets can be used to access it.

To use the smart camera on a subnet other than the one on which the development computer resides, first connect and configure the smart camera on the same subnet as the development computer. Next, physically move the smart camera to the other subnet. Contact your network administrator for assistance in determining which network ports reside on the same subnet.

Software Options

National Instruments provides two options for developing applications for the NI Smart Camera.

Vision Builder
for
Automated Inspection

or

LabVIEW
LabVIEW Real-Time Module
NI Vision Development Module
NI Vision Acquisition Software

- **NI Vision Builder for Automated Inspection** (Vision Builder AI)—Interactive, menu-driven configuration software for developing, benchmarking, and deploying machine vision applications. The latest version of Vision Builder AI is included with the smart camera.

  To use Vision Builder AI to configure the smart camera and develop your application, complete the instructions in the *Configuring the NI Smart Camera with Vision Builder AI* section of this document.

- **NI LabVIEW**—Graphical programming environment for developing flexible and scalable applications. The following add-on modules are required for developing machine vision applications:

  – **LabVIEW Real-Time Module**—Programming library for developing distributed, deterministic applications.

  – **NI Vision Development Module**—Programming library for developing machine vision and scientific imaging applications.

  – **NI Vision Acquisition Software**—Includes NI-IMAQ driver software for acquiring images and controlling I/O using the smart camera. The latest version of NI Vision Acquisition software is included with the smart camera.

  To use LabVIEW to configure the smart camera and develop your application, complete the instructions in the *Configuring the NI Smart Camera with LabVIEW* section of this document.

> **Note** The installation and configuration process for each development environment is different. Complete *only* the instructions for your chosen development environment.

Configuring the NI Smart Camera with Vision Builder AI

Complete the following steps to install Vision Builder AI and configure the NI Smart Camera.

1. Install and activate Vision Builder AI on the development computer. Refer to the *NI Vision Builder for Automated Inspection Readme* for installation instructions.

2. Launch Vision Builder AI.

3. On the Vision Builder AI welcome screen, select the NI Smart Camera in the list of targets.

   If the NI Smart Camera does not appear in the list of targets, refer to the *Subnet Considerations* section of this document and Appendix B, *Troubleshooting*, of the *NI 17xx Smart Camera User Manual* for information about subnets and troubleshooting smart camera configuration issues.

4. Click **Install Software**. The Remote Target Configuration Wizard launches in a new window.

5. In the **Name** field, enter a name for the device. Use the **Description** field to enter any additional information or a brief description of the device.

   Device names are limited to 31 characters with no spaces or special characters, except hyphens. The first and last characters must be alphanumeric.

6. Click **Next**.

Configure the IP Address

1. If the network is configured to issue IP addresses using DHCP, select **Obtain IP address from DHCP server**. Otherwise, configure the IP address manually by selecting **Edit the IP settings** and clicking **Suggest Values**.

2. If you want to prevent other users from configuring the smart camera, select **Enable Password** and click **Set Password** to set up password protection.

3. Click **Next**.

Install Software on the NI Smart Camera

Complete the following steps to install software from the development computer to the NI Smart Camera.

1. In the Remote Target Configuration Wizard, enable the **Update Target Software** checkbox.

2. Click the **Browse** button next to the **Software Image to Install on the Target** control.

3. Navigate to the Vision Builder AI software image you want to use, and click **OK**. Software images provided by National Instruments are installed to the `<Vision Builder AI>\ RT Images` directory, where `<Vision Builder AI>` is the location where Vision Builder AI is installed.

4. Click **OK** to apply the IP configuration settings and download software to the smart camera.

5. Click **OK** to close the Remote Target Configuration Successful dialog box.

Acquire an Image

Complete the following steps to acquire an image using Vision Builder AI.

1. On the Vision Builder AI welcome screen, select the NI Smart Camera in the list of targets.

2. Click **Acquire Image (Smart Camera) Example** to open the image acquisition example in the Vision Builder AI Configuration Interface.

3. Click the **Run State Once** button to acquire a single image.

4. In the State Configuration Window, select the **Acquire Image (Smart Camera)** step.

5. Click the **Edit Step** button. The property page for the step opens.

6. Use the controls on the **Main**, **Trigger**, **Lighting**, and **Advanced** tabs to configure any additional settings necessary for your application.

7. Click **OK** to save the step configuration.

The smart camera is now configured and acquiring images. Use Vision Builder AI to add and configure additional inspection steps to create your application. Refer to the *Where to Go from Here* section for a list of documentation and other resources to help you set up and use the smart camera in an application.

Configuring the NI Smart Camera with LabVIEW

Complete the following steps to install LabVIEW, the LabVIEW Real-Time Module, the NI Vision Development Module, and NI Vision Acquisition Software and configure the NI Smart Camera. Install the software in the following order:

1. **LabVIEW**—Refer to the *LabVIEW Release Notes* for installation instructions for LabVIEW and system requirements for the LabVIEW software. Refer to the *LabVIEW Upgrade Notes* for additional information about upgrading to the most recent version of LabVIEW.

   Documentation for LabVIEW is available by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals**.

2. **LabVIEW Real-Time Module**—Refer to the *LabVIEW Real-Time Module Release and Upgrade Notes* for installation instructions and information about getting started with the LabVIEW Real-Time Module.

   Documentation for the LabVIEW Real-Time Module is available by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals**.

3. **NI-IMAQ**—Refer to the *NI Vision Acquisition Software Release Notes* on the NI Vision Acquisition Software installation media for system requirements and installation instructions for the NI-IMAQ driver.

   Documentation for the NI-IMAQ driver software is available by selecting **Start»All Programs»National Instruments»Vision»Documentation»NI-IMAQ**.

4. **NI Vision Development Module**—Refer to the *NI Vision Development Module Readme* on the NI Vision Development Module installation media for system requirements and installation instructions.

   Documentation for the NI Vision Development Module is available by selecting **Start»All Programs»National Instruments»Vision»Documentation»NI Vision**.

Configure the IP Address

You can assign the NI Smart Camera a static IP address or configure it to automatically acquire an IP address from a DHCP server. Complete the following steps to configure an IP address for the NI Smart Camera.

1. Launch Measurement & Automation Explorer (MAX), the National Instruments configuration utility, by double-clicking the Measurement & Automation icon on the desktop, or selecting **Start»All Programs»National Instruments» Measurement & Automation**.

2. Expand the **Remote Systems** branch of the configuration tree, and select the device you want to configure. To uniquely identify multiple unconfigured devices, connect and configure one device at a time.

    Refer to the *Subnet Considerations* section of this document and Appendix B, *Troubleshooting*, of the *NI 17xx Smart Camera User Manual* for information about subnets and troubleshooting smart camera configuration issues.

3. In the **Name** field, enter a name for the device. Use the **Comment** field to enter any additional information or a brief description of the device.

4. Device names are limited to 31 characters with no spaces or special characters, except hyphens. The first and last characters must be alphanumeric.

5. Verify the IP address configuration. The IP address is either a network address, an automatic private IP address ($169.254.x.x$), or $0.0.0.0$, depending on how the network is configured to issue network addresses.

    • If the network is configured to issue IP addresses using DHCP, select **Obtain IP address from DHCP server**.

    • Otherwise, configure the IP address manually. Select **Edit the IP settings**, click **Suggest Values**, and click **OK**.

    Note If the smart camera IP address is $169.254.x.x$ or $0.0.0.0$, the smart camera is only accessible from the local subnet. To access the smart camera from a remote subnet, configure the smart camera to obtain an IP address from a DHCP server or manually assign a static IP address.

6. If you want to prevent other users from resetting the smart camera, click the **Lock** button on the MAX toolbar to set up password protection for the smart camera. To require users to enter the password before restarting the smart camera, enable the **Password-protect Resets** checkbox.

7. Click **Apply** on the MAX toolbar.

8. When prompted, click **Yes** to restart the smart camera. The initialization process may take several minutes.

Install Software on the NI Smart Camera

Complete the following steps to install software from the development computer to the NI Smart Camera.

1. In the Remote Systems branch of the MAX configuration tree, expand the folder for your device and select **Software**.

2. Click **Add/Remove Software** on the MAX toolbar to launch the LabVIEW Real-Time Software Wizard.

3. Select **LabVIEW Real-Time**, **NI Vision RT**, **NI-IMAQ RT**, **NI-IMAQ Server**, and any additional software necessary for your application, as shown in Figure 6.
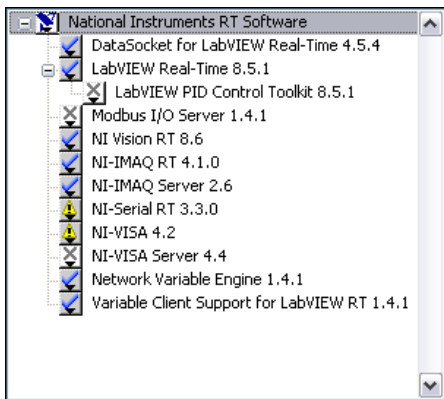

Figure 5. Selecting Software to Install in MAX

4. Click **Next**.

5. Verify your software installation choices, and click **Next**.

6. When the installation is complete, click **Finish**.

Acquire an Image

Complete the following steps to acquire an image using MAX.

1. In the Remote Systems branch of the MAX configuration tree, expand the folder for your device.

2. Click **img0:NI *17xx***, where *17xx* is replaced by the actual model number of your smart camera.

3. Click **Snap** to acquire a single image, or click **Grab** to acquire continuous images. Click **Grab** again to stop a continuous acquisition.

4. Use the controls on the **Sensor**, **Triggering**, **Lighting**, and **LUT** tabs to adjust the acquisition settings.

The NI Smart Camera is now configured and acquiring images. Use LabVIEW to create your application. Refer to the *Where to Go from Here* section for a list of documentation and other resources to help you set up and use the smart camera in an application.

Where to Go from Here

The following documents and resources contain information you may find helpful as you set up and use the NI Smart Camera in an application.

Refer to the *NI 17xx Smart Camera User Manual* for detailed information about:

- Power and I/O requirements
- The image sensor and scan modes
- Exposure time and field of view
- The Direct Drive Lighting Controller and external lighting controllers
- Acquiring images with the smart camera and calculating the maximum frame rate
- Understanding the LED indicators and configuring the DIP switches
- Ethernet connections
- Smart camera specifications
- Troubleshooting network, firewall, software, and power issues

Additional Resources for Vision Builder for Automated Inspection Users

Refer to the *NI Vision Builder for Automated Inspection Tutorial* to learn how to perform basic machine vision techniques using Vision Builder AI. You can access the *NI Vision Builder for Automated Inspection Tutorial* and other documentation by selecting **Start»All Programs»National Instruments»Vision Builder AI»Documentation**. You can also access context help within Vision Builder AI by clicking the **Show Context Help** button on the Vision Builder AI toolbar.

Examples of common Vision Builder AI inspections are installed to the <Vision Builder AI>\Examples directory.

Visit the NI Developer Zone at ni.com/zone for the latest example programs, tutorials, technical presentations, and a community area where you can share ideas, questions, and source code with developers around the world.

Additional Resources for LabVIEW Users

Documentation for LabVIEW and the LabVIEW Real-Time Module is available from the **Help** menu on the LabVIEW toolbar. You can access documentation for the NI Vision Development Module by selecting **Start»All Programs»National Instruments»Vision»Documentation»NI Vision**.

Documentation for the NI-IMAQ driver software is available by selecting **Start»All Programs»National Instruments»Vision»Documentation»NI-IMAQ**.

Documentation for the MAX configuration software is available from the **Help** menu on the MAX toolbar. Specific information about using MAX with NI Vision hardware is available by selecting **Help»Help Topics»NI Vision»NI-IMAQ**.

Examples of image acquisitions and common machine vision inspections are installed to the <LabVIEW>\Examples\IMAQ and <LabVIEW>\Examples\Vision directories, where <LabVIEW> is the location where LabVIEW is installed.

Visit the NI Developer Zone at ni.com/zone for the latest example programs, tutorials, technical presentations, and a community area where you can share ideas, questions, and source code with developers around the world.

Safety Information

⚠ **Caution** The following paragraphs contain important safety information you *must* follow when installing and operating the NI smart camera.

Do *not* operate the device in a manner not specified in the documentation. Misuse of the device may result in a hazard and may compromise the safety protection built into the device. If the device is damaged, turn it off and do *not* use it until service-trained personnel can check its safety. If necessary, return the device to National Instruments for repair.

Keep away from live circuits. Do *not* remove equipment covers or shields unless you are trained to do so. If signal wires are connected to the device, hazardous voltages can exist even when the equipment is turned off. To avoid a shock hazard, do *not* perform procedures involving cover or shield removal unless you are qualified to do so. Disconnect all field power prior to removing covers or shields.

If the device is rated for use with hazardous voltages (>30 V_{rms}, 42.4 V_{pk}, or 60 V_{dc}), it may require a safety earth-ground connection wire. Refer to the device specifications for maximum voltage ratings.

Because of the danger of introducing additional hazards, do *not* install unauthorized parts or modify the device. Use the device only with the chassis, modules, accessories, and cables specified in the installation instructions. All covers and filler panels *must* be installed while operating the device.

Do *not* operate the device in an explosive atmosphere or where flammable gases or fumes may be present. Operate the device only at or below the pollution degree stated in the specifications. Pollution consists of any foreign matter—solid, liquid, or gas—that may reduce dielectric strength or surface resistivity. The following is a description of pollution degrees.

• Pollution Degree 1—No pollution or only dry, nonconductive pollution occurs. The pollution has no effect.

• Pollution Degree 2—Normally only nonconductive pollution occurs. Occasionally, nonconductive pollution becomes conductive because of condensation.

- Pollution Degree 3—Conductive pollution or dry, nonconductive pollution occurs. Nonconductive pollution becomes conductive because of condensation.

Clean the device and accessories by brushing off light dust with a soft, nonmetallic brush. Remove other contaminants with a stiff, nonmetallic brush. The unit *must* be completely dry and free from contaminants before returning it to service.

You *must* insulate signal connections for the maximum voltage for which the device is rated. Do *not* exceed the maximum ratings for the device. Remove power from signal lines before connection to or disconnection from the device.

⚠ **Caution** National Instruments measurement products may be classified as either Measurement Category I or II. Operate products at or below the Measurement Category level specified in the hardware specifications.

Measurement Category[1]: Measurement circuits are subjected to working voltages[2] and transient stresses (overvoltage) from the circuit to which they are connected during measurement or test. Measurement (Installation[3]) Category establishes standardized impulse withstand voltage levels that commonly occur in electrical distribution systems. The following is a description of Measurement Categories:

- Measurement Category I is for measurements performed on circuits *not* directly connected to the electrical distribution system referred to as MAINS[4] voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

- Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such

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[1] Measurement Categories as defined in electrical safety standard IEC 61010-1.

[2] Working voltage is the highest rms value of an AC or DC voltage that can occur across any particular insulation.

[3] Measurement Category is also referred to as Installation Category.

[4] MAINS is defined as the (hazardous live) electrical supply system to which equipment is designed to be connected for the purpose of powering the equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

as that provided by a standard wall outlet (e.g., 115 V for U.S. or 230 V for Europe). Examples of Measurement Category II are measurements performed on household appliances, portable tools, and similar products.

- Measurement Category III is for measurements performed in the building installation at the distribution level. This category refers to measurements on hard-wired equipment such as equipment in fixed installations, distribution boards, and circuit breakers. Other examples are wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and stationary motors with permanent connections to fixed installations.

- Measurement Category IV is for measurements performed at the primary electrical supply installation (<1,000 V). Examples include electricity meters and measurements on primary overcurrent protection devices and on ripple control units.

Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At ni.com/support you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at ni.com/support and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 1800 300 800, Austria 43 662 457990-0,
Belgium 32 (0) 2 757 0020, Brazil 55 11 3262 3599,
Canada 800 433 3488, China 86 21 5050 9800,
Czech Republic 420 224 235 774, Denmark 45 45 76 26 00,
Finland 358 (0) 9 725 72511, France 01 57 66 24 24,
Germany 49 89 7413130, India 91 80 41190000,
Israel 972 3 6393737, Italy 39 02 41309277, Japan 0120-527196,
Korea 82 02 3451 3400, Lebanon 961 (0) 1 33 28 28,
Malaysia 1800 887710, Mexico 01 800 010 0793,

Netherlands 31 (0) 348 433 466, New Zealand 0800 553 322,
Norway 47 (0) 66 90 76 60, Poland 48 22 328 90 10,
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