

### NI Vision Builder for Automated Inspection: Configuration Help

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This help file contains information about how to configure and test a vision inspection system using National Instruments Vision Builder for Automated Inspection (Vision Builder AI). Included are topics to familiarize yourself with the Vision Builder AI Configuration Interface, explanations of when to use and how to use each step, configuration panel control descriptions, and frequently asked questions.

For more information about this help file, refer to the following topics:

Using Help

**Related Documentation** 

<u>Glossary</u>

**Important Information** 

Technical Support and Professional Services

To comment on National Instruments documentation, refer to the <u>National</u> <u>Instruments Web site</u>.

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# **Activating Your Software**

#### How do I activate my software?

Use the NI Activation Wizard to obtain an activation code for your software. You can launch the NI Activation Wizard two ways:

- Launch the product and choose to activate your software from the list of options presented.
- Launch NI License Manager by selecting **Start»All Programs»National Instruments»NI License Manager**. Click the **Activate** button in the toolbar.
- Note You do not need to activate your software if it is managed by NI Volume License Manager as a part of a Volume License Agreement.

### What is activation?

Activation is the process of obtaining an activation code to enable your software to run on your computer. An *activation code* is an alphanumeric string that verifies the software, version, and computer ID to enable features on your computer. Activation codes are unique and are valid on only one computer.

### What is the NI Activation Wizard?

The NI Activation Wizard is a part of NI License Manager that steps you through the process of enabling software to run on your machine.

### What information do I need to activate?

You need your product serial number, user name, and organization. The NI Activation Wizard determines the rest of the information. Certain activation methods may require additional information for delivery. This information is used only to activate your product. Complete disclosure of National Instruments licensing privacy policy is available at ni.com/activate/privacy. If you optionally choose to register your software, your information is protected under the National Instruments privacy policy, available at ni.com/privacy.

### How do I find my product serial number?

You can find your serial number on the proof-of-ownership and registration card that you received with your product, as shown in the

following example.



If your software kit does not include a Certificate of Ownership, you can find your serial number on the product packing slip or on the shipping label.

### What is a Computer ID?

The computer ID contains unique information about your computer. National Instruments requires this information to enable your software. You can find your computer ID through the NI Activation Wizard or by using NI License Manager, as follows:

- 1. Launch NI License Manager by selecting **Start»All Programs»National Instruments»NI License Manager**.
- 2. Click the **Display Computer Information** button in the toolbar.

For more information about product activation and licensing refer to ni.com/activate.

## **Related Documentation**

Most Vision Builder for AI manuals also are available as PDFs. You must have Adobe Reader with Search and Accessibility 5.0.5 or later installed to view the PDFs. Refer to the <u>Adobe Systems Incorporated Web site</u> at www.adobe.com to download Adobe Reader. Refer to the <u>National</u> <u>Instruments Product Manuals Library</u> at ni.com/manuals for updated documentation resources.

The following documents contain information that you may find helpful as you use this help file:

- <u>Vision Builder for Automated Inspection Tutorial</u>—This manual 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: Inspection Help* This help file contains information about running applications created with Vision Builder for Automated Inspection (Vision Builder AI) in the Vision Builder AI Interface.
- *NI Vision Concepts Manual*—This 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.

## **Using Help**

<u>Conventions</u> <u>Navigating Help</u> <u>Searching Help</u> <u>Printing Help File Topics</u>

# Conventions

This help file uses the following conventions:

- [] Square brackets enclose optional items—for example, [response].
- The » symbol leads you through nested menu items and dialog box options to a final action. The sequence File»Page Setup»Options directs you to pull down the File menu, select the Page Setup item, and select Options from the last dialog box.
- This icon denotes a 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.

- **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.
- dark red Text in this color denotes a caution.
- green Underlined text in this color denotes a link to a help topic, help file, or Web address.
- *italic* Italic text denotes variables, emphasis, cross-references, 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.

*monospace* Italic text in this font denotes text that is a placeholder for a *italic* word or value that you must supply.

# **Navigating Help (Windows Only)**

To navigate this help file, use the **Contents**, **Index**, and **Search** tabs to the left of this window or use the following toolbar buttons located above the tabs:

- **Hide**—Hides the navigation pane from view.
- Locate—Locates the currently displayed topic in the Contents tab, allowing you to view related topics.
- **Back**—Displays the previously viewed topic.
- Forward—Displays the topic you viewed before clicking the **Back** button.
- **Options**—Displays a list of commands and viewing options for the help file.

# **Searching Help (Windows Only)**

Use the **Search** tab to the left of this window to locate content in this help file. If you want to search for words in a certain order, such as "related documentation," add quotation marks around the search words as shown in the example. Searching for terms on the **Search** tab allows you to quickly locate specific information and information in topics that are not included on the **Contents** tab.

### Wildcards

You also can search using asterisk (\*) or question mark (?) wildcards. Use the asterisk wildcard to return topics that contain a certain string. For example, a search for "prog\*" lists topics that contain the words "program," "programmatically," "progress," and so on.

Use the question mark wildcard as a substitute for a single character in a search term. For example, "?ext" lists topics that contain the words "next," "text," and so on.



**Note** Wildcard searching will not work on Simplified Chinese, Traditional Chinese, Japanese, and Korean systems.

### **Nested Expressions**

Use nested expressions to combine searches to further refine a search. You can use Boolean expressions and wildcards in a nested expression. For example, "example AND (program OR VI)" lists topics that contain "example program" or "example VI." You cannot nest expressions more than five levels.

### **Boolean Expressions**

Click the **•** button to add Boolean expressions to a search. The following Boolean operators are available:

- **AND** (default)—Returns topics that contain both search terms. You do not need to specify this operator unless you are using nested expressions.
- **OR**—Returns topics that contain either the first or second term.
- **NOT**—Returns topics that contain the first term without the second term.
- **NEAR**—Returns topics that contain both terms within eight words of each other.

### **Search Options**

Use the following checkboxes on the **Search** tab to customize a search:

- **Search previous results**—Narrows the results from a search that returned too many topics. You must remove the checkmark from this checkbox to search all topics.
- Match similar words—Broadens a search to return topics that contain words similar to the search terms. For example, a search for "program" lists topics that include the words "programs," "programming," and so on.
- Search titles only—Searches only in the titles of topics.

# **Printing Help File Topics (Windows Only)**

Complete the following steps to print an entire book from the **Contents** tab:

- 1. Right-click the book.
- 2. Select **Print** from the shortcut menu to display the **Print Topics** dialog box.
- 3. Select the **Print the selected heading and all subtopics** option.
  - Note Select Print the selected topic if you want to print the single topic you have selected in the **Contents** tab.
- 4. Click the **OK** button.

### **Printing PDF Documents**

This help file may contain links to PDF documents. To print PDF documents, click the print button located on the Adobe Acrobat Viewer toolbar.

### Getting Help in the Vision Builder AI Configuration Interface

In addition to this help file, you can access help for the Vision Builder AI Configuration Interface in the Context Help window. Click the Context Help button on the Vision Builder AI toolbar to launch the

Context Help window. The content of the Context Help window automatically updates to reflect what is currently selected in Vision Builder AI. When you click one of the eight tabs in the **Inspection Steps** palette, the context help displays information about when to use each step in the selected tab. When you select a step, the property page for that step appears and the context help displays information about how to use the step, descriptions of the controls on the property page, and frequently asked questions.

## **Configuration Interface**

Use the Configuration Interface to configure and debug an inspection.



- Main window—Displays the image being processed, property pages for some inspection steps, or the state diagram for the inspection. Use the Main window to define regions of interest in an image, configure step parameters for some steps, and create/modify the state diagram for an inspection.
- **Overview window**—Displays a thumbnail view of either the current inspection image, or the state diagram for the inspection.
- **Inspection Steps palette**—Lists and describes the steps that you use to create your inspection. When you click on a step, this palette transforms into the property page for the step.
- **State Configuration window**—Displays the list of steps that comprise the currently selected state in the inspection.

# Switching Between the Configuration and Inspection Interfaces

If you are in the Configuration Interface and want to switch to the Inspection Interface, select **File**»**Switch to Inspection Interface**. If you have not already saved your current inspection, Vision Builder AI prompts you to save your current inspection before switching to the Inspection Interface.

## **Creating a New Inspection**

To create a new inspection, select **File**»**New** or click the **New** button on the toolbar. Vision Builder AI prompts you to save the current inspection—if you have not already saved it—before creating a new inspection.

## **Opening an Inspection**

Complete the following steps to open an existing inspection in the Configuration Interface:

- 1. Select **File**»**Open** or click the **Open** button on the toolbar.
- 2. Navigate to the location of the inspection you want to open and select the inspection.
- 3. Click **OK** to open the selected inspection.

# **Saving an Inspection**

Select **File**»**Save** or click the **Save** button on the toolbar to save changes to an existing inspection.

to save an inspection for the first time or to make a copy of an existing inspection, complete the following steps:

- 1. Select File»Save As.
- 2. Navigate to the location where you want to save the file and enter a **File name** for the inspection file.
- 3. Click **Save** to save the inspection.

# **Printing an Inspection**

Follow these instructions to print the inspection state diagram and/or details about the states and transitions in the inspection:

- 1. Select **File**»**Print Inspection** to launch the **Print Inspection** dialog box.
- 2. Enable the **Print Inspection State Diagram** control to print the state diagram from the inspection.
- 3. Enable the **Print State and Transition Details** to print details about the states and transitions in the inspection. The Inspection details contain information about the steps in each state and transition conditions.
- 4. Click **OK** to print the inspection.

## **Inspection Properties**

Every inspection has properties including the inspection name, creation date, last modification date, and a description of the inspection. To access the Inspection Properties dialog box, select **File»InspectionProperties**.

Use the Inspection Properties dialog box to enter or modify a description of the inspection.

# **Running an Inspection**

Use the **Operate** menu options or the buttons on the Vision Builder AI toolbar to run an inspection from the Configuration Interface. The following options are available:

lcon	Run Mode	Description
⇒1	Run Inspection Once	Runs the inspection through one iteration of the state diagram.
2	Run Inspection in Loop	Runs the inspection continuously.
**	Run Inspection Until Failure	Runs the inspection until the Inspection Status variable has a value of FAIL.
	Run Inspection Multiple Times	Runs the inspection a specified number of times. This option is available only from the <b>Operate</b> menu.
	Stop Inspection	Stops the inspection.
() Co	Highlight Execution	Highlights the inspection execution when you run an inspection. If the <b>Highlight Execution</b> button appears yellow, execution highlighting is enabled.
II	Pause	Pauses or resumes execution of the inspection. If the <b>Pause</b> button appears red, execution is paused.
4a	Single Step	Step through the inspection. <b>Single Step</b> is only available when the <b>Pause</b> button is pressed.

### **Selecting the Next Inspection Image**

Use the Select Next Inspection Image buttons on the Configuration Interface toolbar to specify which image to process during the next iteration of an inspection. The Select Next Inspection Image buttons apply only to inspections that either contain a **Simulate Acquisition** step, or have **Smart Camera Emulator** or **Compact Vision System Emulator** selected as the **Execution Target**. The following options are available:

lcon	Next Inspection Image	Description
	Use Previous Image	Uses the previous inspection image the next time the inspection executes.
	Use Current Image	Uses the current inspection image the next time the inspection executes.
	Use Next Image	Uses the next inspection image the next time the inspection executes.
<b>™</b>	Select Next Image	Specifies the inspection image to process the next time the inspection executes.

### **Running a Single Inspection State**

You can run only the steps in the currently selected state of an inspection by clicking the buttons on the <u>State Configuration window</u> toolbar. The following options are available:

lcon	Run State Mode	Description
<b>∲</b> 1	Run State Once	Runs the currently selected state once.
¢. R	Run State in Loop	Run the currently selected state in a continuous loop.
	Stop	Stops the execution of a state running in a loop.
Ŧ	Step Backward	Executes the previous step in the currently selected state using the current image.
1	Step Forward	Executes the next step in the currently selected state using the current image.

## **Benchmarking Inspection Performance**

You can use the Benchmark Inspection tool to estimate how many milliseconds the image analysis steps of your inspection take to complete on the active image. The speed of some steps may vary depending on the image you process.



Note The Benchmark Inspection tool does not account for such processes as user input, wait, and image display. These processes may be time intensive and/or dependant on external conditions. Therefore, these processes may significantly reduce the maximum rate at which you can run the inspection.

Follow these instructions to benchmark the processing time of an inspection:

- 1. Open the inspection whose processing time you want to evaluate.
- 2. Select **Operate**»**Benchmark Inspection** to launch the Benchmark Inspection dialog box.
- 3. In the **Number of runs** control, specify the number of times to run the complete inspection for the benchmarking calculations.
- Note The estimated completion time is computer dependant. Actual run times on target computers may vary from the times estimated on your development computer.
  - 4. Click **OK** to close the dialog box.

## **Opening an Image**

Open an image file in Vision Builder AI by configuring a **Simulate Acquisition** step and adding it to your inspection. Refer to <u>Simulate</u> <u>Acquisition Concepts</u> for more information.

# Saving an Image

Complete the following steps to save the currently displayed image in Vision Builder AI:

- 1. Select File»Save Image to launch the Save Image dialog box.
- 2. Select the hard drive to which you want to save the image.
- 3. Select the directory to which you want to save the image.
- 4. Enter a file name.
- 5. Select a file format. The following formats are available: BMP, TIFF, JPEG, JPEG2000, and PNG. Refer to <u>Image Options</u> for a complete list of the options available for each file format.

JPEG, JPEG2000, and PNG are compressed file formats. If you select one of these formats, you must also select the image quality or compression ratio you desire. The image quality ranges from 0 to 1000, where 0 equals maximum compression and 1000 equals no compression. The compression ration is the degree to which to compress the JPEG2000 file. For example, if the Compression Ratio is 50, the resulting file will be 50 times smaller than the size of the image in memory.



- Note PNG format always performs a lossless compression. JPEG2000 can perform a lossless or lossy compression based on the value of the Lossless control.
- 6. Enable the **Merge Image Overlay** control if you want to add the overlay information to the saved image.
  - Note Merging the overlay modifies the content of the image and causes Vision Builder AI to save the image as a color image.
- 7. Click **Save** to save the image.

## **Printing an Image**

Follow these instructions to print the currently displayed image in Vision Builder AI:

- 1. Select File»Print Image to launch the Print Image Comment dialog box.
- 2. Enter a descriptive title for the image. This title appears above the image on the printout.
- 3. Enter a comment about the image.
- 4. Enable the **Print Results Overlaid on the Image** control if you want to add the overlay information to the printed image.
- 5. Click **OK** to print the image.

# **Viewing Options**

Use the **View** menu options or the buttons on the Vision Builder Al toolbar to change the display in the Main window. The following options are available:

View Option	Toolbar Icon	Description
Zoom In	€	Increases the magnification of the active image.
Zoom Out	Q	Decreases the magnification of the active image.
Zoom 1:1	<b>P</b> <sub>1:1</sub>	Displays the active image at its original size with no magnification.
Zoom to Fit	Q.	Scales the active image to fit in the Main window.
Toggle Main Window View	4 	Switches the Main window view between the active image and the inspection state diagram.
View Inspection State Diagram		Displays the inspection state diagram in the Main window.
View Complete Inspection Setup		Displays the inspection state diagram in the Main window along with the Setup, Cleanup, and Select Inspection configuration states.

## Adding a Step to an Inspection

Follow these general instructions to add a step to the current inspection:

- 1. In the **Inspection Steps** palette, click the step you want to add to the inspection.
- 2. Configure the step according to the instructions in the Context Help window **Configuration** tab.
- 3. Click **OK** to add the step to the inspection.

## **Removing a Step from an Inspection**

Follow one of these instructions to remove an inspection step from the State Configuration window:

- Right-click the step and select **Delete**.
- Click the step and select Edit»Delete.
- Click the step and click the **Delete** button.

## Modifying a Step in an Inspection

Follow one of these instructions to open the property page of a step to modify its controls:

- Right-click the step, and select **Edit**.
- Click the step, and select Edit»Edit Step.
- Click the step, and click the **Edit Step** button.
- Double-click the step.

# **Region of Interest Tools**

In most inspection steps, you want to focus on the inspection on specific areas of the image. You can define these specific areas with region of interest tools. The following tools are available depending on the inspection step:

lcon	<b>Tool Name</b>	Description
+	Point	Select a pixel in the image. Action: Click on the desired position.
1	Line	Draw a line in the image. Action: Click on the initial position and click again on the final position.
$\Diamond$	Broken Line	Draw a broken line in the image. Action: Click to place a new vertex and double-click to complete the region.
r	Freehand Line	Draw a freehand line in the image. Action: Click on the initial position, drag to the desired shape, and release the mouse button to complete the shape.
	Rectangle	Draw a rectangle or square in the image. Action: Click on one corner and drag to the opposite corner.
$\diamond$	Rotated Rectangle	Draw a rotated rectangle in the image. Action: Click on one corner and drag to the opposite corner to create the rectangle. Click on the lines inside the rectangle and drag to adjust the rotation angle.
0	Oval	Draw an oval or circle in the image. Action: Click on the center position and drag to the desired size.
3	Annulus	Draw an annulus in the image. Action: Click on the center position and drag to the desired size. Adjust the inner and outer radii, and adjust the start and end angle.
Ъ	Polygon	Draw a polygon in the image. Action: Click to place a new vertex and double-click to complete the region.
Ø	Freehand Region	Draw a freehand region in the image. Action: Click on the initial position, drag to the desired shape, and release the mouse button to complete the region.



## **Inspection Step Overlays**

Click the Setup Overlay button to configure which inspection step results are overlayed on the image.

Use the following controls to select the overlay elements you want to show when the image is displayed.

Control Name	Description
Overlay Feature Table	Specifies the overlay elements you can overlay for each inspection step.
Show All	Enables all overlay features.
Hide All	Disables all overlay features.
Use Default	Enables only the default overlay features.

To create an overlay that contains more than step results, use the <u>Custom Overlay</u> step to create a custom overlay for the inspection. Custom overlays can contain text, shapes, images, and/or boolean indicators.
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## **Acquire Images**

This palette contains steps for different methods of acquiring images for the inspection.

Step Name	Description
Acquire Image	Configures an acquisition from an analog, parallel digital, or Camera Link camera connected to a National Instruments Image Acquisition device.
Acquire Image (IEEE 1394)	Configures an acquisition from an IEEE 1394 camera. Refer to <u>Acquire Image (IEEE 1394)</u> <u>Concepts</u> for related information.
Acquire Image (IEEE 1394 or GigE)	Configures an acquisition from an IEEE 1394 or Gigabit Ethernet camera.
Acquire Image (Smart Camera)	Configures an acquisition from an NI Smart Camera.
Simulate Acquisition	Simulates a live acquisition by loading images from file. Vision Builder AI ships with several images you can use as simulation images. You can find these images in the <vision builder<br="">AI&gt;\DemoImg directory. You can also load your own images as simulation images. Refer to <u>Simulate Acquisition Concepts</u> for related information.</vision>
Select Image	Switches to a previously acquired image for processing. Refer to <u>Select Image Concepts</u> for related information.



How to Acquire an Image

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Select the NI device connected to your camera.
- 3. Select the **Acquisition Type** for the acquisition.
- 4. Select the **Acquisition Mode** you want to use.

#### Image Trigger Tab

- 3. Select **Triggered Acquisition** if you want to start the image capture with a trigger.
  - Note The trigger signal must be connected to a trigger line of your NI device.
  - **Caution** The external trigger and RTSI lines of NI devices expect TTL signals and are not isolated. Do not provide anything other than TTL signals on these lines. Doing so could permanently damage your NI device.
- 4. Select the trigger line to which your trigger signal is connected.
- 5. Select the trigger polarity. Select **Rising Edge** if you want to start the acquisition of a new image on the rising edge of the trigger signal. Select **Falling Edge** if you want to start the acquisition of a new image on the falling edge of the trigger signal.
- 6. Enter a timeout value. If a trigger signal is not received within the timeout period, the step fails.
- 7. If you are using a line scan camera, proceed to the next section. Otherwise, click **OK** to add the step the inspection.

#### Line Trigger Tab

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**Note** The following steps only apply to line scan cameras.

- 8. Select the trigger line to which your trigger signal is connected.
- 9. Select the trigger polarity. Select **Rising Edge** if you want to start the acquisition of a new line on the rising edge of the trigger signal. Select **Falling Edge** if you want to start the acquisition of a new line on the falling edge of the trigger signal.
- 10. In the **Skip Trigger** control, enter the number of trigger signals to skip before acquiring a new line. If a trigger signal is not received within the timeout period, the step fails.
- 11. Click **OK** to add the step to the inspection.



### **Acquire Image Controls**

The following controls are available on all tabs.

<b>Control Name</b>	Description
	Acquires and displays a single image from the selected National Instruments image acquisition device. When you click this button, the step acquires and displays the next image provided by the camera. If you enabled the <b>Triggered Acquisition</b> control in the Trigger tab, the step waits for the next trigger signal to acquire and display an image.
	Performs a continuous acquisition, or a triggered grab if <b>Triggered Acquisition</b> is enabled, and displays the image. When you click this button, the step starts the continuous acquisition and display of images. If you enabled the <b>Triggered Acquisition</b> control in the Trigger tab, the step waits for the next trigger signal to acquire and display a new image for each iteration. Click this button a second time to stop the continuous image acquisition.

#### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Devices	Displays the available NI devices and channels you can use to acquire an image.
Acquisition Mode	Specifies whether the step returns the image currently being acquired or the last completely acquired image.
	<ul> <li>Wait for Next Image—Waits for the next available image before transferring an image.</li> <li>Immediate—Immediately transfers the current image if it is newer than the image that was last acquired.</li> </ul>
	Tip Set the Acquisition Mode control to Immediate when you want to acquire from multiple cameras triggered simultaneously. The first acquisition step acquiring from camera 1 synchronizes the inspection by waiting for the next trigger signal. In subsequent acquisition steps, set the Acquisition Mode control to Immediate so that the images acquired by other cameras on the same trigger as camera 1 are transferred immediately.

#### Image Trigger Tab

The following controls are available on the Image Trigger tab.

<b>Control Name</b>	Description
Triggered Acquisition	When enabled, you can synchronize image acquisition with events external to the computer, such as receiving a pulse from a sensor that indicates the position of an item on an assembly line. The trigger signal must be connected to a trigger input of the NI device.
Trigger Line	Specifies which external trigger line receives the incoming trigger signal.
Polarity	Specifies whether to start the acquisition of a new image on the rising or falling edge of the trigger signal.
Timeout (ms)	Amount of time to wait for the trigger signal before returning a timeout error.
Variable Height Acquisition	When enabled, the height of the acquisition is based on the duration of the trigger line assertion. This control is only available for line scan cameras.

#### Line Trigger Tab

The following controls are available on the Line Trigger tab.

 $\infty$  Note The Line Trigger tab is only available for line scan cameras.

<b>Control Name</b>	Description
Triggered Acquisition	When enabled, you can synchronize line acquisition with events external to the computer, such as receiving a pulse from a quadrature encoder that indicates the position of an item on an assembly line.
Trigger Line	Specifies which external trigger line receives the incoming trigger signal.
Polarity	Specifies whether to start the acquisition of a new line on the rising or falling edge of the trigger signal.
Skip Trigger	Specifies the number of trigger signals to skip before acquiring a line.



### **Acquire Image FAQs**

## Q: How do I adjust the size, brightness, and other settings of the acquired images?

You can adjust all the image settings from the Measurement & Automation Explorer (MAX) property page of the NI device connected to your camera. Launch MAX to access the property page for the NI device.

#### Q: What types of images does Vision Builder AI support?

Vision Builder AI supports the following image types: 8-bit, 16-bit, float, RGB, and HSL.

#### Q: Can I wait for a trigger indefinitely?

The maximum amount of time you can wait for a trigger before timing out is 60,000 ms (60 seconds).

#### Q: What are the voltage limits for external trigger and RTSI signals?

The voltage limits are 0–5 V TTL.

## Q: I specified a trigger. Why is my acquisition not synchronized with the trigger signal?

Even if you specify a trigger signal is Vision Builder AI, you must also make sure that the camera is set to a triggered acquisition mode. In MAX, verify that the acquisition mode for the specified camera is set to a triggered mode.

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### **Acquire Image (IEEE 1394) Concepts**

IEEE 1394 industrial digital video cameras are digital cameras that use the IEEE 1394 standard to transfer images from the camera to the host computer. Vision Builder AI ships with NI Vision Acquisition Software, which includes the NI-IMAQ for IEEE 1394 Cameras driver software, to acquire images from your IEEE 1394 camera. NI-IMAQ for IEEE 1394 Cameras supports industrial IEEE 1394 digital cameras.

For more information on IEEE 1394 cameras, refer to <u>FireWire®/IEEE</u> <u>1394 Overview</u> or <u>IEEE 1394 Trade Association</u>.

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### How to Acquire an Image with an IEEE 1394 Camera

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Select the IEEE 1394 camera you want to use to acquire an image.
- 3. Select the Video Mode you want to use.

#### **Features Tab**

4. Select and configure each camera feature you want to use for the acquisition.

#### **Trigger Tab**

- 5. Select **Triggered Acquisition** if you want to acquire images based on an external signal.
- 6. Select a **Trigger Mode**.
- 7. Enter the amount of time you want to wait before the acquisition times out.
- 8. Select the trigger polarity. When triggered, the camera behaves differently depending on which **Trigger Mode** you select.
- 9. Specify the optional **Control Parameter** if you select **Mode 2 Trigger Pulse Control** or **Mode 3**—**Internal Trigger** from the **Trigger Mode** control.

#### Format 7 Features Tab

10. If you selected **Format 7 Video Mode**, specify the top and left offsets and the width and height of the region you want the camera to acquire.

**Note** Not all IEEE 1394 cameras support this feature.

- 11. Specify the size, in bytes, of each packet transmitted by the camera during an isochronous cycle.
- 12. Click **OK** to add the step to the inspection.

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## Acquire Image (IEEE 1394) Controls

The following controls are available on all tabs.

<b>Control Name</b>	Description
	Acquires and displays a single image from an IEEE 1394 camera. When you click this button, the step acquires and displays the next image provided by the camera. If you enabled the <b>Triggered Acquisition</b> control in the Trigger tab, the step waits for the next trigger signal to acquire and display an image.
	Performs a continuous acquisition, or a triggered grab if <b>Triggered Acquisition</b> is enabled, and displays the image. When you click this button, the step starts the continuous acquisition and display of images. If you enabled the <b>Triggered Acquisition</b> control in the Trigger tab, the step waits for the next trigger signal to acquire and display a new image for each iteration. Click this button a second time to stop the continuous image acquisition.
2	Updates the Devices list on the Main tab.

#### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Devices	Lists the image acquisition devices currently installed on the computer.
Video Mode	Displays a list of available video modes for the IEEE 1394 camera currently selected in <b>Devices</b> .
Acquisition Mode	<ul> <li>Specifies whether the step returns the image currently being acquired or the last completely acquired image.</li> <li>Wait for Next Image—Waits for the next available image before transferring an image.</li> <li>Immediate—Immediately transfers the current image if it is newer than the image that was last acquired.</li> <li>Tip Set the Acquisition Mode control to Immediate when you want to acquire from multiple cameras triggered simultaneously. The first acquisition step acquiring from camera 1 synchronizes the inspection by waiting for the next trigger signal. In subsequent acquisition steps, set the Acquisition Mode control to Immediate so that the images acquired by other cameras on the same trigger as camera 1 are transferred immediately.</li> </ul>

#### **Features Tab**

The following controls are available on the Features tab.

<b>Control Name</b>	Description
Features	Lists the features available on the camera you selected in the <b>Devices</b> table on the Main tab.
Mode	<ul> <li>Specifies how the selected feature is controlled and updated.</li> <li>Manual (Relative)—Sets the selected feature to use values that do not map to real-world units.</li> <li>Manual (Absolute)—Sets the selected feature to use values that map to real-world units.</li> <li>Auto—Sets the value of the selected feature automatically.</li> <li>One Push—Sets the value of the selected feature dimage then returns to manual control with the adjusted values.</li> <li>Off—Disables the selected feature.</li> </ul>
Value	Specifies the value of the selected feature. You can specify the feature value manually, set the value of the feature to the result of a previous measurement, or set the feature to the value of a variable.

#### Trigger Tab

The following controls are available on the Trigger tab.

<b>Control Name</b>	Description
Triggered Acquisition	Enables the <b>Trigger Mode</b> control and its associated controls. When enabled, you can coordinate an image acquisition with events external to the computer, such as receiving a pulse from a detector that indicates the position of an item on an assembly line. The trigger signal must be connected to a trigger input of the camera.
Trigger Mode	<ul> <li>Specifies how the camera integrates with a trigger signal. The following options are available.</li> <li>Note Not all IEEE 1394 cameras support these modes. Check the camera documentation to determine which modes the camera supports.</li> <li>Mode 0-Programmable Shutter—The camera starts integration from the external trigger input falling edge. Specify the integration time by defining the Shutter attribute in Measurement &amp; Automation Explorer (MAX).</li> <li>Mode 1-Pulse Width Control—The camera starts integration from the external trigger input falling edge. Integration time is equal to the low state of the external trigger.</li> <li>Mode 2-Trigger Pulses Control—The camera starts integration from the first external trigger input falling edge. At the N<sup>th</sup> external trigger input falling edge, integration is stopped. N is defined by the control parameter.</li> <li>Mode 3-Internal Trigger—The camera issues a trigger internally. The cycle time is N times the cycle time of the fastest frame rate. N is defined with the control parameter.</li> </ul>
	<ul> <li>determine which modes the camera supports.</li> <li>Mode 0-Programmable Shutter—The camera starts integration from the external trigger input falling edge. Specify the integration time by defining the Shutter attribute in Measurement &amp; Automation Explorer (MAX).</li> <li>Mode 1-Pulse Width Control—The camera starts integration from the external trigger input falling edge. Integration time is equal to the low state of the external trigger.</li> <li>Mode 2-Trigger Pulses Control—The camera starts integration from the first external trigger input falling edge. At the N<sup>th</sup> external trigger input falling edge, integration is stopped. N is defined by the control parameter.</li> <li>Mode 3-Internal Trigger—The camera issues a trigger internally. The cycle time is N times the cycle time of the fastest frame rate. N is defined with the control parameter. Specify the integration time by defining the Shutter attribute in MAX.</li> </ul>

	<ul> <li>Mode 4–N Frames, Programmable Shutter— The camera starts frame integration when the external trigger input changes to an active value. Each frame is exposed for a duration specified by the shutter attribute. The number of frames is specified by the optional parameter, <i>N</i>, which must have a value of 1 or more.</li> <li>Mode 5–N Frames, Pulse Width Control—The camera starts frame integration when the external trigger input changes to an active value. Each frame is exposed while the external trigger is active. The number of frames is specified by the optional parameter, <i>N</i>, which must have a value of 1 or more.</li> <li>Mode 14—Vendor specific. Refer to your camera documentation for information about this trigger mode.</li> <li>Mode 15—Vendor specific. Refer to your camera documentation for information about this trigger mode.</li> </ul>
Trigger Timeout	Specifies the amount of time, in milliseconds, to wait for the trigger signal before returning a timeout error.
Control Parameter	In Trigger Mode 2–Trigger Pulse Control, this parameter <i>N</i> defines the integration time in the number of trigger input falling edges. In Trigger Mode 3, <b>Internal Trigger</b> , <i>N</i> defines the cycle time. The cycle time of the internal trigger acquisition is <i>N</i> times the cycle of the fastest frame rate.
Polarity	<ul> <li>Specifies if you reset the camera and start the acquisition of a new image on the rising or falling edge of the trigger signal.</li> <li>Note Not all IEEE 1394 cameras support the ability to set the trigger polarity. Check the camera documentation to determine which polarity options the camera supports.</li> </ul>

#### Format 7 Features Tab

The following controls are available on the Format 7 Features tab.

<b>Control Name</b>	Description
Region of Interest	Specifies the acquisition Window. Use the following controls to define the acquisition window.
	• <b>Left</b> —X origin of the acquisition window. This value is rounded to a multiple of the camera unit width.
	<ul> <li>Top—Y origin of the acquisition window. This value is rounded to a multiple of the camera unit height.</li> </ul>
	<ul> <li>Width—Height of the acquisition window. This value is rounded to a multiple of the camera unit height.</li> </ul>
	• <b>Height</b> —Width of the acquisition window. This value is rounded to a multiple of the camera unit width.
Packet Size	Specifies the size, in bytes, of each packet transmitted by the camera during an isochronous cycle. Decrease this value to allow multiple IEEE 1394 cameras to share bandwidth.

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## Acquire Image (IEEE 1394) FAQs

## Q: In the Acquire Images tab, why is the Acquire Image (IEEE 1394) icon disabled?

The icon may be disabled for several reasons. Verify that the correct version of the NI-IMAQ for IEEE 1394 Cameras driver software is installed. If necessary, install the driver software. If the icon is still disabled after verifying that the correct driver is installed, refer to <u>Troubleshooting Tips for IEEE 1394 Cameras</u> for troubleshooting tips.

#### Q: The name of my camera appears in Measurement & Automation Explorer (MAX) but does not appear in the Devices list. How can I get the name of my camera to appear in the Devices list?

Make sure that the camera is associated with the NI-IMAQ for IEEE 1394 Cameras driver in MAX. If the camera is listed under NI-IMAQdx Devices, right-click the camera and select Driver»NI-IMAQ IEEE 1394 IIDC Digital Camera. Refer to Troubleshooting Tips for IEEE 1394 Cameras for additional trouble shooting tips if this does not resolve the problem.

#### Q: I cannot acquire images when I press the Acquire Image or Continuous Acquisition buttons.

Close Vision Builder AI. Open MAX, and verify the camera appears correctly in the Devices and Interfaces branch of the Configuration tree. Refer to <u>Troubleshooting Tips for IEEE 1394 Cameras</u> for troubleshooting tips.

#### Q: Why does my 16-bit image appear incorrectly?

Complete the following steps to adjust the 16-bit Pixel Representation parameters and correct the image using MAX:

- 1. Close Vision Builder AI.
- 2. Launch MAX.
- 3. In the MAX Configuration tree, expand **Devices and Interfaces**.
- 4. Expand NI-IMAQ for IEEE 1394 Devices.
- 5. Click the camera name to select the appropriate camera.
- 6. Click the Acquisition Parameters tab.

- 7. Adjust the values for the **Actual Bit Depth**, **Bit Alignment**, and **Byte Order** controls to correct the image.
- 8. Click **Save** to save the current configuration. These settings become the default settings for the camera.
- 9. Close MAX.
- 10. Launch Vision Builder AI and continue your application.
- $\overline{\mathbb{N}}$
- **Note** Some image processing algorithms do not support 16-bit images.

#### **Q:** How do I change the Bayer pattern for a camera?

Complete the following steps to change the Bayer pattern using MAX:

- 1. Close Vision Builder AI.
- 2. Launch MAX.
- 3. In the MAX Configuration tree, expand **Devices and Interfaces**.
- 4. Expand NI-IMAQ for IEEE 1394 Devices.
- 5. Click the camera name to select the appropriate camera.
- 6. Click the **Bayer Color** tab.
- 7. Select the appropriate Bayer pattern using the **Bayer Pattern** control.
- 8. Click **Save** to save the current configuration. These settings become the default settings for the camera.
- 9. Close MAX.
- 10. Launch Vision Builder AI and continue your application.
  - Note If the Bayer pattern is defined by the camera, you will not be able to adjust the Bayer pattern using MAX.

## Q: Why does the acquired image not use the current attribute settings?

If your inspection contains multiple acquisition steps that use the same camera with different attribute settings, it may take 2 or 3 frames for the camera to apply the new attribute settings. The exact number of frames required is camera-dependant. To ensure that an acquisition uses the correct attribute settings, you may have to allow the camera to acquire a few frames before processing the image. 1. 84:

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# How to Acquire an Image with an IEEE 1394 or GigE Camera

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Select the camera you want to use to acquire an image.
- 3. Complete one of the following steps:
  - For IEEE 1394 cameras, select the **IEEE 1394 Video Mode** you want to use.
  - For GigE cameras, select the **Camera Control Mode** you want to use.
- 4. Select the Acquisition Mode you want to use.

#### **Attributes Tab**

- 5. Select and configure each camera feature you want to use for the acquisition.
- 6. Click **OK** to add the step to the inspection.
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# Acquire Image (IEEE 1394 or GigE) Controls

The following controls are available on all tabs.

<b>Control Name</b>	Description
	Acquires and displays a single image from an IEEE 1394 or Gigabit Ethernet (GigE) camera. When you click this button, the step acquires and displays the next image provided by the camera. If the camera is in a triggered mode, the step waits for the next trigger signal to acquire and display an image.
	Performs a continuous acquisition, or a triggered grab if the camera is in a triggered mode, and displays the image. When you click this button, the step starts the continuous acquisition and display of images. If the camera is in a triggered mode, the step waits for the next trigger signal to acquire and display a new image for each iteration. Click this button a second time to stop the continuous image acquisition.
2	Refreshes the Devices list on the Main tab.

### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Devices	List of image acquisition devices installed on the computer and associated with the NI-IMAQdx driver software. Use Measurement & Automation Explorer (MAX) to associate the camera with the NI-IMAQdx driver software if the camera does not appear in the list.
IEEE 1394 Video Mode	Displays a list of available video modes for the IEEE 1394 camera currently selected in <b>Devices</b> .
Camera Control Mode	Displays a list of available control modes for the GigE camera currently selected in <b>Devices</b> . The following options are available:
	<ul> <li>Controller: Only this machine receives images—Allows Vision Builder AI to control the camera and no other computers or remote targets can access images from the camera. The Destination Mode camera attribute is set to Unicast.</li> <li>Controller: Multiple machines receive images —Allows Vision Builder AI to control the camera and other computers or remote targets can access images from the camera. The Destination Mode camera attribute is set to Multicast. The Destination Mode attribute can also be set to Broadcast.</li> <li>Listener: Only receive images from camera— Allows Vision Builder AI to access images from a camera that is already acquiring in broadcast or multicast mode. You can not change the camera acquisition settings while in Listener mode.</li> </ul>
Acquisition Mode	<ul> <li>Specifies whether the step returns the image currently being acquired or the last completely acquired image.</li> <li>Wait for Next Image—Waits for the next</li> </ul>

available image before transferring an image.
 Immediate—Immediately transfers the current image if it is newer than the image that was last acquired.
 Tip Set the Acquisition Mode control to Immediate when you want to acquire from multiple cameras triggered simultaneously. The first acquisition step acquiring from camera 1 synchronizes the inspection by waiting for the next trigger signal. In subsequent acquisition steps, set the Acquisition Mode control to Immediate so that the images acquired by other cameras on the same trigger as camera 1 are transferred immediately.

### Attributes Tab

The following controls are available on the Attributes tab.

<b>Control Name</b>	Description
Show All Attributes	When enabled, all of the attributes available on the selected camera are displayed in the <b>Attribute</b> tree, including attributes that cannot be configured.
Show Attribute Help	When enabled, information about the selected attribute is displayed. The attribute descriptions are returned by the camera and are camera-specific.
Attribute	List of the attributes for the selected camera.
Attribute Help	Displays information about the selected attribute returned by the camera.
Value	Specifies the value for the currently selected attribute.
Reset to Defaults	Resets all of the attributes to the default values configured in MAX.

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# Acquire Image (IEEE 1394 or GigE) FAQs

# Q: In the Acquire Images tab, why is the Acquire Image (IEEE 1394 or GigE) icon disabled?

The icon may be disabled for several reasons. Verify that the correct version of the NI-IMAQdx driver software is installed. If necessary, install the driver software. If the icon is still disabled after verifying that the correct driver is installed, refer to <u>Troubleshooting Tips for GigE</u> <u>Vision Cameras</u> for troubleshooting tips.

#### Q: My camera appears in Measurement & Automation Explorer (MAX) but does not appear in the Devices list. How can I get the name of my camera to appear in the Devices list?

Make sure that the camera is associated with the NI-IMAQdx driver in MAX. If the camera is listed under **Legacy NI-IMAQ IEEE 1394 Devices**, right-click the camera and select **Driver»NI-IMAQdx IIDC Digital Camera**. For IEEE 1394 cameras, refer to <u>Troubleshooting Tips</u> for IEEE 1394 Cameras for troubleshooting tips. For GigE cameras, refer to <u>Troubleshooting Tips for GigE Vision Cameras</u> for troubleshooting tips.

# Q: I cannot acquire images when I press the Acquire Image or Continuous Acquisition buttons.

Close Vision Builder AI. Open MAX, and verify the camera appears correctly in the Devices and Interfaces branch of the Configuration tree. For IEEE 1394 cameras, refer to <u>Troubleshooting Tips for IEEE 1394</u> <u>Cameras</u> for troubleshooting tips. For GigE cameras, refer to <u>Troubleshooting Tips for GigE Vision Cameras</u> for troubleshooting tips.

#### Q: Why does my 16-bit image appear incorrectly?

Complete the following steps to adjust the 16-bit pixel representation parameters and correct the image:

- In the property page for the Acquire Image (IEEE 1394 or GigE) step, on the Main tab, select the camera from the Devices list.
- 2. Click the **Attributes** tab.
- 3. Select the **Show All Attributes** checkbox to list all of the

attributes for the camera.

- 4. Adjust the values for the **BitsPerPixel**, **ShiftPixelBits**, and **SwapPixelBytes** attributes to correct the image.
- 5. Click OK to save the configuration settings.



**Note** Some image processing algorithms do not support 16-bit images.

# Q: Why do only some attributes allow me to specify the result of a previous step as the value for the attribute?

Only attributes that can be modified while the camera is acquiring can be set to a previous measurement result. Any attribute that cannot be modified during an acquisition must use a constant value. If the same camera is used in multiple steps, attributes that cannot be modified during an acquisition are forced to use the same value throughout the inspection to ensure optimized acquisition performance.

# Q: When should I use the Immediate Acquisition Mode instead of the Wait for Next Image Acquisition Mode?

Immediate mode is useful for triggered applications to help ensure that a triggered image is not lost while executing other steps in the inspection. Immediate mode allows this step to use an image that was acquired before the step is called. If the camera has not acquired an image since the last time a step acquired an image from the camera, Immediate mode will behave like the Wait for Next Image **Acquisition Mode**. The Wait for Next Image mode is useful when you want to ensure that the image returned by this step is a current image and not a previously acquired image.

#### Q: Why do some of the attributes not have an effect on the image?

Even though an attribute is writable, the camera may be in a mode that ignores the attribute you are trying to set. For example, if the camera is in an 8-bit mode and you set the BitsPerPixel or ShiftPixelBits attribute, the image will not be affected because those attributes only apply to 16-bit images.

#### Q: Why are no triggering modes listed in the Attribute tree?

Not all cameras support triggering. Only attributes supported by the camera are listed in the Attribute tree.

# Q: Why does the acquired image not use the current attribute settings?

If the value specified for an attribute is out of range, the last valid value is used. Also, if your inspection contains multiple acquisition steps that use the same camera with different attribute settings, it may take 2 or 3 frames for the camera to apply the new attribute settings. The exact number of frames required is camera-dependant. To ensure that an acquisition uses the correct attribute settings, you may have to allow the camera to acquire a few frames before processing the image.

#### Q: Why does the camera return errors when using the Controller: Multiple machines receive images Camera Control Mode?

When you select **Controller: Multiple machines receive images** for the **Camera Control Mode**, Vision Builder AI sets the **Destination Mode** attribute for the camera to **Multicast**. Not all cameras support Multicast mode. If you get an error, try setting the **Destination Mode** attribute to **Broadcast**. To change the **Destination Mode** to **Broadcast**, complete the following steps:

- 1. On the Attributes tab, enable the **Show all Attributes** checkbox.
- 2. In the Attribute tree, select Acquisition Attributes»Advanced Ethernet»Controller»Destination Mode.
- 3. Set the **Destination Mode** to **Broadcast**.

If the camera still returns errors, try setting the **Destination Mode** to **Unicast**. If the camera works in Unicast mode, it is likely that the camera does not support either Multicast or Broadcast modes.



## How to Acquire an Image with an NI Smart Camera

### Main Tab

1. In the **Step Name** control, enter a descriptive name for the step.

### **Trigger Tab**

- 2. Select **Triggered Acquisition** if you want to start the image capture with a trigger.
  - Note The trigger signal must be connected to the trigger line of the NI Smart Camera. Refer to the *NI 17xx Smart Camera User Manual* for information about connecting signals to the NI Smart Camera.
- 3. Select the trigger polarity. Select **Rising Edge** if you want to start the acquisition of a new image on the rising edge of the trigger signal. Select **Falling Edge** if you want to start the acquisition of a new image on the falling edge of the trigger signal.
- 4. Enter a **Timeout** value. If a trigger signal is not received within the timeout period, the step fails.
- 5. Select the **Acquisition Mode** you want to use for the acquisition.

### **Lighting Tab**

6. If you want to use the internal Direct Drive lighting controller, enable the **Enable Direct Drive** control and <u>select the light</u> connected to the smart camera.

If you want to use an external lighting controller with the NI Smart Camera, use the **5 V TTL Strobe** or **24 V Strobe** control, depending on the voltage your lighting controller requires, to generate strobe signals for the lighting controller.

### **Advanced Tab**

- 7. Select and configure each camera feature you want to use for the acquisition.
- 8. Click **OK** to add this step to the inspection.



# Acquire Image (Smart Camera) Controls

The following controls are available on all tabs.

<b>Control Name</b>	Description
	Acquires and displays a single image from the NI Smart Camera. When you click this button, the step acquires and displays the next image provided by the camera. If the camera is in a triggered mode, the step waits for the next trigger signal to acquire and display an image.
	Performs a continuous acquisition, or a triggered grab if the camera is in a triggered mode, and displays the image. When you click this button, the step starts the continuous acquisition and display of images. If the camera is in a triggered mode, the step waits for the next trigger signal to acquire and display a new image for each iteration. Click this button a second time to stop the continuous image acquisition.

### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Exposure Time	Time during which the camera sensor is exposed to light. <b>Exposure Time</b> can be adjusted in 31.2µs increments.
Gain	Adjusts the gain of an image.

### Trigger Tab

The following controls are available on the Trigger tab.

<b>Control Name</b>	Description
Triggered Acquisition	Enables the <b>Trigger Mode</b> control and its associated controls. When enabled, you can synchronize an image acquisition with events external to the smart camera, such as receiving a pulse from a detector that indicates the position of an item on an assembly line. The trigger signal must be connected to the trigger input of the smart camera.
Trigger Polarity	Specifies if you reset the camera and start the acquisition of a new image on the rising or falling edge of the trigger signal.
Exposure Delay	Specifies the amount of time to delay the exposure of the smart camera sensor after receiving a trigger signal.
Delay Unit	<ul> <li>Specifies the units for Exposure Delay.</li> <li>Note The Encoder Counts option is only available for smart cameras that support quadrature encoders.</li> </ul>
Timeout	Specifies the amount of time, in milliseconds, to wait for the trigger signal before returning a timeout error.
Acquisition Mode	<ul> <li>Specifies whether the step returns the image currently being acquired or the last completely acquired image.</li> <li>Wait for Next Image—Waits for the next available image before transferring an image. The step acquires a single image when the step executes and returns the acquired image.</li> <li>Immediate—Immediately transfers the current image if it is newer than the image that was last acquired. The step continuously acquires images and returns the current image when the step runs only if it is newer than the previous image.</li> </ul>

### Lighting Tab

The following controls are available on the Lighting tab.

<b>Control Name</b>	Description
Enable Direct Drive Lighting	When enabled, this control allows you to use the smart camera internal lighting controller. Direct Drive lighting is not available on NI 1722 Smart Cameras.
Direct Drive Lighting Mode	<ul> <li>Specifies the operation mode for the Direct Drive lighting controller. The following values are valid:</li> <li>Continuous—Continuously powers the connected light.</li> <li>Strobe—Drives the connected light only when the smart camera sensor is exposed. Strobe mode allows you to temporarily overdrive the light.</li> </ul>
Desired Current Level	Specifies the amount of current, in milliamperes, to use to drive the light. If the specified current is greater than the maximum current level for the connected light, the actual current level is lowered to protect the light.
Configure Light	Launches the <u>Configure Light</u> dialog box. Use the controls in the dialog box to configure your light.
5 V TTL Strobe	When enabled, the NI Smart Camera generates a 5 V TTL strobe signal for use with an external lighting controller.
24 V Strobe	When enabled, the NI Smart Camera generates a 24 V strobe signal for use with an external lighting controller.
Polarity	Specifies whether the strobe pulse is high or low while the smart camera is acquiring. In the rising mode, the strobe pulse is high when the camera is acquiring. In the falling mode, the strobe pulse is low when the camera is acquiring.

### Advanced Tab

The following controls are available on the Advanced tab.

Control Name	Description
Show Attribute Help	When enabled, information about the selected attribute is displayed.
Attribute	List of the attributes for the smart camera.
Attribute Help	Displays information about the selected attribute returned by the camera.
Value	Specifies the value for the currently selected attribute.



## **Acquire Image (Smart Camera) FAQs**

#### Q: How can I prevent my acquisition step from timing out?

The Acquire Image (Smart Camera) step returns a timeout error if the step is configured for a triggered acquisition and a trigger is not received before the specified Timeout period expires. Refer to *Chapter 8, Acquiring an Image with the NI Smart Camera*, of the NI Vision Builder for Automated Inspection Tutorial for instructions about using the Vision Builder AI state diagram to prevent an acquisition timeout.



## **Simulate Acquisition Concepts**

Use the **Simulate Acquisition** step as the first step in your inspection sequence when you want to explore Vision Builder AI steps without connecting a camera to your computer. You can configure the step to load an image similar to an image of the part you want to inspect. Then you can experiment with different processing steps to find out which ones meet your inspection needs.



## How to Simulate an Acquisition

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Click **Browse** to select a path to an image from file.
- 3. Enable the **Cycle Through Folder Images** control if you want to load a different simulation image each time the step is run.
- 4. Enable the **Cache Images** control if you want to load all of the images into memory when the inspection opens. By default, each image is loaded individually when the step executes.



**Simulate Acquisition Controls** 

### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Path	Specifies the file path to the image(s) to use for the inspection.
Cycle Through Folder Images	When enabled, the inspection cycles through all images in the folder each time the step is run.
Cache Images	When enabled, the step loads all of the images in the specified folder into memory when an inspection loads. By default, images are individually loaded each time the step executes.



# **Simulate Acquisition FAQs**

# Q: How do I cycle through all the images in a folder when I run an inspection?

Enable the **Cycle Through Folder Images** control in the **Main** tab of the Simulate Acquisition property page.

#### Q: Which image file formats are supported?

Vision Builder AI supports the following image file formats: BMP, TIFF, JPEG, JPEG2000, and PNG.

Note JPEG2000 images are not supported on remote targets.

#### Q: Is there a size limit for images I want to load?

Vision Builder AI does not have an image size limit. However, the image size limit or the number of images you can cache in Vision Builder AI may be limited you the amount of available memory on your device.

#### Q: What is the advantage/disadvantage to caching images?

Caching images loads all images in the specified folder when the inspection is loaded. When the inspection runs, the **Simulate Acquisition** step takes less time to run. The disadvantage to this approach is that it can use a lot of memory to load all the images when the inspection is opened if the folder contains a large number of images. Also, if the images change during the inspection, caching them will not load the modified images.



## **Select Image Concepts**

Use the **Select Image** step to switch to a previously acquired image for processing. For example, if you insert two acquisition steps to sequentially acquire two consecutive images from different cameras, the inspection steps that follow process only the second image. However, you can insert a **Select Image** step after the inspection steps to select the first image for processing. Inspection steps that follow the **Select Image** step process the first image. You can then make a decision using the **Calculator** step or **Logic Calculator** step based on measurements from the two images.

You can also use the **Select Image** step to apply different processing algorithms to the same image. If you insert a **Vision Assistant** step that modifies an image, you can use a **Select Image** step to retrieve the original image and apply another processing algorithm.



How to Select Images
### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. From the **Image Selection** list, select the previously acquired image you now want to process.
- 3. Enable the **Copy Current Image Overlay** control if you want to copy the overlay of the current image to the image you selected from the **Image Selection** list.



Select Image Controls

### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Image Selection	Displays all images acquired up to this point in the inspection.
Copy Current Image Overlay	When enabled, copies the overlay of the current image to the image you selected from the <b>Image Selection</b> list.



## Select Image FAQs

# Q: Why can I not insert the Select Image step as the first step of the inspection?

The **Select Image** step retrieves a previously acquired image, or an image modified by a **Vision Assistant** step, and cannot be the first step of the inspection. Acquire an image using one of the **Acquire Image** steps or the **Simulate Acquisition** step before calling this step.

#### Q: Can I use images acquired from a different state?

Yes. The image selection list lists all steps that log images from every state. If you do not see the image you want, make sure that the step has executed by clicking it.



## **Enhance Images**

If lighting conditions for the acquisition are not optimal, you may need to preprocess or enhance the image to extract information and make precise measurements. Enhancing images consists of applying algorithms to the image to modify the pixel information. For example, to enhance the contrast and brightness, Vision Builder AI contains a set of image processing functions you can call through Vision Assistant to preprocess your image before making measurements.

Step Name	Description
Vision Assistant	Processes images prior to inspection. Processing images can improve the quality of your image for inspection. You can remove noise, highlight features of interest, and separate features of interest from the background. Refer to <u>Vision Assistant</u> <u>Concepts</u> for related information.
Filter Image	Applies a filter to images prior to inspection. Image filters can be useful for detecting edges along a specific direction, smoothing images, or removing noise. Refer to <u>Filter</u> <u>Image Concepts</u> for related information.
Threshold Image	Separates objects of interest in an image from the rest of the image. The thresholding step sets all pixels within the Threshold Range to 255 and sets all other pixels in the image to 0. The resulting image is a binary image. Refer to <u>Threshold Image Concepts</u> for related information.
Calibrate Image	Calibrates an image to rea-world units. Real- world units include units such as inches, centimeters, and kilometers. After you insert a <b>Calibrate Image</b> step, all subsequent steps return results in both pixels and calibrated units. Refer to <u>Calibrate Image</u> <u>Concepts</u> for related information.

<b>Create Region of Interest</b>	Creates a region of interest (ROI) for an
_	inspection image. The ROI created by this
	step can be used in future steps to apply
	several algorithms to the exact same ROI.
	Refer to Create Region of Interest Concepts
	for related information.





## **Vision Assistant Concepts**

When you click the **Vision Assistant** step, Vision Builder AI launches the Vision Assistant interface. Use Vision Assistant to create a script of image processing and analysis functions that can improve the quality of your image for inspection. You can access the *Vision Builder AI Vision Assistant Help* from the **Help** menu inside Vision Assistant.





How to Use Vision Assistant

### **Vision Assistant Interface**

- 1. Create a script of image processing and analysis functions.
- Note Refer to the Vision Builder AI Vision Assistant Help for information about configuring a script from within Vision Assistant. You can access the Vision Builder AI Vision Assistant Help from the **Help** menu inside Vision Assistant

### Main Tab

- 2. In the **Step Name** control, enter a descriptive name for the step.
- 3. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
      - Tip Hold down the <Ctrl> key to specify a region of interest containing several contours using the same or different tools. Hold down the <Shift> key to draw a horizontal or vertical line.
  - Select a previously defined region of interest from the **Region of Interest** listbox.
- 4. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

5. Verify that the **Image Processing Steps** list contains the correct functions. To change items in the list, click **Edit** to launch Vision Assistant.





**Vision Assistant Controls** 

### Main Tab

The following controls are available on the Main tab.

Note Refer to the Vision Builder AI Vision Assistant Help for information about Vision Assistant controls. You can access the Vision Builder AI Vision Assistant Help from the **Help** menu inside Vision Assistant

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.
lmage Processing Steps	List of image processing steps you configured within Vision Assistant.
Edit	Launches Vision Assistant.





## **Vision Assistant FAQs**

# Q: I modified an image with Vision Assistant. Can I take measurements from the original image?

Yes, you can use the **Select Image** step to retrieve the original image and make different measurements.

# Q: My binary image appears black and red in Vision Assistant. Why does the same image appear black and white in Vision Builder AI?

A binary image in Vision Assistant has two pixel values: 0 (black) and 1 (shown in red for display purposes). Vision Builder AI scales the intensity values such that pixels whose values were 1 in Vision Assistant now have values of 255 (white). Pixel values of 0 and 255 have better contrast than pixel values of 0 and 1.

#### Q: The Reposition Region of Interest and Reference Coordinate System controls are dimmed. How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.

#### Q: When I return to Vision Builder AI after configuring a Vision Assistant step, why does a Lookup Table step appears at the end of the Image Processing Steps list?

When you threshold an image in Vision Assistant, the pixels in the resulting binary image have values of 0 and 1. Vision Builder AI adds a Lookup Table step to convert the pixels whose values equal 1 to 255 so that you are able to distinguish pixels of interest from background pixels.



## **Filter Image Concepts**

Image Filters serve a variety of purposes, such as reducing noise, detecting edges along a specific direction, contouring patterns, and detail outlining or smoothing. Filters can smooth, sharpen, transform, and remove noise from an image so that you can extract the information you need. Filter algorithms are divided into two types: linear and nonlinear.

A linear filter, or convolution, is an algorithm that consists of recalculating the value of a pixel based on its own pixel value and the pixel values of its neighbors weighted by the coefficients of a convolution kernel. The sum of this calculation is divided by the sum of the elements in the kernel to obtain a new pixel value. Vision Builder AI features a set of standard convolution kernels for the most common sizes (3×3, 5×5, and 7×7). You can also create your own convolution kernels. With this capability, you can create filters with specific characteristics.

Nonlinear filters either extract the contours (edge detection) or remove the isolated pixels. Vision Builder AI has four different methods you can use for contour extraction (Differentiation, Prewitt, Roberts, or Sobel).

Filters alter pixel values with respect to variations in light intensity in their neighborhood. The neighborhood of a pixel is defined by the size of a matrix, or mask, centered on the pixel itself. These filters can be sensitive to the presence or absence of light-intensity variations.



How to Filter an Image

### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest that includes all of the objects you want to detect.
    - Tip You can use the region of interest you define for the Filter Image step as the region of interest for future inspection steps. To use the specified region of interest in future inspection steps, select the Filter Image step from the Region of Interest control on the Main tab of the inspection step.

Using the same region of interest for multiple steps allows the inspection to be run only on the filtered area of the image. For example, to find straight edges in a noisy image, you can apply a filter to remove noise from the area where you want to search for straight edges. You can then use the same region of interest to search for straight edges in the filtered area of the image.

- Select a previously defined region of interest from the **Region of Interest** listbox.
- 3. Verify that the **Reposition Region of Interest** checkbox is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

## **Filters Tab**

- 4. Select the Filter Type you want to use.
- 5. If necessary, adjust the **Kernel Size**, **Filter Size**, and/or **Kernel** to achieve the desired filter result.
- 6. Click OK.



**Filter Image Controls** 

### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

## **Filters Tab**

The following controls are available on the Filters tab.

<b>Control Name</b>	Description
Filter Type	Type of filter to apply to the region of interest. The following options are available:
	<ul> <li>Original Image—Original input image.</li> </ul>
	Smoothing
	<ul> <li>Lowpass—Lowpass filtering. Smoothes images by eliminating details and blurring edges.</li> </ul>
	<ul> <li>Local Average—Local Averaging of the image pixels based on the kernel.</li> </ul>
	<ul> <li>Gaussian—Gaussian filtering based on the kernel. Attenuates the variations of light intensity in the neighborhood of a pixel. The Gaussian kernel has the following model: a d c b x b c d a where a, b, c, and d are integers and x&gt;1.</li> <li>Median—Median filtering. Each pixel is assigned the median value of its neighborhood.</li> </ul>
	Edge Detection
	<ul> <li>Laplacian—Laplacian filtering. Extracts the contour of objects and outlines details. The Laplacian filter kernel has the following model:</li> </ul>
	a d c b x b c d a
	where <i>a, b, c,</i> and <i>d</i> are integers and <i>x</i> is greater than or equal to the sum of the absolute values of the outer coefficients.
	<ul> <li>Diff—Differentiation filtering. Produces continuous contours by highlighting each pixel where an intensity variation occurs between itself and its three upper left neighbors.</li> </ul>
	<ul> <li>Prewitt—Prewitt filtering. A highpass filter that extracts the outer contours of objects.</li> <li>Sobel—Sobel filter. A highpass filter that</li> </ul>
	extracts the outer contours of objects.

	<ul> <li>Roberts—Roberts filter to detect edges. Outlines the contours that highlight pixels where an intensity variation occurs along the diagonal axes.</li> <li>Convolution         <ul> <li>Highlight Details—Convolution kernel that highlights the edges of an image.</li> <li>Custom—Custom filtering using the kernel coefficients and size that you specify.</li> </ul> </li> </ul>
Kernel Size	<ul> <li>Size of the structuring element. The following options are available:</li> <li>3×3</li> <li>5×5</li> <li>7×7</li> <li>A default Kernel is used for each filter type. If you modify the Kernel, Filter Type will change to Custom Filter.</li> </ul>
Filter Size	Size of the filter for the <b>Lowpass</b> and <b>Median</b> filters.
Kernel	<ul> <li>Specifies the Kernel coefficients.</li> <li><b>Tip</b> When you select a <b>Filter Type</b> the kernel coefficients are set to default values. You may need to experiment with different kernel coefficients and kernel sizes to obtain the desired result.</li> </ul>



## **Filter Image FAQs**

Q: The Reposition Region of Interest and Reference Coordinate System controls are dimmed. How can I make these options available?

Insert a Set Coordinate System step before the Filter Image step to make the **Reposition Region of Interest** and **Reference Coordinate** System controls available.



## **Threshold Image Concepts**

The **Threshold Image** step is based on a technique called particle analysis. A particle is an area of touching pixels with the same logical state. All pixels in an image that belong to a particle are in a foreground state. All other pixels are in a background state. In a binary image, pixels in the background have values equal to zero while every nonzero pixel is part of a particle.

Thresholding enables you to select ranges of pixel values in grayscale images that separate the objects under consideration from the background. Thresholding converts an image into a binary image, with pixel values of 0 or 1. This process works by setting to 255 all pixels whose value falls within a certain range, called the threshold interval, and setting all other pixel values in the image to 0. Figure 1a shows a grayscale image, and Figure 1b shows the same image after thresholding.



Figure 1


How to Threshold an Image

### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose the type of objects you want to threshold from the **Look For** control.

If the intensities of the pixels that belong to objects of interest are brighter (greater) than the surrounding—particularly if the pixels along the inside boundary of the objects are brighter than their surrounding pixels—choose **Bright Objects**. If the pixels that belong to the objects of interest are darker (less) than their surrounding pixels, choose **Dark Objects**. In all other cases, choose **Gray Objects**.

- 3. Select the thresholding method you want to use from the **Method** listbox. This Histogram shows the range of pixel intensities in the region of interest.
- 4. Specify the threshold range.
  - For Manual Thresholding methods, use the **Lower Value** and **Upper Value** controls to specify the threshold range.
    - **Tip** Click the drop-down list to use the value of a previous measurement as the threshold value.
  - For Automatic Thresholding methods, the step automatically specifies a threshold range corresponding to the region of interest based on the selected thresholding **Method**. Use the **Lower Limit** and **Upper Limit** controls to coerce the threshold range to use a specific range of values.
  - For Local Thresholding methods, the step calculates threshold values for each pixel based on the statistics of surrounding pixels. Use the **Kernel size** control to specify the approximate size of the objects to threshold.
- 5. Click **OK** to add the step to the inspection.



**Threshold Image Controls** 

# Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Look For	<ul> <li>Specifies the type of objects to search for in the image.</li> <li>The following options are available:</li> <li>Bright Objects—When selected, the step counts bright pixels whose intensity values range from Lewer Values to 255</li> </ul>
	<ul> <li>Dark Objects—When selected, the step counts dark pixels whose intensity values range from 0 to Upper Value.</li> <li>Gray Objects—When selected, the step counts</li> </ul>
	gray pixels whose intensity values range from Lower Value to Upper Value.
Method	<ul> <li>Specifies the type of threshold to use. The following options are available:</li> <li>Manual Threshold—Use this method when you want to determine the upper and lower threshold values manually.</li> <li>Automatic Threshold: Clustering—Use this method as a starting point. This method is appropriate for most images, but if the image requires more specialized thresholding, select another automatic threshold: Entropy—Use this method when you are inspecting an image that contains very small objects of interest, such as small cosmetic defects.</li> <li>Automatic Threshold: Metric—Use this method when the object of interest and the background contain a comparable number of pixels.</li> <li>Automatic Threshold: Moments—Use this method when the object of interest and the background contain a comparable number of pixels.</li> <li>Automatic Threshold: Moments—Use this method for images that have poor contrast.</li> <li>Automatic Threshold: InterVariance—Use this</li> </ul>

	<ul> <li>method when the object of interest and the background contain a comparable number of pixels.</li> <li>Local Threshold: Niblack—Use this method for images that contain non-uniform lighting conditions.</li> <li>Local Threshold: Background Correction—Use this method for images that contain non-uniform lighting conditions. Background correction also helps reduce noise in large, empty areas.</li> <li>Note Refer to the <i>NI Vision Concepts Manual</i> for more information about automatic thresholding methods.</li> </ul>
Histogram	Displays the number of pixels at each grayscale intensity in the region of interest. The x-axis represents the grayscale intensities, and the y-axis represents the number of pixels.
Lower Value	Range of intensity values for those pixels you want to consider as objects. When looking for bright objects, all pixels whose values range from <b>Lower Value</b> to 255 are considered object pixels. <b>Lower Value</b> can be set to a constant or to the value of a previous measurement.
Upper Value	Range of intensity values for those pixels you want to consider as objects. When looking for dark objects, all pixels whose values range from 0 to <b>Upper Value</b> are considered object pixels. <b>Upper Value</b> can be set to a constant or to the value of a previous measurement.
Lower Limit	The lower boundary of the threshold range for manual thresholding. For automatic thresholding, <b>Lower Limit</b> displays the threshold value computed by the selected automatic thresholding method.
Upper Limit	The upper boundary of the threshold range for manual thresholding. For automatic thresholding, <b>Upper Limit</b> displays the threshold value computed by the selected automatic thresholding method.

Kernel Size	<ul> <li>The size of the area around each pixel used to compute the average intensity value for the pixel when using a locally adaptive threshold. Kernel Size is typically equal to the size of the object you want to isolate using the threshold. Kernel Size is only available for local thresholding methods.</li> <li>ROI Size—Indicates the size of the current region of interest.</li> <li>Tip You can determine the approximate size of an object in your image by drawing a region of interest around the object. ROI Size displays the value of the last ROI drawn. Click the </li> <li>Apply ROI Size.</li> </ul>
ROI Size	Indicates the size of the current region of interest. <b>Tip</b> You can determine the approximate size of an object in your image by drawing a region of interest around the object. <b>ROI Size</b> displays the value of the last ROI drawn. Click the <b>Apply</b> <b>ROI</b> button to set <b>Kernel Size</b> equal to <b>ROI Size</b> .
Deviation Factor	Determines the sensitivity of the Niblack thresholding algorithm. Values range for 0 to 1, with 0 being the most sensitive to noise. This control is available only for the <b>Local Threshold: Niblack</b> thresholding method.



# Threshold Image FAQs

Currently, there are no FAQs associated with this step.



# **Calibrate Image Concepts**

Vision Builder AI can calibrate images containing linear, perspective, or nonlinear distortions in order to return accurate measurements. The **Calibrate Image** step calibrates images so that inspection results are returned in real-world units.

Calibrating an image is a two-step process. The first is an offline step during which you specify the type of calibration, the calibration parameters, and the real-world unit in which you want to express measurements. The second step of the calibration process applies the computed calibration to the image during the inspection process. This step is represented in your inspection as the **Calibrate Image** step.

Vision Builder AI supports four types of calibration, which depend on the position of the camera in relation to the object under inspection and the type of lens used in the application: **Simple Calibration**, **Calibration Using User-Defined Points**, **Grid Calibration**, and **Calibration from Image**.

- Select Simple Calibration when your camera angle is perpendicular to the image plane and lens distortion is negligible.
   Simple Calibration transforms a pixel coordinate to a real-world coordinate through scaling in the x (horizontal) and y (vertical) directions.
- Select **Calibration Using User-Defined Points** when lens distortion is negligible and when your camera is not perpendicular to the image plane, which causes perspective distortion in the image. This calibration type uses a set of known mappings between points in the image and their corresponding locations in the real world to compute the pixel-to-real-world mapping for the entire image.
- Select **Grid Calibration** when your image exhibits either perspective or nonlinear distortion. Nonlinear distortion usually occurs when you use a wide-angle lens. **Grid Calibration** uses the distances between dots in a calibration grid and the distances between dots in an image of the grid to generate a list of pixel-to-real-world mappings for the calibration process.
- Select **Calibration from Image** to apply the calibration information from a calibrated image to the current image. Both

images must be the same size.



**Tip** Whenever possible, position the camera perpendicular to the object to minimize perspective distortion in the image. Use a quality lens or a telecentric lens to minimize nonlinear distortion in the image.



How to Calibrate an Image

### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Complete one of the following steps.
  - a. Click **New Calibration** to launch the calibration wizard, and select the type of calibration you want.

When you complete the calibration wizard, the **Calibration Type** indicator is updated to reflect the calibration you selected. If you chose **Calibration from Image**, the path to the calibrated image you selected appears in the **Calibrated Image File Path** indicator.

- b. Click **Edit Calibration** if you need to return to the calibration wizard to change your calibration setup.
- 3. If you used points defined in a previous step to learn the calibration, you can choose to relearn the calibration based on the new position of these points each time you acquire a new image. Enable the **Relearn Calibration at Each Iteration** control if the camera position or imaging conditions change from one image to another.
- 4. You can save the calibration to file by enabling the Save Calibrated Image to File control and selecting a path in which to save the new calibrated image. The calibrated image will be saved at each iteration of the Calibrate Image step. The calibration can be used in a different inspection to automatically calibrate all acquired images using the Calibrate from Image method.
- 5. Click the **Axis** tab, and select **Correct Image** if you want to correct the calibrated image. You must also specify the **Interpolation Type** and **Replace Value** to use to correct the image.
- **Tip** Refer to the **Calibration** and **Axis** tabs to view the calibration and calibration axis information you specified in the calibration wizard.
  - 6. Click **OK** to add the step to the inspection.



**Calibrate Image Controls** 

# Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Calibration Type	Type of calibration you selected in the calibration wizard, either <b>Simple Calibration</b> , <b>Calibration Using User-</b> <b>Defined Points</b> , <b>Grid Calibration</b> , or <b>Calibration from</b> <b>Image</b> .
Calibrated Image File Path	Path to the calibrated image whose calibration information you use to set the calibration information of the current image.
New Calibration	Launches the calibration wizard so you can create a new calibration setup.
Edit Calibration	Loads the calibration wizard so you can change your calibration setup.
Relearn Calibration at Each Iteration	When enabled, the step relearns the calibration information at each iteration of the inspection.
Save Calibrated Image to File	When enabled, the step saves the calibrated image to the path specified in the <b>New Calibrated Image File Path</b> control.
New Calibrated Image File Path	File path to which you want to save the image calibrated by this step.

# **Calibration Tab**

The following information is available on the Calibration tab.

Note The contents of the Calibration tab vary depending on the Calibration Type selected in the Calibration Wizard.

#### Simple Calibration

Control Name	Description
Pixel Type	Indicates whether the image has square or nonsquare pixels.
Correspondence Image - Real World	Gives the real-world size of a pixel in both the horizontal (x) and vertical (y) directions.

#### **User Points Calibration**

<b>Control Name</b>	Description
Calibration Points	Lists the points selected for calibration in the calibration wizard.
Image Coordinates	Coordinates of the currently selected calibration point, given as the number of pixels from the origin.
Real-World Coordinates	Coordinates of the currently selected calibration point, given as the number of <i>Units</i> from the origin.
Unit	Unit of measure selected in the calibration wizard.
Distortion	Type of distortion selected in the calibration wizard, either <b>Perspective</b> or <b>Nonlinear</b> .

#### **Grid Calibration**

Control Name	Description
Pixel Type	Indicates whether your image has square or nonsquare pixels.
Correspondence Image - Real World	Coordinates of the currently selected calibration point, given as the number of <i>Units</i> from the origin.
Unit	Unit of measure you selected in the calibration

	wizard.
Distortion	Type of distortion you selected in the calibration wizard, either <b>Perspective</b> or <b>Nonlinear</b> .

### **Calibration from Image**

Control Name	Description
Pixel Type	Indicates whether your image has square or nonsquare pixels.
Correspondence Image - Real World	Gives the real-world size of a pixel in both the horizontal (x) and vertical (y) directions.

### Axis Tab

The following controls are available on the Axis tab.

<b>Control Name</b>	Description
Axis Origin	X- and y-coordinates of the origin you selected in the calibration wizard.
Axis Reference	Direction of the y-axis, either <b>Direct</b> or <b>Indirect</b> .
Angle Relative to Horizontal	Angle of the x-axis of the calibration axis you selected relative to horizontal.
Correct Image	When enabled, the step corrects the calibrated image by applying a calibration to create a spatially correct image.
Interpolation Type	<ul> <li>Specifies the interpolation method to use to obtain the corrected image. The following options are valid:</li> <li>Zero Order (default)—Rounds to the nearest integral pixel location.</li> <li>Bi-Linear—Uses linear interpolation in both the x- and y-directions to compute the pixel location.</li> </ul>
Replace Value	Specifies the value that the step uses to fill pixels in the corrected image that the step could not correct in the original image. The default is 0.



# **Calibrate Image FAQs**

### Q: Why do the calibrated measurements vary from part to part?

If the position of the parts in the inspection images varies considerably, enable the **Relearn calibration at each iteration** control. When this control is enabled, the inspection relearns calibration information based on the new coordinates of the selected points during each iteration of the inspection.



**Note** To enable the **Relearn calibration at each iteration** control, you must select points defined in previous step instead of defining your own points.

# Q: Is it possible to configure Vision Builder AI to periodically recalibrate the vision system?

Yes. One method to implement this feature consists of configuring two separate inspections.

- The first inspection is dedicated to system calibration, and can locate features disposed at known locations in the image. A calibration step uses these points of reference to learn a new calibration, and saves the calibrated image to file.
- The second inspection performs visual inspection tasks on calibrated images. The images are calibrated using the **Calibrate from Image** setting and the calibrated image saved from the first inspection.

Refer to <u>How to Automatically Select which Inspection to Run</u> to learn how to switch between inspections.



# **Create Region of Interest Concepts**

The **Create Region of Interest** step creates a region of interest (ROI) for an inspection image. This step allows you to create point, line, rectangle, rotated rectangle, annulus, and oval ROIs.

Create an ROI by drawing a region on the image, or by specifying coordinate values that define the region. You may also use the measurement results from previous steps or the value of a user-defined variable to define the ROI. For example, you can use measurements from a previous step to position the ROI at the center of found objects.

The ROI created by this step can be used in future steps. This allows you to apply several algorithms to the exact same ROI.



How to Create a Region of Interest

### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Verify that the **Reposition Region of Interest** control is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

Note If the Reposition Region of Interest control is enabled and any of the parameters for the region of interest are based on previous measurement results these parameters will not be updated by the coordinate system.

### **Coordinates Tab**

- 3. Select the type of region of interest you want to create from the **ROI Type** listbox.
- 4. Create a region of interest in the image using the mouse or by entering values for the corresponding region of interest parameter controls. You can select to use a previous measurement or variable for the value of an region of interest parameter by selecting the measurement or variable from the drop-down list.

Note If the value of an ROI parameter is set to a previous measurement and the step taking the measurement has **Reposition Region of Interest** enabled, the value of the measurement may change if the coordinate system changes.



**Create Region of Interest Controls** 

# Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

# **Coordinates Tab**

The following controls are available on the Coordinates tab.

<b>Control Name</b>	Description
ROI Type	Type of region of interest (ROI) to create. The following options are available:
	Line—Creates a Line ROI.
	<ul> <li>Rectangle (Top/Left)—Creates a rectangular ROI defined by the coordinates of the top-left and bottom-right corners of the rectangle.</li> </ul>
	<ul> <li>Rectangle (Center)—Creates a rectangular ROI defined by the coordinates of the center point, width, and height of the rectangle.</li> </ul>
	Rotated Rectangle—Creates a Rectangle     (Center) ROI rotated by a specified angle.
	<ul> <li>Annulus—Creates an annulus ROI.</li> <li>Oval—Creates an oval ROI.</li> </ul>
ROI	Use these controls to specify values, or measurements
Parameters	<b>Type</b> . The available parameters will vary depending on the <b>ROI Type</b> selected. The following are the parameters available for each ROI Type:
	<b>Tip</b> To use the measurement from a previous step or the value of a variable as the value for an ROI parameter, select the measurement or variable from the drop-down list of the parameter you want to specify. These values are not changed by repositioning the ROI.
	Point
	• <b>X</b> —The x-coordinate of the point.
	<ul> <li>Y—The y-coordinate of the point.</li> </ul>
	Line
	• <b>Start X</b> —The x-coordinate of the starting point.
	<ul> <li>Start Y—The y-coordinate of the starting point.</li> <li>End Y — The y-coordinate of the ording point.</li> </ul>
	<ul> <li>End X—The x-coordinate of the ending point.</li> <li>End Y—The y-coordinate of the ending point.</li> </ul>
	Rectangle (Ton/Left)

- Left—The x-coordinate for the left side of the rectangle.
- **Top**—The y-coordinate for the top of the rectangle.
- **Right**—The x-coordinate for the right side of the rectangle.
- **Bottom**—The y-coordinate for the bottom of the rectangle.

### **Rectangle (Center)**

- **Center X**—The x-coordinate of the center of the rectangle.
- **Center Y**—The y-coordinate of the center of the rectangle.
- Width—The width of the rectangle.
- **Height**—The height of the rectangle.

### Rotated Rectangle

- **Center X**—The x-coordinate of the center of the rectangle.
- **Center Y**—The y-coordinate of the center of the rectangle.
- Width—The width of the rectangle.
- **Height**—The height of the rectangle.
- **Angle**—The rotation angle in degrees of the rectangle. The center of the rectangle is the point of rotation.

#### Annulus

- **Center X**—The x-coordinate of the center of the circle or annulus.
- **Center Y**—The y-coordinate of the center of the circle or annulus.
- Inner Radius—The radius in pixels of the inner circle defining one edge of the circular strip.
- **Outer Radius**—The radius in pixels of the outer circle defining the second edge of the circular strip.

•	<ul> <li>Start Angle—The first angle of the circular strip. The angle is measured counter-clockwise from the x-axis of a coordinate system centered on the circle or annulus.</li> <li>End Angle—The second angle of the circular strip. The angle is measured counter-clockwise from the x-axis of a coordinate system centered on the circle or annulus.</li> </ul>
Oval	
•	<b>Center X</b> —The x-coordinate of the center of the circle or annulus.
•	<b>Center Y</b> —The y-coordinate of the center of the circle or annulus.
•	Width—The width of the oval.
•	Height—The height of the oval.


# **Create Region of Interest FAQs**

# Q: Why is my region of interest not drawn in the image when I insert the step in the inspection?

The **Create Region of Interest** step does not overlay the region of interest onto the image because the step where the region of interest is used will overlay the region of interest.

You can modify this default behavior by modifying the step overlay.

Click the Setup Overlay button and enable the overlay of the region of interest for the Create Region of Interest step.

# Q: Why is the region of interest I created not repositioned correctly in subsequent steps?

If one or more coordinates of the region of interest are based on measurements from previous steps or variable values, the value of the measurement or variable is likely to change each time it is computed. If this is the case, there is no need to reposition the ROI again in the step where the ROI is used. It is not recommended to use both **Reposition Region of Interest** and previous measurements to define an ROI.

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# **Locate Features**

This palette groups several visual inspection steps whose purpose is locating known features on an object under inspection. Common features include edge points along the boundary of an object, patterns on the object, and the entire object itself. You can use located features in the following ways:

- Determining the location of the object in the image.
- Linking the location of a region of interest to the feature so that the region moves within the image in relation to the object.
- Defining object landmarks on which you can base measurements. In most applications, you can make measurements based on points detected in the image or geometric fits to the detected points. Object features that are useful for measurements fall into three categories:
  - Edge points along the boundary of an object
  - Shapes or patterns within the object

Step Name	Description
Find Edges	Locates and counts edge points along a search line. For example, you can use this step to locate and count the edges of pins on a chip. Refer to <u>Find Edges Concepts</u> for related information.
Find Straight Edge	Locates a straight edge on the object. For example, you can use this step to find the left edge of a floppy disk and determine the orientation of the disk in the image. Refer to <u>Find Straight Edge Concepts</u> for related information.
Find Circular Edge	Locates a circular edge on the object under inspection. For example, you can use this step to locate and measure a hole drilled in a mechanical part. Refer to Find Circular Edge <u>Concepts</u> for related information.

 Pixels with uniform intensity values that you can easily distinguish from surrounding pixels

Match Pattern	Locates regions of an image that match a predefined template of a pattern. Use this step when the feature you want to locate can only be described by its 2D intensity and edge info. For example, you can use <b>Match Pattern</b> to locate a company logo printed on a container. The <b>Match Pattern</b> step is indifferent to image noise, blur, and uniform lighting changes. Refer to <u>Match Pattern Concepts</u> for related information.
Geometric Matching	Locates regions in a grayscale image that match a model, or template, of a reference pattern. <b>Geometric matching</b> is specialized to locate templates that are characterized by distinct geometric or shape information. <b>Geometric Matching</b> finds templates regardless of lighting variation, blur, noise, occlusion, and geometric transformations such as shifting, rotation, or scaling of the template. Refer to <u>Geometric Matching Concepts</u> for related information.
Set Coordinate System	Creates a coordinate system based on points defined during previous steps. As the locations of these defined points vary from image to image, the coordinate system moves. You can use the coordinate system you create to reposition regions of interest during subsequent steps so that the region matches the position of the object under inspection. Refer to <u>Set Coordinate System Concepts</u> for related information.
Detect Objects	Locates area features whose pixels intensities are uniform and vary significantly from the intensities of background pixels. Use this step when you cannot distinguish the feature from the rest of the image by its edge or pattern information. Refer to <u>Detect Objects</u> <u>Concepts</u> for related information.

Match Color Pattern	Detects the presence of an object using a color template pattern that describes the edge information and color information of the object. Use this step if the object contains color information that is very different from the background, and you want to find the precise location of the object in the image or count the number of objects present in a region of the image. Also, use this step if the object is very similar to other objects in the image but has a distinct hue. Refer to Match Color Pattern Concepts for related information.
Adv. Straight Edge	Locates difficult to detect straight edges in an image. This step provides greater control over the edge detection algorithm used to detect straight edges and allows you to detect multiple straight edges within a region of interest. Refer to <u>Adv. Straight Edge Concepts</u> for related information.

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# **Find Edges Concepts**

The **Find Edges** step searches for edges along a one-dimensional region of interest, such as a line, broken line, or curve. Edges are typically characterized by sharp transitions in pixel intensities.

The step locates an edge based on its edge strength. You can study the **Edge Strength Profile** to determine the edge strengths along the region of interest. A peak in the profile indicates that an edge is present at that position along the region of interest. The strength of that edge is given by the amplitude of the peak.

The default region of interest tool is a line. You can examine different path profiles of the image using the broken line tool or the freehand tool. Also, you can locate edges along multiple regions of interest.

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How to Find Edges

### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
      - Tip Hold down the <Ctrl> key to specify a region of interest containing several contours using the same or different tools. Hold down the <Shift> key to draw a horizontal or vertical line.
  - Select a previously defined region of interest from the **Region of Interest** listbox.

When you specify a region of interest, the step automatically tries to locate edge points along the region. The located edges are marked on the image with blue and red squares.

3. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

## **Settings Tab**

- 4. Choose the type of edges you want to detect from the **Look For** control. You can choose from **All Edges**, **First Edge**, **First & Last Edge**, and **Best Edge**.
- 5. Select the polarity of the edges you want to locate.
- If the automatically located edges correspond to the edges you expected to find, proceed to step 7. Otherwise, disable the Auto Setup control and manually adjust the edge location parameters. Use the edge information on the Advanced tab to determine appropriate settings for the edge location parameters.

## Limits Tab

7. Set the minimum and/or maximum number of edges you want locate.

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**Find Edges Controls** 

## Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

# Setting Tab

The following controls are available on the Settings tab.

<b>Control Name</b>	Description
Look For	<ul> <li>Specifies the type of edges to find in the image. The following options are available:</li> <li>All Edges—Finds all edges of the specified polarity along the search line.</li> <li>First Edge—Finds only the first edge of the specified polarity along each independent search line based on the direction of the search line.</li> <li>First &amp; Last Edge—Finds only the first and last edges of the specified polarity along each independent search line.</li> <li>Best Edge—Finds only the best edge of the specified polarity along each independent search line.</li> </ul>
Edge Polarity	<ul> <li>Specifies the pixel intensity transitions to use to determine edges. The following options are available:</li> <li>All Edges—Finds edges characterized by dark-to-bright and bright-to-dark pixel intensity transitions.</li> <li>Dark to Bright Only—Finds only those edges characterized by dark-to-bright pixel intensity transitions along the direction of the search line.</li> <li>Bright to Dark Only—Finds only those edges characterized by bright-to-dark pixel intensity transitions along the direction of the search line.</li> </ul>
Auto Setup	When enabled, the step determines a set of parameters optimized to locate all edges in the region of interest automatically, regardless of polarity.
Minimum Edge Strength	Minimum difference in the intensity values between the edge and its surroundings.

Kernel Size	Specifies the size of the edge detection kernel.
Projection Width	Specifies the number of pixels averaged perpendicular to the search direction to compute the edge profile strength at each point along the region of interest.
Edge Strength Profile	A graphical representation of the edge contrast along the search line.

# Advanced Tab

The following controls are available on the Advanced tab.

<b>Control Name</b>	Description
Edge Strength Profile	A graphical representation of the edge contrast along the search line. The yellow lines indicate the location of the edges.
Edge Points Found	Displays information about the edge points found on the specified <b>Search Line/Edge Index</b> . The following information is displayed for each edge:
	<ul> <li>Strength—Strength of the edge. Values range from 0 to 1000 with larger values indicating a stronger edge.</li> </ul>
	<ul> <li>STR—Signal to threshold ratio for the edge, expressed in decibels.</li> </ul>
	<ul> <li>TNR—Threshold to noise ratio for the edge, expressed in decibels.</li> </ul>
	<ul> <li>SNR—Signal to noise ratio for the edge, expressed in decibels.</li> </ul>

# Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>	Description
Minimum Number of Edges	Minimum number of edges you expect the step to find.
Maximum Number of Edges	Maximum number of edges you expect the step to find.
Number of Edges Found	Number of edges the step found.
Step Results	Displays information about the edges found in the image.
	Note When you calibrate the image using a <b>Calibrate Image</b> step, <b>X</b> and <b>Y</b> are returned in the calibration unit you specified.

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# **Find Edges FAQs**

#### Q: The Reposition Region of Interest and Reference Coordinate System controls are dimmed. How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.

#### Q: What settings does Auto Setup use?

**Auto Setup** analyzes the pixel information along the region of interest and estimates the parameters that locate the maximum number of strong, distinct edges. The parameter values estimated by **Auto Setup** appear in the dimmed setting controls.

#### Q: Why are the edge points different colors?

The blue edge points represent edges whose pixels go from dark to light intensity values. The red edge points represent edges whose pixels go from light to dark intensity values.

# Q: What should I do if the step does not find the edges but the Edge Strength Profile shows definite peaks?

In the Edge Strength Profile, drag the blue edge strength line until it lies below the peaks, or decrease the value of the **Minimum Edge Strength** control.

# Q: What should I do if the step finds edges in locations slightly different from where I expected them?

- 1. Adjust the **Kernel Size** and **Projection Width** values until the profile shows peaks at the appropriate locations.
- 2. Drag the yellow edge strength line in the profile until it lies below the peaks, or adjust the **Minimum Edge Strength** control.



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# **Find Straight Edge Concepts**

The **Find Straight Edge** step searches for a straight edge in a twodimensional region of interest. The region of interest contains a number of search lines along which the step searches for sharp transitions in pixel intensities. A sharp transition typically characterizes the edge of an object in the image. The step fits a straight line through the individual edge points of each search line to determine a straight edge on the object under inspection.

The step locates an edge based on its edge strength. You can study the **Edge Strength Profile** to determine the edge strengths for each search line in the region of interest. A peak in the profile indicates that an edge is present at that position in the region of interest. The strength of that edge is given by the amplitude of the peak.

The default region of interest tool is a rectangle. If the edge you want to locate is at an angle in the image, use the rotated rectangle tool to draw the region of interest. If the edge extends radially from a center point, use the annulus tool to draw the region.

Draw the region of interest so that it encloses the entire edge that you want to find but excludes as many edges of no interest as possible. Make sure the edge fills up most of the region length. Also, make sure that the region is at least 20 pixels wide on either side of the edge to accurately detect the points along the edge.



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How to Find a Straight Edge

### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.
- 3. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.
  - **Tip** Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

When you specify a region of interest, the step automatically tries to locate a straight edge in the region. If the automatically located edge corresponds to the edge you expected to find, proceed to step 5. Otherwise, proceed to step 4.

### **Settings Tab**

4. Select the **Direction** property of the search lines. Select a search line orientation that is perpendicular to the edge. For example, the orientation of the edge in the following figure is vertical. Therefore, the search lines are horizontal.

Also, select the search direction along the lines that has the least number of obstacles between the edge of the region and the object edge you want to find. In the following figure, the search direction is right to left so that the step avoids detecting the edges of miscellaneous objects.



- 5. Select the Edge Polarity of the edges you want to locate.
- 6. Choose the type of edges you want to detect from the **Look For** control. You can choose from **First Edge** or **Best Edge**.
- 7. If the automatically located straight edge corresponds to the edge you expected to find, proceed to step 8. Otherwise, disable the **Auto Setup** control and manually adjust the edge location parameters. Use the edge information on the Advanced tab to determine appropriate settings for the edge location parameters.

If the Edge Strength Profile contains a strong peak that corresponds to the edge you want to find, adjust the blue edge strength line so that it lies slightly below the top of the edge peak but above all of the other peaks. Use the **Search Line Index** control to display edge profile information for each search line in the region of interest.

If the Edge Strength Profile does not contain peaks that correspond to all the edges, adjust the **Kernel Size** and **Projection Width** controls until distinct peaks appear. If the step still cannot find the edge or the location of the detected edge is inaccurate, adjust the **Gap** between the search lines until you achieve the expected result.

## Limits Tab

8. Set the limits that correspond to the specifications of the part under inspection.

The following figures illustrate the calculations you can use to locate a straight edge within a region of interest.



**Note** The Short Distance and Long Distance measurements are not available for annulus regions of interest.









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Find Straight Edge Controls

## Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

# Settings Tab

The following controls are available on the Settings tab.

Direction in which you want the search lines to look for a straight edge within the region of interest. The following options are available: • Left to Right—Searches for edges from left to
<ul> <li>Left to Right—Searches for edges from left to</li> </ul>
right.
<ul> <li>Right to Left—Searches for edges from right to left.</li> </ul>
<ul> <li>Top to Bottom—Searches for edges from top to bottom.</li> </ul>
<ul> <li>Bottom to Top—Searches for edges from bottom to top.</li> </ul>
<ul> <li>Specifies the pixel intensity transitions to use to determine edges. The following options are available:</li> <li>All Edges—Finds edges characterized by dark-to-bright and bright-to-dark pixel intensity transitions.</li> <li>Dark to Bright Only—Finds only those edges characterized by dark-to-bright pixel intensity transitions along the direction of the search line.</li> <li>Bright to Dark Only—Finds only those edges characterized by bright-to-dark pixel intensity transitions along the direction of the search line.</li> </ul>
<ul> <li>Specifies the type of edges to find in the image. The following options are available:</li> <li>First Edge—Finds only the first edge of the specified polarity along each independent search line based on the direction of the search line.</li> <li>Best Edge—Finds only the best edge of the specified polarity along each independent search line.</li> </ul>

Auto Setup	When enabled, the step automatically locates the strongest edge in the region of interest and returns the parameters it used to find the edge.
Minimum Edge Strength	Minimum difference in the intensity values between the edge and its surroundings.
Kernel Size	Specifies the size of the edge detection kernel.
Projection Width	Specifies the number of pixels averaged perpendicular to the search direction to compute the edge profile strength at each point along the region of interest.
Gap	Specifies the size, in pixels, of the space between the search lines.
Edge Strength Profile	Graphical representation of the edge contrast along the search line specified by the <b>Search Line Index</b> .
Search Line Index	Specifies the index of the search line represented in the <b>Edge Strength Profile</b> .

# Advanced Tab

The following controls are available on the Advanced tab.

<b>Control Name</b>	Description
Edge Strength Profile	A graphical representation of the edge contrast along the specified search line. The yellow line indicates the location of the found edge.
Search Line Index	Specifies the index of the search line represented in the <b>Edge Strength Profile</b> .
Edge Points Found	Displays information about the edge points found along all the search lines in the ROI. The following information is displayed for each edge:
	<ul> <li>Strength—Strength of the edge. Values range from 0 to 1000 with larger values indicating a stronger edge.</li> </ul>
	<ul> <li>STR—Signal to threshold ratio for the edge, expressed in decibels.</li> </ul>
	<ul> <li>TNR—Threshold to noise ratio for the edge, expressed in decibels.</li> </ul>
	<ul> <li>SNR—Signal to noise ratio for the edge, expressed in decibels.</li> </ul>
# Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>	Description
Minimum Angle	Minimum counterclockwise angle at which the edge can be located from a line perpendicular to the search direction.
Maximum Angle	Maximum counterclockwise angle at which the edge can be located from a line perpendicular to the search direction.
Maximum Deviation	Maximum average error between found edge points and the fitted straight line.
Minimum Short Distance	<ul> <li>Minimum distance allowed for the shorter of the following distances:</li> <li>The distance between the start point of the first search line and the intersection of the fitted line and the first search line.</li> <li>The distance between the start point of the last search line and the intersection of the fitted line and the last search line.</li> </ul>
Maximum Long Distance	<ul> <li>Maximum distance allowed for the longer of the following distances:</li> <li>The distance between the start point of the first search line and the intersection of the fitted line and the first search line.</li> <li>The distance between the start point of the last search line and the intersection of the fitted line and the last search line.</li> </ul>
Step Results	<ul> <li>Displays information about the straight edge found in the image.</li> <li>Note When you calibrate the image using a Calibrate Image step, X and Y are returned in the calibration unit you specified.</li> </ul>



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# **Find Straight Edge FAQs**

#### Q: The Reposition Region of Interest and Reference Coordinate System controls are dimmed. How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.

#### Q: What settings does Auto Setup use?

**Auto Setup** tries to determine the best straight edge in the region of interest by searching through several combinations of edge parameters in the specified search direction. The values for **Minimum Edge Strength**, **Kernel Size**, **Projection Width**, and **Gap** are estimated to find the best edge. The quality of the edge is based on the strength of the edge along the fitted line. The parameters that locate the strongest edge are returned as the **Auto Setup** results. The parameter values estimated by **Auto Setup** appear in the dimmed setting controls.



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# **Find Circular Edge Concepts**

The **Find Circular Edge** step searches for a circular edge in a twodimensional, annulus-shaped region of interest. The region of interest contains a number of search lines along which the step searches for sharp transitions in pixel intensities. A sharp transition typically characterizes the edge of an object in the image. The step fits a circle through the individual edge points of each search line to determine a circular edge on the object under inspection.

Note The search lines extend radially in the region of interest.

For the best results, ensure that the region of interest encloses the entire edge that you want to find but excludes as many edges of no interest as possible. Make sure the edge fills up most of the region length. Also, make sure that the region is at least 20 pixels wide on either side of the edge to accurately detect the points along the edge.



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How to Find a Circular Edge

### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.

When you specify a region of interest, the step automatically tries to locate a circular edge in the region. If the automatically located edge corresponds to the edge you expected to find, proceed to step 5. Otherwise, proceed to step 4.

3. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

### **Settings Tab**

- 4. Select the **Direction** property of the search lines. Select the search direction along the lines that has the least number of obstacles between the edge of the region and the object edge you want to find.
- 5. Select the **Edge Polarity** of the circular edge you want to find.
- 6. Choose the type of edges you want to detect from the **Look For** control. You can choose from **First Edge** or **Best Edge**.
- 7. If the automatically located circular edge corresponds to the edge you expected to find, proceed to step 8. Otherwise, disable the **Auto Setup** control and manually adjust the edge location parameters. Use the edge information on the Advanced tab to determine appropriate settings for the edge location parameters.

If the Edge Strength Profile contains a strong peak that corresponds to the edge you want to find, adjust the blue edge strength line so that it lies slightly below the top of the edge peak but above all of the other peaks. Use the **Search Line Index** control to display edge profile information for each search line in the region of interest.

If the Edge Strength Profile does not contain peaks that correspond to all the edges, adjust the **Kernel Size** and **Projection Width** controls until distinct peaks appear. If the step still cannot find the edge or the location of the detected edge is inaccurate, adjust the **Gap** between the search lines until you achieve the expected result.

## Limits Tab

8. Set the limits that correspond to the specifications of the part under inspection.



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Find Circular Edge Controls

## Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

# Settings Tab

The following controls are available on the Settings tab.

<b>Control Name</b>	Description
Direction	Direction in which you want the search lines to look for a straight edge within the region of interest. The following options are available:
	<ul> <li>Outside to Inside—Searches for edges from the outside edge to inside edge of the region of interest.</li> </ul>
	<ul> <li>Inside to Outside—Searches for edges from the inside edge to outside edge of the region of interest.</li> </ul>
Edge Polarity	<ul> <li>Specifies the pixel intensity transitions to use to determine edges. The following options are available:</li> <li>All Edges—Finds edges characterized by dark-to-bright and bright-to-dark pixel intensity transitions.</li> <li>Dark to Bright Only—Finds only those edges characterized by dark-to-bright pixel intensity transitions along the direction of the search line.</li> <li>Bright to Dark Only—Finds only those edges characterized by bright-to-dark pixel intensity transitions along the direction of the search line.</li> </ul>
Look For	<ul> <li>Specifies the type of edges to find in the image. The following options are available:</li> <li>First Edge—Finds only the first edge of the specified polarity along each independent search line based on the direction of the search line.</li> <li>Best Edge—Finds only the best edge of the specified polarity along each independent search line.</li> </ul>
Auto Setup	When enabled, the step locates the strongest edge in the region of interest using the specified <b>Direction</b> , <b>Edge Polarity</b> , and <b>Look For</b> values and returns the

	parameters used to find the edge.
Minimum Edge Strength	Minimum difference in the intensity values between the edge and its surroundings. Only those edges whose strength is greater than this value are used in the detection process.
Kernel Size	Specifies the size of the edge detection kernel.
Projection Width	Specifies the number of pixels averaged perpendicular to the search direction to compute the edge profile strength at each point along the region of interest.
Gap	Number of degrees between search lines in the region of interest.
Edge Strength Profile	Graphical representation of the edge contrast along the search line specified by the <b>Search Line Index</b> .
Search Line Index	Specifies the index of the search line represented in the <b>Edge Strength Profile</b> .

## Advanced Tab

The following controls are available on the Advanced tab.

<b>Control Name</b>	Description
Edge Strength Profile	Graphical representation of the edge contrast along the search line specified by the <b>Search Line Index</b> . The yellow line indicates the location of the found edge.
Search Line Index	Specifies the index of the search line represented in the <b>Edge Strength Profile</b> .
Edge Points Found	Displays information about the edge points found along all the search lines in the ROI. The following information is displayed for each edge:
	<ul> <li>Strength—Strength of the edge. Values range from 0 to 1000 with larger values indicating a stronger edge.</li> </ul>
	<ul> <li>STR—Signal to threshold ratio for the edge, expressed in decibels.</li> </ul>
	<ul> <li>TNR—Threshold to noise ratio for the edge, expressed in decibels.</li> </ul>
	<ul> <li>SNR—Signal to noise ratio for the edge, expressed in decibels.</li> </ul>

## Limits Tab

The following controls are available on the Limits tab.

Note If you calibrate the image using the **Calibrate Image** step, **Current Radius** is returned in the calibration unit you specified. Therefore, **Minimum Radius** and **Maximum Radius** must be specified in calibration units.

<b>Control Name</b>	Description
Minimum Radius	Minimum radius the detected circle can have.
Maximum Radius	Maximum radius the detected circle can have.
Maximum Deviation	Maximum average error between found edge points and the fitted straight circle.
Step Results	<ul> <li>Displays information about the detected circle in the image.</li> <li>Note When you calibrate the image using a Calibrate Image step, X and Y are returned in the calibration unit you specified.</li> </ul>



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# **Find Circular Edge FAQs**

Q: Reposition Region of Interest and Reference Coordinate System are dimmed. How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.

#### Q: What settings does Auto Setup use?

**Auto Setup** tries to determine the best circular edge in the region of interest by searching through several combinations of edge parameters in the specified search direction. The values for **Minimum Edge Strength**, **Kernel Size**, and **Projection Width**, and **Gap** are estimated to find the best edge. The quality of the edge is based on the strength of the edge along the fitted circle. The parameters that locate the strongest edge are returned as the **Auto Setup** results. The parameter values estimated by **Auto Setup** appear in the dimmed setting controls. Po

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# **Match Pattern Concepts**

The **Match Pattern** step is based on a technique called pattern matching. With pattern matching you create a template—or pattern—that represents the object for which you are searching. Then your inspection step searches for the pattern in each acquired image or portion of the image, calculating a score for each match. The score relates how closely the instances of the template match the pattern.

The selection of a good template image plays a critical part in obtaining good results. Because the template image represents the pattern that you want to find, make sure that all the important and unique characteristics of the pattern are well defined in the image. Several factors are critical in creating a template image, as follows:

• **Symmetry**—A rotationally symmetric template, as shown in Figure 1a, is less sensitive to changes in rotation than one that is rotationally asymmetric, as shown in Figure 1b. A rotationally symmetric template provides good positioning information but no orientation information.





• Feature detail—A template with relatively coarse features is less sensitive to variations in size and rotation than a template with fine features. However, a template must contain enough detail for the software to accurately identify matches to the template. Figure 2a shows a template with good feature detail. Figure 2b shows a template with ambiguous feature detail.



Figure 2

• **Positional information**—A template with strong edges in both the x and y directions, as shown in Figure 3a, is easier to locate than a template with edges in only one direction, as shown in Figure 3b.





• **Background information**—Unique background information in a template, as shown in Figure 4b, improves search performance and accuracy.



Figure 4

When learning a template, you can choose to mask portions of the template that my vary between images. Masked areas in a template are ignored during the matching process. Masking inconsistent portions of a template can significantly increase the reliability pattern matching.

The following image demonstrates using a pattern matching mask to ignore regions of a template that change from image to image. When the pattern matching algorithm learns the template, it will ignore the serial number and the 2D code that change from image to image.



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**How to Match Patterns** 

## **Template Editor**

- 1. Draw a region of interest around an area of the image for which you want to search in your inspection images. This region becomes the pattern matching template.
- 2. Click **Next** to accept the template.
- 3. Specify any areas of the template you want to ignore during pattern matching.
- 4. Click **Finish** to learn the template image.

When you specify a template, the step automatically tries to find the template in the image. Template matches appear inside red rectangles in the image. The green rectangle indicates the region of interest in which the step searches for matches.

### Main Tab

- 3. In the **Step Name** control, enter a descriptive name for the step.
- 4. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.
- 5. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

**Note** This step can find rotated instances of the template without the assistance of a **Set Coordinate System** step.



## **Template Tab**

By default, the center of the template is used as the focal point of the template. You can change the location of the focal point to any position in the template.

6. Change the focal point of the template by dragging the green pointer in the template image or adjusting the Match Offset values.

### **Settings Tab**

- 7. Set up the search conditions for finding the template.
  - a. Select the number of matches you expect in the image.
  - b. Specify whether a match can be a rotated version of the template. You can restrict the amount of rotation you want to allow by specifying an acceptable angle range. You can also include the mirrored angle range by enabling the **Mirror Angle** control.
  - c. Set the minimum score that a match must have to be valid. Refer to the **Matches** table in the **Limits** tab to determine this score. The table lists matches whose score is above the minimum score and the first match whose score is below the minimum score. You can use this table to choose a **Minimum Score** value that finds the number of matches you request but excludes unwanted matches.
  - d. Adjust the **Search Level** control to choose the appropriate search strategy for your application. If the template is very distinctive and different from the rest of the image, choose a more coarse strategy. This is the fastest but least thorough search level. As the template information becomes less distinctive and more similar to the background, use a more thorough search level.

## Limits Tab

8. Set the minimum and/or maximum number of matches you expect to find.

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**Match Pattern Controls** 

## Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

# Template Tab

The following controls are available on the Template tab.

<b>Control Name</b>	Description
Template Image	Image you want to search for in an inspection image. Portions of the template ignored during matching are shown in red.
Template Size	The width and height, in pixels, of the selected template image.
Create Template	When clicked, this button launches the template editor. Use the template editor to select a region of the image to become the template. You can also specify areas of the template to ignore.
Edit Template	When clicked, this button launches the template editor and allows you to modify an existing template.
Match Offset	Specifies the number of pixels you want to shift the focal point of the template from the center of the template. The focal point of the template is the coordinate location of the template match within an inspection image.

# Settings Tab

The following controls are available on the Settings tab.

<b>Control Name</b>	Description
Number of Matches to Find	Specifies the number of matches you expect to find in the image.
Minimum Score	Specifies the minimum score an instance of the template can have to be considered a valid match. This value can vary between 0 and 1000. A score of 1000 indicates a perfect match.
Search Level	Specifies the thoroughness with which you want to search for template matches. A coarse search is faster but sometimes less accurate than a thorough search. A thorough search is very accurate but takes more time than a coarse search.
Search for Rotated Patterns	When enabled, the step searches for the template at all specified angle ranges in the inspection image.
Angle Range (Degrees)	Specifies the angles at which you want to search for the template image. The step searches for the template image at angles ranging from the positive angle to the negative angle, as shown in the graph adjacent to this control.
Mirror Angle	When enabled, the step searches for the template image in the angle range you specified in Angle Range (degrees) and the mirror of that angle range, as shown in the graph adjacent to this control.

## Limits Tab

The following controls are available on the Limits tab.

Note If you calibrate the image using the **Calibrate Image** step, **X** and **Y** are returned in the calibration unit you specified.

<b>Control Name</b>	Description
Minimum Number of Matches	Minimum number of matches you expect the step to find.
Maximum Number of Matches	Maximum number of matches you expect the step to find.
Matches	<ul> <li>Displays information about the possible matches.</li> <li>Possible matches whose scores are less than Minimum</li> <li>Score appear in a different color with the match number in parentheses.</li> <li>X—X-coordinate position of the match at the focal point.</li> <li>Y—Y-coordinate position of the match at the focal point.</li> <li>Angle—Clockwise angle of the match from the x-axis.</li> <li>Score—Number ranging from 0 to 1000 that indicates how similar a potential match is to the template image. A score of 1000 indicates a perfect match. A score of 0 indicates no match.</li> </ul>
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# **Match Pattern FAQs**

# Q: Reposition Region of Interest and Reference Coordinate System are dimmed. How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.

#### Q: What does the green dot in the template image indicate?

The green dot indicates the point on the template whose coordinate location you want returned when the step finds matches of the template in the inspection image.

#### Q: When should I mirror the search angle?

Mirror the search angle when the fixture of the part under inspection constrains the location of the part along a specified axis. Another typical use for this parameter is to find templates that are symmetric along one axis.

#### Q: What is the difference between the green and red overlays?

The green overlay indicates the region of the image in which you want to search for matches to the template. The red overlay indicates an area that matches the template.

# Q: Why does the Matches table sometimes contain one match more than I requested?

The **Matches** table displays one extra match, in a different color with the match number in parentheses, if the step can find one. The score for the extra match is an estimation of the **Minimum Score** required for the step to return the object as a match. The actual **Minimum Score** required to return the object as a match may vary from the estimated score. However, you can use the estimated score of the extra match to adjust the **Minimum Score**, as follows:

- If the step does not find all of the matches you specified in the **Number of Matches to Find** control, set the **Minimum Score** to be less than the score of the match you want.
- If the step finds all of the matches you specified in the Number

of Matches to Find control, set Minimum Score to be between the scores of the last expected match and the extra match listed in the Matches table.

The **Minimum Score** must be low enough to detect the expected patterns properly but high enough to avoid detecting mismatches—areas of the image with some degree of similarity to the learned template. To build a reliable inspection process, maximize the range between the lowest score of the expected matches and the highest score of the extra matches. Also, take into account the usual variations of your process when setting the **Minimum Score**.



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# **Geometric Matching Concepts**

The **Geometric Matching** step locates regions in a grayscale image that match a model, or template, of a reference pattern. Geometric matching is specialized to locate templates that are characterized by distinct geometric or shape information.

When using geometric matching, you create a template that represents the object for which you are searching. Vision Builder AI then searches for instances of the template in each inspection image and calculates a score for each match. The score relates how closely the template resembles the located match.

Geometric matching finds templates regardless of lighting variation, blur, noise, occlusion, and geometric transformations such as shifting, rotation, or scaling of the template.

The following figure shows examples of objects with good geometric or shape information.



You can use geometric matching in the following application areas:

- **Gauging**—Locates the object, or areas of the object, you want to gauge. Use information about the size of the object to preclude geometric matching from locating objects whose sizes are too big or small.
- **Inspection**—Detects simple flaws in objects. Use the occlusion score returned by geometric matching to determine if an area of the object under inspection is missing. Use the curve matching scores returned by geometric matching to compare the boundary (or edges) of a reference object to the object under inspection.
- Alignment—Determines the position and orientation of a known object by locating points of reference on the object or characteristic features of the object.
- **Sorting**—Sorts objects based on shape and/or size. Geometric matching returns the location, orientation, and size of each object. You can use the location of the object to pick up the object

and place it into the correct bin. Use geometric matching to locate different types of objects, even when objects may partially occlude each other.



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How to use Geometric Matching

## **Template Selection Interface**

- 1. Draw a region of interest around an area of the image for which you want to search in your inspection images. This region becomes the geometric pattern matching template.
- 2. Click **OK** to accept the template.

When you specify a template, the step automatically tries to find the template in the image. Template matches appear inside red rectangles in the image. The green rectangle indicates the region of interest in which the step searches for matches.

### Main Tab

- 3. In the **Step Name** control, enter a descriptive name for the step.
- 4. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.
- 5. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.



**Note** This step can find rotated instances of the template without the assistance of a Set Coordinate System step.

## Template Tab

By default, the center of the template is used as the focal point of the template. You can change the location of the focal point to any position in the template.

6. Change the focal point of the template by adjusting the **Match Offset** values.

### **Curve Tab**

By default, the values of the parameters in this tab are initialized to the values you selected in the training interface. You can adjust these values to improve edge detection in the inspection image.

7. If necessary, modify the Extraction Mode, Edge Threshold, Edge Filter Size, Minimum Length, Row Search Step Size, and Column Search Step Size to improve edge detection.

## **Settings Tab**

- 8. Set Number of Matches to Find and Minimum Score.
- 9. Enable **Rotated**, **Scaled**, or **Occluded** to indicate that a match may be a rotated, scaled, or occluded version of the template. Specify an acceptable range for each parameter to restrict the amount of rotation, scale, or occlusion allowed in a valid match.

# Limits Tab

10. Set the minimum and/or maximum number of matches you expect to find.



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**Geometric Matching Controls** 

# Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

# Template Tab

The following controls are available on the Template tab.

<b>Control Name</b>	Description
Template Image	Image you want to search for in an inspection image.
Template Size	The width and height, in pixels, of the selected template image.
New Template	Launches the NI Vision Template Editor wizard, in which you can learn a template and use the resulting template for searching.
Edit Template	Launches the Geometric Matching Training Interface wizard, in which you can modify an existing template and use the resulting template for searching.

# Curve Tab

The following controls are available on the Curve tab.

<b>Control Name</b>	Description		
Extraction Mode	Specifies the mode to use to identify the location of the curves in the image.		
	<ul> <li>Normal—Makes no assumptions about the uniformity of objects in the image or the image background.</li> </ul>		
	<ul> <li>Uniform Regions—Assumes that either the objects in the image or the image background consists of uniform pixel values. Use this mode to calculate the external curves of objects with greater accuracy.</li> </ul>		
Edge Threshold	Specifies the threshold value for grayscale edge detection. This value can range from 0 to 255. The default value is 75.		
Edge Filter Size	<ul> <li>Specifies the kernel size for computing the edges in the image. The following options are available:</li> <li>Normal</li> <li>Fine</li> </ul>		
Minimum Length	Specifies the minimum length, in pixels, of an extracted curve. The default value is 25.		
Row Search Step Size	Specifies the number of pixels to skip in the vertical direction when searching for curves. The default value is 15.		
Column Search Step Size	Specifies the number of pixels to skip in the horizontal direction when searching for curves. The default value is 15.		

# Settings Tab

The following controls are available on the Settings tab.

<b>Control Name</b>		Description	
Number of Matches to Find	Specifies the number of valid matches you expect the geometric matching function to return.		
Minimum Score	Specifies the minimum score an instance of the template can have to be considered a valid match. This value can range from 0 to 1000. A score of 1000 indicates a perfect match.		
Rotated	When enabled, the step searches for the template image within the angle range you specify. When disabled, this function searches for the image regardless of shifting along the x-axis and y-axis.		
Scaled	When enabled, the step searches for a template image that may be scaled in the inspection image.		
Occluded	When enabled, the step searches for a template image that may be occluded in the inspection image.		
Matches	Displays the following information after searching the image for the template:		
	Property	Description	
	Score	Score of each valid match. Score values can range from 0 to 1000. A score of 1000 indicates a perfect match.	
	X Position	X-coordinate of each object that matches the template.	
	Y Position	Y-coordinate of each object that matches the template.	
	Angle	Rotation angle, in degrees, of each object that matches the template at the current match location. This output is valid only when you enable the <b>Rotated</b> control on the <b>Settings</b> tab.	

Scale	The percent change in scale of the object found in the image relative to the template.
Occlusion %	The amount of occlusion for each object that matches the template.
Template Target Curve Score	Specifies how closely the curves in the template match the curves in the match region of the inspection image. Score values can range from 0 to 1000. A score of 1000 indicates that all template curves have a corresponding curve in the match region of the inspection image.
Correlation Score	Specifies how closely a match matches the template using a correlation metric that compares the two regions as a function of their pixel values.

# Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>		Description	
Minimum Number of Matches	Minimum number of matches you expect the step to find.		
Maximum Number of Matches	Maximum number of matches you expect the step to find.		
Number of Matches Found	Number of matches the step found.		
Matches	Displays the following information after searching the image for the template:		
	Property	Description	
	Score	Score of each valid match. Score values can range from 0 to 1000. A score of 1000 indicates a perfect match.	
	X Position	X-coordinate of each object that matches the template.	
	Y Position	Y-coordinate of each object that matches the template.	
	Angle	Rotation angle, in degrees, of each object that matches the template at the current match location. This output is valid only when you enable the <b>Rotated</b> control on the <b>Settings</b> tab.	
	Scale	The percent change in scale of the object found in the image relative to the template.	
	Occlusion %	The amount of occlusion for each object that matches the template.	
	Template Target	Specifies how closely the curves in the template match the curves in the match	

CI So	urve core	region of the inspection image. Score values can range from 0 to 1000. A score of 1000 indicates that all template curves have a corresponding curve in the match region of the inspection image.
Ci Si	orrelation core	Specifies how closely a match matches the template using a correlation metric that compares the two regions as a function of their pixel values.



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# **Geometric Matching FAQs**

Q: Reposition Region of Interest and Reference Coordinate System are dimmed. How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.

#### Q: What does the red dot in the template image indicate?

The red dot indicates the coordinate location on the template that is returned when the step finds template matches in the inspection image. The offset between the center of the template and the match location returned can be specified in the NI Vision Template Editor.

#### Q: What is the difference between the green and red regions?

The green region indicates the area of the image in which you want to search for matches to the template. The red region indicates an area that matches the template.

# Q: Additional edges are detected in the image, besides the curves of my template. Does this affect the accuracy of the matching?

Extra edge detection can negatively affect the accuracy of geometric matching. Adjust the curve parameters so that the algorithm detects only the curves of your template object. For example, if the algorithm detects additional edges because of glare, use the Geometric Matching Training Interface to define regions with edges you want the function to ignore.

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# **Set Coordinate System Concepts**

The **Set Coordinate System** step defines a coordinate system relative to a feature in the image.

In a typical machine vision inspection, you limit your inspection and processing to a region of interest rather than the entire image. To limit the inspection area, the parts of the object you are interested in must always appear inside the region of interest you define.

If the object under inspection is always at the same location and orientation in the images you need to process, defining a region of interest is simple. However, the object under inspection often appears shifted or rotated within the images you need to process. When this occurs, the region of interest needs to shift and rotate with the parts of the object you are interested in. In order for the region of interest to move in relation to the object, you need to define a coordinate system relative to a feature in the image.

A coordinate system is specified by its origin and the angle its x-axis makes with the horizontal axis of the image. Assign a coordinate system based on how you expect the object to move in the image. If the object is going to only translate in the horizontal or vertical directions, you need only to select a feature whose location can represent the origin of the coordinate system. The angle is 0 by default. If the object is going to translate and rotate, you need to select features that can represent the location of the origin and angle of the coordinate system.  $\downarrow$ 

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How to Set a Coordinate System

### Main Tab

1. In the **Step Name** control, enter a descriptive name for the step.

## **Settings Tab**

- 2. Select the mode that best represents the position of the object under inspection. Take into account the position of the camera, lighting, and the type of synchronization between the image acquisition and the motion of the object under inspection.
- 3. Select the feature whose location and angle measurement you want to use to specify the origin and angle of the coordinate system. Refer to <u>Set Coordinate System Concepts</u> for information.

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Set Coordinate System Controls

# Main Tab

The following control is available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.

# Settings Tab

The following controls are available on the Settings tab.

<b>Control Name</b>	Description		
Mode	Directions in which you expect the object under inspection to move within the inspection images. The following options are available:		
	<ul> <li>Horizontal Motion—When selected, Vision Builder AI adjusts the region of interest positions for moves along the horizontal axis of the image for steps linked to this Set Coordinate System step. Select this mode when the position of the object under inspection is mechanically constrained so that the part cannot rotate or move vertically within the camera's field of view.</li> </ul>		
	<ul> <li>Vertical Motion—When selected, Vision Builder Al adjusts the region of interest positions for moves along the vertical axis of the image for steps linked to this Set Coordinate System step. Select this mode when the position of the object under inspection is mechanically constrained so that the part cannot rotate or move horizontally within the camera's field of view.</li> </ul>		
	<ul> <li>Horizontal and Vertical Motion—When selected, Vision Builder AI adjusts the region of interest positions for moves along the horizontal and vertical axes of the image for steps linked to this Set Coordinate System step. Select this mode when the position of the object under inspection is mechanically constrained so that the part cannot rotate within the camera's field of view.</li> <li>Horizontal Vertical and Angular Motion—</li> </ul>		
	When selected, Vision Builder AI adjusts the region of interest positions for moves along the horizontal and vertical axes as well as rotational		

	<ul> <li>changes for steps linked to this Set Coordinate</li> <li>System step. Select this mode when the position of the object under inspection is not mechanically constrained.</li> <li>Tip This mode requires more time to reposition a region of interest than the other modes. If the object does not rotate in the field of view, select another mode that meets your application needs.</li> </ul>
Origin	Feature whose x-coordinate and y-coordinate locations are used as the origin of the coordinate system. You may also use the value of a point variable as the origin.
X-Axis Angle	Feature whose angle measurement you want to use to represent the angle made by the x-axis of the coordinate system and the horizontal axis of the system. This control is available only if you select the <b>Horizontal</b> , <b>Vertical</b> , and <b>Angular Motion</b> mode.
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# Set Coordinate System FAQs

# Q: Why are there no measurements listed in the X-Axis Angle listbox?

You must configure a step that defines an x-axis angle or produces a numeric result for the X-Axis Angle listbox to contain items. You can use Match Pattern, Find Straight Edge, and Geometry to define an x-axis angle or steps such as the Calculator or Run LabVIEW VI steps that produce numeric results or a variable.

# Q: I want to select an x-axis angle but the items in the X-Axis Angle list are dimmed. What should I do?

Select the Horizontal, Vertical, and Angular Motion option of the Mode control to enable the X-Axis Angle list.

# Q: What steps should I use to find features on which to base a coordinate system origin?

Coordinate system origins are based on feature locations. You can locate features using the following steps: Find Edges, Find Straight Edge, Find Circular Edge, Detect Objects, Match Pattern, Caliper, and Geometry.



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## **Detect Objects Concepts**

The **Detect Objects** step is based on a technique called particle analysis. A particle is an area of touching pixels with the same logical state. All pixels in an image that belong to a particle are in a foreground state. All other pixels are in a background state. In a binary image, pixels in the background have values equal to zero while every nonzero pixel is part of a particle.

You can use particle analysis to detect particles in an image and make selected measurements of those particles. Particle analysis consists of a series of processing operations and analysis functions that produce information about any two-dimensional shape in an image.

### Thresholding

Thresholding enables you to select ranges of pixel values in grayscale and color images that separate the objects under consideration from the background. Thresholding converts an image into a binary image, with pixel values of 0 or 1. This process works by setting to 1 all pixels whose value falls within a certain range, called the threshold interval, and setting all other pixel values in the image to 0. Figure 1a shows a grayscale image, and Figure 1b shows the same image after thresholding.



Figure 1

### **Binary Morphology**

Because thresholding is a subjective process, the resulting binary image may contain unwanted information, such as noise particles, particles touching the border of images, particles touching each other, and particles with uneven borders. By affecting the shape of particles, morphological functions can remove this unwanted information, thus improving the information in the binary image.



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How to Detect Objects

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest that includes all of the objects you want to detect. Minimize the number of noisy objects in the region of interest to improve the accuracy of the inspection step.
      - Note A noisy object is an object with characteristics similar to the objects you want to detect but is irrelevant to the current inspection step.
  - Select a previously defined region of interest from the **Region of Interest** listbox.

When you specify a region of interest, the step automatically tries to locate objects in the region. Pixels with intensity values in the specified threshold range appear blue in the image. A red region and label mark the bounding rectangles of each individual object that the step located.

3. Verify that the **Reposition Region of Interest** checkbox is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

### **Threshold Tab**

4. Choose the type of objects you want to detect from the **Look For** control.

If the intensities of the pixels that belong to objects of interest are brighter (greater) than the surrounding—particularly if the pixels along the inside boundary of the objects are brighter than their surrounding pixels—choose **Bright Objects**. If the pixels that belong to the objects of interest are darker (less) than their surrounding pixels, choose **Dark Objects**. In all other cases, choose **Gray Objects**.

- 5. Select the thresholding method you want to use from the **Method** listbox. This Histogram shows the range of pixel intensities in the region of interest.
- 6. Specify the threshold range.
  - For Manual Thresholding methods, use the **Lower Value** and **Upper Value** controls to specify the threshold range.
    - Note You can specify a constant, a previous measurement, or a variable for the threshold range.
  - For Automatic Thresholding methods, the step automatically specifies a threshold range corresponding to the region of interest based on the selected thresholding Method. Use the Lower Limit and Upper Limit controls to coerce the threshold range to use a specific range of values.
  - For Local Thresholding methods, the step calculates threshold values for each pixel based on the statistics of surrounding pixels. Use the Kernel size control to specify the approximate size of the objects to threshold.
- 7. Study the blue regions in the image. If all of the objects you want to detect are highlighted with a red rectangle, go to step 12. Otherwise, adjust the settings in the **Settings** tab.

#### **Settings Tab**

- 8. Enable the Ignore Objects Touching Region of Interest control to remove objects that touch the border of the inspection region. Information about these objects is usually incomplete, so you may want to ignore them.
- 9. Enable the **Fill Holes Within Objects** control to remove any holes within the detected objects. Enabling this control results in more accurate area measurements when you are uncertain about the optimal threshold range.



- **Note** Do not enable this option if your object is supposed to have physical holes in it.
- 10. Enable the Minimum Object Size and Maximum Object Size controls to limit the area of the objects you want to find. Use the Object Measurement table to determine the size of your objects of interest.
- 11. Specify the order in which the objects are returned using the **Sort** by control. By default, objects are listed in the order the algorithm detected them, scanning the region of interest horizontally from top left to bottom right.

### Limits Tab

12. Set the minimum and/or maximum number of objects that you expect to find.



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**Detect Objects Controls** 

### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description	
Step Name	Name to give the step.	
Region of Interest	The region of interest you want to use for the step.	
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.	
Reference Coordinate System	Coordinate system to which you want to link the region of interest.	

### Threshold Tab

The following controls are available on the Threshold tab.

<b>Control Name</b>	Description
Look For	Specifies the type of objects to search for in the image. The following options are available:
	<ul> <li>Bright Objects—When selected, the step counts bright pixels whose intensity values range from Lower Value to 255.</li> </ul>
	<ul> <li>Dark Objects—When selected, the step counts dark pixels whose intensity values range from 0 to Upper Value.</li> </ul>
	<ul> <li>Gray Objects—When selected, the step counts gray pixels whose intensity values range from Lower Value to Upper Value.</li> </ul>
Method	Specifies the type of threshold to use. The following options are available:
	<ul> <li>Manual Threshold—Use this method when you want to determine the upper and lower threshold values manually.</li> </ul>
	• Automatic Threshold: Clustering—Use this method as a starting point. This method is appropriate for most images, but if the image requires more specialized thresholding, select another automatic thresholding method.
	<ul> <li>Automatic Threshold: Entropy—Use this method when you are inspecting an image that contains very small objects of interest, such as small cosmetic defects.</li> </ul>
	<ul> <li>Automatic Threshold: Metric—Use this method when the object of interest and the background contain a comparable number of pixels.</li> </ul>
	<ul> <li>Automatic Threshold: Moments—Use this method for images that have poor contrast.</li> </ul>
	<ul> <li>Automatic Threshold: InterVariance—Use this</li> </ul>

	<ul> <li>method when the object of interest and the background contain a comparable number of pixels.</li> <li>Local Threshold: Niblack—Use this method for images that contain non-uniform lighting conditions.</li> <li>Local Threshold: Background Correction—Use this method for images that contain non-uniform lighting conditions. Background correction also helps reduce noise in large, empty areas.</li> <li>Note Refer to the <i>NI Vision Concepts Manual</i> for more information about automatic thresholding methods.</li> </ul>	
Histogram	Displays the number of pixels at each grayscale intensity in the region of interest. The x-axis represents the grayscale intensities, and the y-axis represents the number of pixels.	
Lower Value	Range of intensity values for those pixels you want to consider as objects. When looking for bright objects, all pixels whose values range from <b>Lower Value</b> to 255 are considered object pixels. <b>Lower Value</b> can be set to a constant or to the value of a previous measurement.	
Upper Value	Range of intensity values for those pixels you want to consider as objects. When looking for dark objects, all pixels whose values range from 0 to <b>Upper Value</b> are considered object pixels. <b>Upper Value</b> can be set to a constant or to the value of a previous measurement.	
Lower Limit	The lower boundary of the threshold range for manual thresholding. For automatic thresholding, <b>Lower Limit</b> displays the threshold value computed by the selected automatic thresholding method.	
Upper Limit	The upper boundary of the threshold range for manual thresholding. For automatic thresholding, <b>Upper Limit</b> displays the threshold value computed by the selected automatic thresholding method.	

Kernel Size	<ul> <li>The size of the area around each pixel used to compute the average intensity value for the pixel when using a locally adaptive threshold. Kernel Size is typically equal to the size of the object you want to isolate using the threshold. Kernel Size is only available for local thresholding methods.</li> <li>ROI Size—Indicates the size of the current region of interest.</li> <li>Tip You can determine the approximate size of an object in your image by drawing</li> </ul>	
	a region of interest around the object. <b>ROI</b> <b>Size</b> displays the value of the last ROI drawn. Click the <u>Apply ROI</u> button to set <b>Kernel Size</b> equal to <b>ROI Size</b> .	
ROI Size	Indicates the size of the current region of interest. <b>Tip</b> You can determine the approximate size of an object in your image by drawing a region of interest around the object. <b>ROI Size</b> displays the value of the last ROI drawn. Click the << Apply <b>ROI</b> button to set <b>Kernel Size</b> equal to <b>ROI Size</b> .	
Deviation Factor	Determines the sensitivity of the Niblack thresholding algorithm. Values range for 0 to 1, with 0 being the most sensitive to noise. This control is available only for the <b>Local Threshold: Niblack</b> thresholding method.	
Number of Objects Found	Number of objects the step found.	

## Settings Tab

The following controls are available on the Settings tab.

<b>Control Name</b>	Description	
Ignore Objects Touching Region of Interest	When enabled, the step ignores objects that touch the inspection region border.	
Fill Holes within Objects	When enabled, the step fills holes contained in objects. The step does not fill holes that touch the image border because it cannot determine whether the holes are part of an object.	
Minimum Object Size	Smallest area, in pixels, an object can have for the step to detect it.	
Maximum Object Size	Largest area, in pixels, an object can have for the step to detect it.	
Sort by	<ul> <li>Specifies the order in which the objects detected are returned. The following options are available:</li> <li>Scan Order (x,y)—Corresponds to the order in which the objects are detected by the algorithm. The region of interest is examined from top left to bottom right, line by line. A new object is created as soon as a pixel that does not belong to another object is found.</li> <li>X Position (Pixels)—Sorts detected objects in ascending or descending order of the horizontal position (in pixels) of their center of mass.</li> <li>Y Position (Pixels)—Sorts detected items in ascending or descending order of the vertical position (in pixels) of their center of mass.</li> <li>Size (Pixels)—Sorts detected objects in ascending or descending order depending on their size expressed in pixels.</li> <li>X Position (Calibrated)—Sorts detected objects in ascending or descending order of the</li> </ul>	

	<ul> <li>horizontal position (in real world units) of their center of mass.</li> <li>Y Position (Calibrated)—Sorts detected items in ascending or descending order of the vertical position (in real world units) of their center of mass.</li> <li>Size (Calibrated)—Sorts detected objects in ascending or descending order depending on their size expressed in real world units.</li> <li>Orientation—Sorts detected objects in ascending or descending order depending on their orientation.</li> <li>Aspect Ratio—Sorts objects in ascending or descending on their aspect ratio. Aspect ratio is the ratio between the width and height of the binary object.</li> <li>Number of Holes—Sorts detected objects in ascending or descending order depending on the provide the provide</li></ul>
Objects	<ul> <li>List of valid objects and their properties. The following properties are displayed:</li> <li>X—X-coordinate position of the object center of mass.</li> <li>Y—Y-coordinate position of the object center of mass.</li> <li>Size—Area of the object.</li> <li>Orient.—Orientation of the longest axis of the object with respect to the horizontal axis.</li> <li>Aspect—Aspect ratio of the object.</li> <li>Holes—Number of holes found in the object.</li> <li>Note If you calibrate the image using the Calibrate Image step, X, Y, and Size are returned in the calibration unit you specified</li> </ul>
Number of Objects	Number of objects the step found.

## Limits Tab

The following controls are available on the Limits tab.

Control Name	Description
Minimum Number of Objects	Minimum number of objects you expect the step to find.
Maximum Number of Objects	Maximum number of objects you expect the step to find.
Number of Objects Found	Number of objects the step found.



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# **Detect Objects FAQs**

Q: Reposition Region of Interest and Reference Coordinate System are dimmed. How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.

# Q: How can I filter the objects in my image based on other features than their size?

You can insert a **Vision Assistant** step to do more advanced particle filtering than what is available in the **Detect Object** step.

# Q: How can I make sure the objects are always returned in the same order?

When using the results of the **Detect Objects** step in further processing steps, for example in the **Geometry**, **Logic Calculator**, and **Calculator** steps, the order of the objects is important because it identifies the object. Slight variations in the relative vertical position between two objects may change the order in which these objects are detected by the Detect Objects algorithm. Use the **Sort by** control to specify a sorting criteria, such as X position or size, that is robust for your specific setup and that always returns the detected objects in the same order.



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## **Match Color Pattern Concepts**

The selection of a good template image plays a critical part in obtaining accurate results with the color pattern matching algorithm. Because the template image represents the color and the pattern that you want to find, make sure that all the important and unique characteristics of the pattern are well defined in the image.

Several factors are critical in creating a template image. These critical factors include color information, symmetry, feature detail, positional information, and background information. Refer to <u>Match Pattern</u> <u>Concepts</u> for more information about some of these factors.

- **Color Information**—A template with colors that are unique to the pattern provides better results than a template that contains many colors, especially colors found in the background or other objects in the image.
- **Symmetry**—A rotationally symmetric template in the luminance plane is less sensitive to changes in rotation than one that is rotationally asymmetric.
- **Feature detail**—A template with relatively coarse features is less sensitive to variations in size and rotation than a model with fine features. However, the model must contain enough detail to identify it.
- **Positional information**—A color template whose luminance plane contains strong edges in both the x and y directions is easier to locate.
- **Background information**—Unique background information in a template improves search performance and accuracy during the grayscale pattern matching phase. This requirement could conflict with the color information requirement of color pattern matching because background colors may not be desirable during the color location phase. Avoid this problem by choosing a template with sufficient background information for grayscale pattern matching while specifying the exclusion of the background color during the color location phase.

Extend the region of interest to the edges of the image when you want to locate the template anywhere in the image. Decrease the region so that it

surrounds only the portion of the object that contains the learned template when you want to locate a part only in a specific area of the image. If necessary, decrease the size of the region of inspection to optimize the search speed and minimize the risk of a mismatch.



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How to Match Color Patterns

#### **Template Selection Interface**

- 1. Draw a region of interest around an area of the image for which you want to search in your inspection images. This region becomes the color pattern matching template.
- 2. Click **OK** to accept the template.

When you specify a template, the step automatically tries to find the template in the image. Template matches appear inside red rectangles in the image. The green rectangle indicates the region of interest in which the step searches for matches.

#### Main Tab

- 3. In the **Step Name** control, enter a descriptive name for the step.
- 4. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.
- 5. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

**Note** This step can find rotated instances of the template without the assistance of a **Set Coordinate System** step.



#### Template Tab

By default, the center of the template is used as the focal point of the template. You can change the location of the focal point to any position in the template.

6. Change the focal point of the template by adjusting the **Match Offset** values.

#### **Settings Tab**

- 7. Set up the search conditions for finding the template.
  - a. Select the number of matches you expect in the image.
  - b. Specify whether a match can be a rotated version of the template. You can restrict the amount of rotation you want to allow by specifying an acceptable angle range. You can also include the mirrored angle range by enabling the **Mirror Angle** control.
  - c. Set the **Minimum Score** that a match can have to be valid. Refer to the **Matches** table in the **Limits** tab to determine this score. The table lists matches whose score is above the minimum score and the first match whose score is below the minimum score. You can use this table to choose a **Minimum Score** value that finds the number of matches you request but excludes unwanted matches.
  - d. Adjust the **Search Level** control to choose the appropriate search strategy for your application. If the template is very distinctive and different from the rest of the image, choose a more coarse strategy. This is the fastest but least thorough search level. As the template information becomes less distinctive and more similar to the background, use a more thorough search level.

### Limits Tab

8. Set the minimum and/or maximum number of matches you expect to find.



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**Match Color Pattern Controls**
#### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

## Template Tab

The following controls are available on the Template tab.

<b>Control Name</b>	Description
Template Image	Displays the image you want to search for in an inspection image.
Create Template	When clicked, this button launches a dialog box that contains an image on which you can draw a region of interest. The image contents of this region become the template image.
Template Size	Displays the width and height, in pixels, of the template image you selected.
Match Offset	Specifies the number of pixels you want to shift the focal point of the template from the center of the template. The focal point of the template is the coordinate location of the template match within an inspection image.

## Settings Tab

The following controls are available on the Settings tab.

<b>Control Name</b>	Description
Number of Matches to Find	Specifies the number of matches you expect to find in the image.
Minimum Score	Specifies the minimum score a template must have for the template to be considered a valid match. This value can vary between 0 and 1000. A score of 1000 indicates a perfect match.
Search Level	Specifies the thoroughness with which you want to search for template matches. A coarse search is faster but sometimes less accurate than a thorough search. A thorough search is very accurate but takes more time than a coarse search.
Search for Rotated Patterns	When enabled, the step searches for the template at all specified angle ranges in the inspection image.
Angle Range (Degrees)	Specifies the angles at which you want to search for the template image. The step searches for the template image at angles ranging from the positive angle to the negative angle, as shown in the graph adjacent to this control.
Mirror Angle	When enabled, the step searches for the template image in the angle range you specified in Angle Range (degrees) and the mirror of that angle range, as shown in the graph adjacent to this control.

## Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>	Description
Minimum Number of Matches	Minimum number of matches you expect the step to find.
Maximum Number of Matches	Maximum number of matches you expect the step to find.
Matches	<ul> <li>Displays information about the possible matches.</li> <li>Possible matches whose scores are less than Minimum</li> <li>Score appear in a different color with the match number in parentheses.</li> <li>X—X-coordinate position of the match at the focal point.</li> <li>Y—Y-coordinate position of the match at the focal point.</li> <li>Angle—Clockwise angle of the match from the x-axis.</li> <li>Score—Number ranging from 0 to 1000 that indicates how similar a potential match is to the template image. A score of 1000 indicates a perfect match. A score of 0 indicates no match.</li> </ul>



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# **Match Color Pattern FAQs**

# Q: Reposition Region of Interest and Reference Coordinate System are dimmed. How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.

#### Q: What does the red dot in the template image indicate?

The red dot indicates the point on the template whose coordinate location you want returned when the step finds matches of the template in the inspection image.

#### Q: When should I mirror the search angle?

Mirror the search angle when the fixture of the part under inspection constrains the location of the part along a specified axis. Another typical use for this parameter is to find templates that are symmetric along one axis.

#### Q: What is the difference between the green and red overlays?

The green overlay indicates the region of the image in which you want to search for matches to the template. The red overlay indicates an area that matches the template.

# Q: Why does the Matches table sometimes contain one match more than I requested?

The **Matches** table displays one extra match, in a different color with the match number in parentheses, if the step can find one. You can use the score of the extra match to adjust the **Minimum Score**, as follows:

- If the step does not find all of the matches you specified in the **Number of Matches to Find** control, set the **Minimum Score** to be less than the score of the match you want.
- If the step finds all of the matches you specified in the **Number** of Matches to Find control, set Minimum Score to be between the scores of the last expected match and the extra match listed in the Matches table.

The **Minimum Score** must be low enough to detect the expected

patterns properly but high enough to avoid detecting mismatches areas of the image with some degree of similarity to the learned template. To build a reliable inspection process, maximize the range between the lowest score of the expected matches and the highest score of the extra matches. Also, take into account the usual variations of your process when setting the **Minimum Score**.

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# **Adv. Straight Edge Concepts**

The **Adv. Straight Edge** step searches for straight edges along a line of pixels in the image. You can use edge detection to identify and locate discontinuities in the pixel intensities of an image. The discontinuities are typically associated with abrupt changes in pixel intensity values that characterize the boundaries of objects in a scene.

The **Adv. Straight Edge** step uses a kernel operator to compute the edge strength. The kernel operator is a local approximation of a Fourier transform of the first derivative. The kernel is applied to each point in the search region where edges are to be located. For example, for a kernel size of 5, the operator is a ramp function that has 5 entries in the kernel. The entries are  $\{2, 1, 0, 1, 2\}$ . The width of the kernel size is user-specified and should be based on the expected sharpness, or slope, of the edges to be located.

To reduce the affect of noise in image, the edge detection algorithm can be configured to extract image data along a search region that is wider than the pixels in the image. The thickness of the search region is specified by the search width parameter. The data in the extracted region is averaged in a direction perpendicular to the search region before the edge magnitudes and edge locations are detected. A search width greater than 1 also can be used to find a best or average edge location or a poorly formed object.

Refer to the *NI Vision Concepts Manual* for more information about edge detection.

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How to Find a Straight Edge

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.

When you specify a region of interest, the step automatically tries to locate a straight edge in the region. If the automatically located edge corresponds to the edge you expected to find, proceed to step 8. Otherwise, proceed to step 3.

- 3. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.
  - **Tip** Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

### **Edge Detector Settings Tab**

4. Select the direction properties of the search lines. Select a search direction that is perpendicular to the edge. For example, the orientation of the edge in the following figure is vertical. Therefore, the search direction is horizontal.

Also, select the search direction along the lines that has the least number of obstacles between the edge of the region and the object edge you want to find. In the following figure, the search direction is right to left so that the step avoids detecting the edges of miscellaneous objects.



5. If the step does not locate the correct edge, disable the **Suggest Values** control, and adjust the blue edge strength line so that it lies slightly below the top of the edge peak but above all of the other peaks. If the Edge Strength Profile does not contain a strong edge peak, adjust the edge detection controls until a peak appears.

The following is a list of guidelines for adjusting the controls on the Edge Detector Settings tab.

• If the correct edge points are detected along the search lines but no straight edges are found, It is likely that there are multiple strong edges along each search line. Reduce the **Minimum Edge SNR** until the step finds a straight edge. Adjusting the **Gap** between search lines can also help detect straight edges.

- If the correct edge points are not detected along the search lines, complete the following steps to try to refine the edge detection:
  - a. Analyze the **Edge Strength Profile** for each line. If the edge profile contains peaks at the location where you expect edges, reduce the blue edge strength line so that it lies slightly below the top edge peak, and, if possible, above all other peaks.
  - b. If the **Edge Strength Profile** does not contain a strong peak, adjust the following controls:
    - If the intensity along the edge changes gradually, increase the **Kernel Size**.
    - If the image is noisy, increase the **Projection Width**.
    - If the image contains salt and pepper, or speckled noise, set the **Projection** Method to Median.
- If the location of the detected straight edge is slightly inaccurate, set the **Interpolation Mode** to **Bilinear**.

#### Straight Edge Settings Tab

- 6. In the **# Straight Edges Requested** control, set the number of edges you want to find in the image.
- 7. If necessary, disable the **Suggest Values** control and use the other controls on the **Edge Settings** tab to specify additional criteria for determining edges.

#### Limits Tab

- 8. Set the limits that correspond to the specifications of the edges you want to find in the image.
- 9. Click **OK** to add the step to the inspection.

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Adv. Straight Edge Controls

#### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

## **Edge Detector Settings Tab**

The following controls are available on the Edge Detector Settings tab.

<b>Control Name</b>	Description
Suggest Values	When enabled, the step suggests appropriate values for the Edge Detector controls.
Detection Method	<ul> <li>Specifies the method to use to find the straight edge.</li> <li>The following options are available: <ul> <li>First Edge Rake—Fits a straight edge on the first points detected using a Rake.</li> <li>Best Edge Rake—Fits a straight edge on the best points detected using a Rake.</li> <li>Best Hough Edge Rake—Fits the strongest straight edge using all points detected using a Rake.</li> <li>First Edge Projection—Uses the location of the first projected edge as the straight edge.</li> <li>Best Edge Projection—Finds the strongest projected edge location to determine the straight edge.</li> </ul> </li> </ul>
Search Direction	<ul> <li>Direction in which you want the search lines to look for a straight edge within the region of interest. The following options are available:</li> <li>Left to Right—Searches for edges within the region of interest from left to right.</li> <li>Right to Left—Searches for edges within the region of interest from right to left.</li> <li>Top to Bottom—Searches for edges within the region of interest from top to bottom.</li> <li>Bottom to Top—Searches for edges within the region of interest from bottom to top.</li> </ul>
Edge Polarity	<ul> <li>Specifies the pixel intensity transitions to use to determine edges. The following options are available:</li> <li>Any Edge—Finds edges characterized by dark-to-bright and bright-to-dark pixel intensity</li> </ul>

	<ul> <li>transitions.</li> <li>Dark to Bright—Finds only those edges characterized by dark-to-bright pixel intensity transitions along the direction of the search line.</li> <li>Bright to Dark—Finds only those edges characterized by bright-to-dark pixel intensity transitions along the direction of the search line.</li> </ul>
Minimum Edge Strength	Minimum difference in the intensity values between the edge and its surroundings.
Minimum Edge SNR	Specifies the minimum signal to noise ration (SNR) of the edge points used to fit the straight line. The default is 0.
Kernel Size	Specifies the size of the edge detection kernel.
Gap	Specifies the size, in pixels, of the space between the search lines. This control is only used with a Rake-based <b>Detection Method</b> .
Projection Width	Specifies the number of pixels averaged perpendicular to the <b>Search Direction</b> to compute the edge profile strength at each point along the region of interest. This control is available only for Rake-based detection methods.
Interpolation	<ul> <li>Specifies the interpolation method used to locate the edge position. The following options are available:</li> <li>Zero Order—Rounds to the nearest integral edge location.</li> <li>Bilinear—Uses bilinear interpolation to compute the edge location.</li> <li>Bilinear Fixed—Uses bilinear fixed interpolation to compute the edge location.</li> </ul>
Projection Method	<ul> <li>Specifies the method used to process the data extracted by the edge detector. The following options are available:</li> <li>Average—Averaged the data extracted for edge detection.</li> </ul>

	<ul> <li>Median—Computes the median of the data extracted for edge detection.</li> </ul>
# Straight Edges Found	Displays the number of straight edges found by the step.
Search Line/Edge Index	For a Rake-based <b>Detection Method</b> , specifies the search line used by the <b>Edge Strength Profile</b> and <b>Edge Points Found on Search Line</b> controls.
Edge Strength Profile	Displays a strength profile of the edges found along the specified <b>Search Line/Edge Index</b> based on the current control settings.
Edge Points Found on Search Line	<ul> <li>Displays information about the edge points found on the specified Search Line/Edge Index. The following information is displayed for each edge:</li> <li>X—X-coordinate of the edge.</li> <li>Y—Y-coordinate of the edge.</li> <li>Strength—Strength of the edge. Higher values indicate a stronger edge.</li> <li>STR—Signal to threshold ratio for the edge.</li> <li>TNR—Threshold to noise ratio for the edge.</li> <li>SNR—Signal to noise ratio for the edge.</li> </ul>

### Straight Edge Settings Tab

The following controls are available on the Straight Edge Settings tab.

<b>Control Name</b>	Description
Suggest Values	When enabled, the step suggests appropriate values for the Straight Edge Settings controls.
Minimum Score	Specifies the minimum score of a detected straight edge. Refer to the <i>NI Vision Concepts Manual</i> for a description of the straight edge score returned by the step.
Maximum Score	Specifies the maximum score of a detected straight edge. Refer to the <i>NI Vision Concepts Manual</i> for a description of the straight edge score returned by the step.
Angle Range	Specifies the positive and negative range within which the straight edge is expected to be found relative to the region of interest.
Angle Tolerance	Specifies the expected angular accuracy of the straight edge.
Minimum Coverage	Specifies the number of points, as a percentage of the number of search lines, that need to be included in the detected straight edge.
Maximum Iterations	Specifies the number of iterations used for a Hough <b>Detection Method</b> .
# Straight Edges Requested	Specifies the number of straight edges to find in the image.
# Straight Edges Found	Displays the number of straight edges found by the step.
Search Line/Edge Index	For a Rake-based <b>Detection Method</b> , specifies the search line used by the <b>Edge Strength Profile</b> and <b>Edge Points Found on Search Line</b> controls.
Edge Strength Profile	Displays a strength profile of the edges found along the specified <b>Search Line/Edge Index</b> based on the current control settings.

Edge Points Found on Search Line	Displays information about the edge points found on the specified <b>Search Line/Edge Index</b> . The following information is displayed for each edge:
	• <b>X</b> —X-coordinate of the edge.
	<ul> <li>Y—Y-coordinate of the edge.</li> </ul>
	<ul> <li>Strength—Strength of the edge. Higher values indicate a stronger edge.</li> </ul>
	<ul> <li>STR—Signal to threshold ratio for the edge.</li> </ul>
	<ul> <li>TNR—Threshold to noise ratio for the edge.</li> </ul>
	• <b>SNR</b> —Signal to Noise (SNR) for the edge.

### Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>	Description
Number of Straight Edges	When enabled, the number of straight edges found by the step must lie within the minimum and maximum values in order for the step to pass.
Angle in Search Area	When enabled, the Angle in search Area of the first straight edge listed in the Straight Edge Results table must lie within the minimum and maximum values in order for the step to pass.
Straightness	When enabled, the Straightness of the first straight edge listed in the Straight Edge Results table must lie within the minimum and maximum values in order for the step to pass.
Sort Results By	<ul> <li>Specifies the measurement result you want to use to sort the results displayed in the Straight Edge Results table. The following options are available:</li> <li>Search Direction—Corresponds to the order in which the edges are detected by the algorithm.</li> <li>Midpoint X then Y Position (Pixels)—Sorts detected edges in order of the horizontal position (in pixels) of their center of mass.</li> <li>Midpoint Y then X Position (Pixels)—Sorts detected edges in order of the vertical position (in pixels) of their center of mass.</li> <li>Midpoint X then Y Position (Calibrated)—Sorts detected edges in order of the horizontal position (in pixels) of their center of mass.</li> <li>Midpoint X then Y Position (Calibrated)—Sorts detected edges in order of the horizontal position (in real world units) of their center of mass.</li> <li>Midpoint Y then X Position (Calibrated)—Sorts detected edges in order of the horizontal position (in real world units) of their center of mass.</li> <li>Midpoint Y then X Position (Calibrated)—Sorts detected edges in order of the vertical position (in real world units) of their center of mass.</li> <li>Midpoint Y then X Position (Calibrated)—Sorts detected edges in order of the vertical position (in real world units) of their center of mass.</li> <li>Angle in Search Area—Sorts detected edges based on the angle at which the edge is</li> </ul>

	<ul> <li>detected relative to the region of interest.</li> <li>Straightness—Sorts detected edges based on the straightness of the edges.</li> <li>Score—Sorts detected edges based on the score of the detected edges.</li> <li>Average SNR—Sorts detected edges based on the average signal to noise ratio of the edges.</li> <li>Coverage—Sorts detected edges based on the number of points, as a percentage of the number of search lines, that need are included in the detected straight edge.</li> </ul>
Sort Order	Specifies how the results are sorted. The following options are available:
	<ul> <li>Ascending—Displays results from the lowest value to the highest value.</li> </ul>
	<ul> <li>Descending—Displays results from the highest value to the lowest value.</li> </ul>
Straight Edge Results	Displays information about the straight edges found in the image.
# Straight Edges Found	Displays the number of straight edges found by the step.

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# Adv. Straight Edge FAQs

#### Q: The Reposition Region of Interest and Reference Coordinate System controls are dimmed. How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.

#### Q: Why does the step always return a Straightness value of 1?

The step always returns a value of 1 for the Straightness if the selected **Detection Method** is **Best Hough Edge Rake**, **First Edge Projection**, or **Best Edge Projection**.

The **Best Hough Edge Rake** detection method finds straight edges by first finding edge points along a Rake and mapping each point to a line in the Hough space. Since each point corresponds to a line in the Hough space, Straightness always has a value of 1.

The **First Edge Projection**, and **Best Edge Projection** detection methods find straight lines by projecting a line though a detected edge point. Since the line is projected through the edge point, the point always lies on the line and Straightness always has a value of 1.

The **First Edge Rake** and **Best Edge Rake** detection methods detect straight edges by finding edge points along a Rake and fitting a line to the detected edge points. Straightness calculates of how far the detected the edge points deviate from the fitted line.

Refer to the *NI Vision Concepts Manual* for information about each detection method.

#### Q: Why does (Legacy) appear next to the specified Detection Method on the property page?

If your inspection was created using Vision Builder AI 3.5, when you open the inspection is Vision Builder AI 3.6 or later, the phrase (Legacy) appears next to the specified **Detection Method**. This is because the way that the step computes the edge score changed between Vision Builder AI 3.5 and Vision Builder AI 3.6 to more accurately describe the quality of found edges. To provide backwards compatibility, Vision

Builder AI still computes the edge score using the original method for inspections created using Vision Builder AI 3.5 and appends (Legacy) to the **Detection Method** to inform you that the step is using the older method to calculate the edge score.

To update the inspection to use the current edge score calculation, select the desired **Detection Method** that does not contain the **(Legacy)** label. If the step no longer detects the correct straight lines in the image, adjust the **Minimum Edge SNR** until the step located the correct straight lines in the image.

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# **Measure Features**

This palette groups several steps whose purpose is extracting dimensional measurements from an image of the part under inspection. You can use the **Caliper** step to measure external or internal dimensions of an object. You can use the **Geometry** step to compute geometrical features and physical dimensions based on the location of part features that were computed during previous steps. You can express all the measurements in real-world units—such as inches and meters—if you calibrate the image using the **Calibrate Image** step.

Step Name	Description
Measure Intensity	Returns the average intensity value of pixels inside a region of interest. Use this step to detect the presence of a part with unique, uniform pixel intensities.
	Another use of the <b>Measure Intensity</b> step is to detect objects or assemblies characterized by intensity levels that vary greatly from surrounding pixels. In such cases, the minimum and maximum intensity values and the standard deviation values can describe the contents of a region of interest. You can use these values to detect the presence or absence of a part without specifying the shape or pattern of the part. Refer to <u>Measure Intensity</u> <u>Concepts</u> for related information.
	Note This step cannot identify between two objects with similarly intense pixel values. Use this step if the lighting conditions of your imaging environment do not vary considerably with the time of day and surrounding lighting conditions.
Measure Colors	Returns the average value of color intensities inside a region of interest. Use this step to detect the presence of a part with unique, uniform color intensities.
	Another use of the <b>Measure Colors</b> step is to detect

	objects or assemblies characterized by colors that vary significantly from surrounding pixels. In such cases, the minimum and maximum color values and the standard deviation values can describe the contents of a region of interest. You can use these values to detect the presence or absence of a part without specifying the shape or pattern of the part. Refer to <u>Measure Colors Concepts</u> for related information.
	Note This step cannot identify between two objects with similarly intense color values. Use this step if the lighting conditions of your imaging environment do not vary considerably with the time of day and surrounding lighting conditions.
Count Pixels	Calculates the percentage of pixels in a region whose pixel intensities fall within a specified intensity range. You also can use this step to check for the presence of a part with known pixel values.
Caliper	<ul> <li>Finds two object edges and measure the distance between them. Refer to <u>Caliper Concepts</u> for related information.</li> <li>Note The Caliper step finds edges automatically. You do not need to insert a Locate Features step before the Caliper step in your inspection.</li> </ul>
Geometry	Computes geometric features—such as line intersections, areas, and best-fit circles. The types of features you can compute depends on the number of previously located points you select. Refer to <u>Geometry Concepts</u> for related information.

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## **Measure Intensity Concepts**

The **Measure Intensity** step computes the intensity statistics of pixels within a region of interest in the image. The step determines the histogram of the intensity values of the pixels in the region of interest and then computes intensity statistics, such as the mean intensity value, the standard deviation, and the minimum and maximum pixel intensities.

The default region of interest tool is a rectangle. However, you can choose any of the <u>region of interest tools</u> to precisely select a region of interest. Correctly selecting a region of interest is important because pixels of no interest inside the region of interest can affect the intensity statistics drastically. =**IIÝ≯×** 

How to Measure Intensity
#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.
- 3. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

#### **Limits Tab**

4. Select the criteria that you want to verify when the feature is present or absent, and set appropriate Minimum and Maximum values for the criteria.



Note Pixel intensities may vary significantly from image to image depending on lighting conditions and object surface aspects.
Check the validity of the parameters you defined in the Limits tab as well as their ability to discern good and bad parts using an image set representative of typical process fluctuations.

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**Measure Intensity Controls** 

# Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

# Histogram Tab

The Histogram tab displays information about the number of pixels at each grayscale intensity contained in the region of interest. The x-axis of the graph represents the grayscale intensities, and the y-axis of the graph represents the number of pixels at the intensity level. Bright pixel intensities are represented with high numerical values, where 255 is the maximum value. Dark pixels are represented with low values, where 0 is the minimum value.

The Histogram tab also displays the average intensity, standard deviation, minimum intensity, and maximum intensity of the pixels contained in the region of interest.



**Note** A higher standard deviation value indicates a better distribution of the grayscale intensities in the region of interest. A lower value characterizes a region of interest with homogeneous pixel intensities.

# Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>	Description
Average Intensity	When enabled, the average intensity of pixels in the region of interest must lie within the minimum and maximum values in order for the step to pass.
Standard Deviation	When enabled, the standard deviation of pixels in the region of interest must lie within the minimum and maximum values in order for the step to pass.
Minimum Intensity	When enabled, the lowest grayscale intensity in the region of interest must lie within the minimum and maximum values in order for the step to pass.
Maximum Intensity	When enabled, the highest grayscale intensity in the region of interest must lie within the minimum and maximum values in order for the step to pass.

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# **Measure Intensity FAQs**

Q: The Reposition Region of Interest and Reference Coordinate System controls are dimmed. How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.



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# **Measure Colors Concepts**

The **Measure Colors** step computes the color statistics of pixels within a region of interest in the image. The step determines the histogram of the pixel color values for the selected color space in the region of interest. **Measure Colors** works for the RGB, HSL, CIE L\*a\*b\*, and CIE XYZ color spaces. Refer to the *NI Vision Concepts Manual* for information about color spaces.

The default region of interest tool is a rectangle. However, you can choose any of the <u>region of interest tools</u> to precisely select a region of interest. Correctly selecting a region of interest is important because pixels of no interest inside the region of interest can affect the intensity statistics significantly.



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How to Measure Colors

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.
- 3. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

#### Histogram Tab

- 4. Select the **Color Space** of interest for making the color measurements.
- 5. If you are using the CIE L\*a\*b\* color space, enter the white reference values you want to use for calculating the color measurements.

# Limits Tab

- 6. Select the criteria you want to use to verify the presence or absence of a feature, and set appropriate Minimum and Maximum values for the criteria.
  - $\overline{\mathbb{N}}$ 
    - **Note** Pixel intensities may vary significantly from image to image depending on lighting conditions and object surface aspects. Check the validity of the parameters defined in the **Limits** tab to discern good and bad parts by using an image set representative of typical process fluctuations.



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**Measure Colors Controls** 

# Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

# Histogram Tab

The following controls are available on the Histogram tab.

Color Space S c a	<ul> <li>Specifies which color space to use when calculating color measurements. The following options are available:</li> <li><b>RGB</b>—Uses the Red, Green, Blue color space and displays the resulting color histogram.</li> <li><b>HSL</b>—Uses the Hue, Saturation, Luminance</li> </ul>
	<ul> <li>RGB—Uses the Red, Green, Blue color space and displays the resulting color histogram.</li> <li>HSL—Uses the Hue, Saturation, Luminance</li> </ul>
	<ul> <li>color space and displays the resulting color histogram.</li> <li>CIE L*a*b*—Uses the CIE L*a*b* color space and displays the resulting leastion on the CIE.</li> </ul>
	<ul> <li>Cle XYZ—Uses the CIE XYZ color space and displays the resulting location on the CIE Color Gamut.</li> </ul>
2	Note Refer to Chapter 14 of the <i>NI Vision</i> <i>Concepts Manual</i> for more information about Color Spaces.
Color D Histogram V T a o	Displays the number of pixels at each intensity for the various color planes contained in the region of interest. The x-axis represents the color intensities, and the y- axis represents the number of pixels. This histogram only applies to RGB and HSL color spaces.
2	Note Bright pixel intensities are represented with high numerical values. 255 is the maximum value. Dark pixels are represented with low values. 0 is the minimum value.
CIE Color D Gamut a ir C	Displays the location on the CIE Color Gamut for the average color components of the pixels in the region of nterest. This color gamut applies only to CIE L*a*b* and CIE XYZ color spaces. • White Reference—CIE X, Y, and Z values

	associated with white. The default values of this control work with RGB values of 255, 255, 255 as white. This control applies only to CIE L*a*b* color space.
White Reference	Specifies the CIE X, Y, and Z values associated with white. The default values of this control work with RGB values of 255, 255, 255 as white. This control applies only to CIE L*a*b* color space.
Results	<ul> <li>Displays the color measurements of the corresponding color space.</li> <li>Average—Average color intensity of the pixels in the region of interest for the specified color plane.</li> <li>Std. Dev.—Standard deviation of the intensity values. A higher value indicates a better distribution of the grayscale intensities in the region of interest. A lower value characterizes a region of interest with homogeneous pixel intensities.</li> </ul>

# Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>	Description
Color Plane <b>Average</b>	When enabled, average intensity of pixels in the region of interest of the selected color plane must lie within the minimum and maximum values in order for the step to pass.
Color Plane <b>Std. Dev.</b>	When enabled, standard deviation of pixels in the region of interest of the selected color plane must lie within the minimum and maximum values in order for the step to pass.



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# **Measure Colors FAQs**

#### Q: How do I use the White Reference?

Using an image with a white area in it, select the **CIE XYZ** color space. Create a region of interest that only includes the white part of the image. Record the average X, Y, and Z values. Then switch to the **CIE L\*a\*b\*** color space and use the previously recorded X,Y, and Z values as the **White Reference**.

# Q: Reposition Region of Interest and Reference Coordinate System are dimmed. How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.



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**How to Count Pixels** 

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.
- 3. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

### **Settings Tab**

- 4. Select the type of pixels you want to count in Look For.
- 5. Select the thresholding method you want to use in **Method**. The histogram now shows the range of pixel intensities in the region of interest.
  - If you selected Manual Threshold in Method, use Lower Value and Upper Value to specify the threshold range.
  - If you selected an automatic thresholding method, Vision Builder AI uses that method to determine the threshold range that corresponds to the region of interest. Use
     Lower Limit and Upper Limit to coerce the threshold range to specific lower and upper values.
  - If you selected a local thresholding method, Vision Builder AI uses that method to calculate a threshold value for each pixel based on the statistics of surrounding pixels. These algorithms compensate for high lighting variations. Use **Kernel Size** to specify the approximate size of the desired objects to threshold.

Note The Percentage of Pixels in Intensity Range control displays the percentage of pixels in the region of interest that are within the range or grayscale intensities you established.

#### **Limits Tab**

6. Use the Minimum Percentage and Maximum Percentage and/or Minimum Number of Pixels and Maximum Number of Pixels controls to specify the valid range you want to use to determine if the inspection passes.

**Percentage of Pixels in Intensity Range** displays the percentage of pixels in the region of interest that are within the range you established.

**Number of Pixels in Intensity Range** displays the number of pixels in the region of interest that are within the range you established.

7. Click **OK** to save the settings and close the Parameter window.



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**Count Pixels Controls** 

# Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

# Settings Tab

The following controls are available on the Settings tab.

<b>Control Name</b>	Description
Look For	Specifies the type of pixels to count. The following options are available:
	• <b>Bright Objects</b> —When selected, the step counts bright pixels whose intensity values range from Lower Value to 255.
	<ul> <li>Dark Objects—When selected, the step counts dark pixels whose intensity values range from 0 to Upper Value.</li> </ul>
	<ul> <li>Gray Objects—When selected, the step counts gray pixels whose intensity values range from Lower Value to Upper Value.</li> </ul>
Method	Specifies the type of threshold to use. The following options are available:
	<ul> <li>Manual Threshold—Use this method when you want to determine the upper and lower threshold values manually.</li> </ul>
	• Automatic Threshold: Clustering—Use this method as a starting point. This method is appropriate for most images, but if the image requires more specialized thresholding, select another automatic thresholding method.
	<ul> <li>Automatic Threshold: Entropy—Use this method when you are inspecting an image that contains very small objects of interest, such as small cosmetic defects.</li> </ul>
	<ul> <li>Automatic Threshold: Metric—Use this method when the object of interest and the background contain a comparable number of pixels.</li> </ul>
	<ul> <li>Automatic Threshold: Moments—Use this method for images that have poor contrast.</li> </ul>
	Automatic Threshold: InterVariance—Use this

	<ul> <li>method when the object of interest and the background contain a comparable number of pixels.</li> <li>Local Threshold: Niblack—Use this method for images that contain non-uniform lighting conditions.</li> <li>Local Threshold: Background Correction—Use this method for images that contain non-uniform lighting conditions. Background correction also helps reduce noise in large, empty areas.</li> <li>Note Refer to the <i>NI Vision Concepts</i></li> </ul>
	Manual for more information about automatic thresholding methods.
Histogram	Displays the number of pixels at each grayscale intensity contained in the region of interest. The x-axis represents the grayscale intensities, and the y-axis represents the number of pixels.
Lower Value	Range of intensity values for those pixels you want to consider as objects. When looking for bright objects, all pixels whose values range from <b>Lower Value</b> to 255 are considered object pixels.
Upper Value	Range of intensity values for those pixels you want to consider as objects. When looking for dark objects, all pixels whose values range from 0 to <b>Upper Value</b> are considered object pixels.
Lower Limit	The lower boundary of the threshold range for manual thresholding. For automatic thresholding, <b>Lower Limit</b> displays the threshold value computed by the selected automatic thresholding method.
Upper Limit	The upper boundary of the threshold range for manual thresholding. For automatic thresholding, <b>Upper Limit</b> displays the threshold value computed by the selected automatic thresholding method.
Kernel Size	The size of the area around each pixel used to compute the average intensity value for the pixel. <b>Kernel Size</b> is

	typically equal to the size of the object you want to isolate using the threshold. <b>Kernel Size</b> is only available for local thresholding methods.
ROI Size	Indicates the size of the current region of interest. <b>Tip</b> You can determine the approximate size of an object in your image by drawing a region of interest around the object. <b>ROI Size</b> displays the value of the last ROI drawn. Click the <b>Apply</b> <b>ROI</b> button to set <b>Kernel Size</b> equal to <b>ROI Size</b> .
Deviation Factor	Determines the sensitivity of the Niblack thresholding algorithm. Values range for 0 to 1, with 0 being the most sensitive to noise. This control is available only for the <b>Local Threshold: Niblack</b> thresholding method.
Percentage of Pixels in Intensity Range	Displays the percentage of pixels in the region of interest that are within the range you established for the current image.
Number of Pixels in Intensity Range	Displays the count of pixels in the region of interest that are within the specified range of intensity values for the current image.

# Limits Tab

The following controls are available on the Limits tab.

Control Name	Description
Minimum Percentage	Specifies the lower limit for the percentage range you want to use to determine if the step passes.
Maximum Percentage	Specifies the upper limit for the percentage range you want to use to determine if the step passes.
Minimum Number of Pixels	Specifies the lower limit for the number of pixels to use to determine if the step passes.
Maximum Number of Pixels	Specifies the upper limit for the number of pixels to use to determine if the step passes.
Percentage of Pixels in Intensity Range	Displays the percentage of pixels in the region of interest that are within the range you established for the current image.
Number of Pixels in Intensity Range	Displays the count of pixels in the region of interest that are within the specified range of intensity values for the current image.


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# **Count Pixels FAQs**

#### Q: How do I use Lower Limit and Upper Limit?

When you select an automatic threshold method, the algorithm attempts to split the histogram of pixel intensities in the region of interest into two classes. During a typical inspection process, acquired images may differ greatly from what the algorithm is expecting. For example, you could be working with an image representing a bright object on a dark background in which the object is unexpectedly missing from the inspected region of interest. An automatic thresholding algorithm might still segment the dark background into two intensity classes and, as a result, return an incorrect threshold level that includes an incorrect number of bright pixels. To prevent this, use **Lower Limit** and **Upper Limit** to coerce the threshold values to define a range that includes only the expected variations that would occur in a typical inspection.



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# **Caliper Concepts**

The **Caliper** step computes the minimum or maximum distance between two edges of an object enclosed in a region of interest. The region of interest contains a number of search lines along which the step searches for sharp transitions in pixel intensities. A sharp transition typically characterizes the edge of an object in the image.

The step locates an edge based on its edge strength. You can study the **Edge Strength Profile** to determine the edge strengths in the region of interest. A peak in the profile indicates that an edge is present at that position in the region of interest. The strength of that edge is given by the amplitude of the peak.

The step searches for two edge points along each search line and computes the distance between the two detected edge points. The step returns the minimum or maximum distance measurement of all the search lines as the caliper measurement.



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How to use the Caliper

### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.
- 3. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

## **Settings Tab**

- 4. Select the appropriate calipering **Process** to use for the measurement.
- 5. Adjust the **Gap**, **Edge Strength**, **Smoothing**, and **Steepness** controls until the step properly detects the edges of the object you want to measure.

# Limits Tab

6. Set the minimum and/or maximum distances that correspond to the specifications of the part under inspection.



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**Caliper Controls** 

# Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

# Settings Tab

The following controls are available on the Setting tab.

<b>Control Name</b>	Description
Process	<ul> <li>Type of caliper to use. The following options are available:</li> <li>Horizontal Max Caliper—Measures a distance in the horizontal direction from the vertical sides of the region of interest toward the center of the region of interest.</li> <li>Horizontal Min Caliper—Measures a distance in the horizontal direction from the center of the region of interest toward the vertical sides of the region of interest.</li> <li>Vertical Max Caliper—Measures a distance in the vertical direction from the center of the region of interest.</li> <li>Vertical Max Caliper—Measures a distance in the vertical direction from the horizontal sides of the region of interest.</li> <li>Vertical Max Caliper—Measures a distance in the vertical direction from the horizontal sides of the region of interest.</li> <li>Vertical Min Caliper—Measures a distance in the vertical direction from the horizontal sides of the region of interest.</li> </ul>
Gap	Number of pixels between search lines in the region of interest.
Edge Strength	Minimum difference in the intensity values between the edge and its surroundings. Only those edges whose strength is greater than this value are used in the detection process.
Smoothing	Number of pixels averaged to find the contrast at either side of the edge.
Steepness	Maximum distance in which the edge strength must occur. <b>Steepness</b> characterizes the slope of the edge. Use a higher <b>Steepness</b> value to detect edges in

	images whose pixel intensities gradually transition from the background to the edge.
Edge Strength Profile	Edge strength along the search line located in the middle of the region of interest.

# Limits Tab

The following controls are available on the Limits tab.

Note When you calibrate the image using a **Calibrate Image** step, all distances are returned using the specified calibration units.

<b>Control Name</b>	Description
Minimum Distance	When enabled, the minimum distance you expect the step to measure between the caliper arms in order for the step to pass.
Maximum Distance	When enabled, the maximum distance you expect the step to measure between the caliper arms in order for the step to pass.
Current Distance	Distance measured between the caliper arms.



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# **Caliper FAQs**

#### Q: The Reposition Region of Interest and Reference Coordinate System controls are dimmed. How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.

# Q: The Caliper step returns results in pixels. How can I get measurements returned in the physical unit I want?

Insert a **Calibrate Image** step before this step to get distance measurements in real-world units. Using the **Calibrate Image** step, you can specify a calibration ratio, measurement unit, and type of distortion correction, if necessary. **.**....

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# **Geometry Concepts**

The **Geometry** step can perform the following general tasks:

- Calculate different geometric values based on features detected in previous steps. For example, **Geometry** can calculate the area of a polygon using points on the corners of the polygon that were detected in a previous step.
- Derive new features on the image based on geometric calculations from other features in the image. For example, **Geometry** can find the intersection point of two lines created by points detected in previous steps.

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**How to Calculate Geometric Features** 

## Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Select the type of geometric feature you want to compute.
  - Note When you select a geometric feature, the step displays the minimum number of points you need to select to compute the feature.
- 3. Select the points that define the geometric feature using one of the following methods:
  - Click the points overlaid on the image.
  - Select the checkboxes in the Available Points list.
  - Double-click the point names in the Available Points list.

## Limits

4. When applicable, set the minimum and maximum values that correspond to the specifications of the part under inspection.

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**Geometry Controls** 

# Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Geometric Feature	Geometric feature you want to compute based on points you located during a previous step. The following options are available:
	Distance—Computes the distance between two selected points.
	<ul> <li>Mid Point—Finds the center of a segment defined by two selected points.</li> </ul>
	<ul> <li>Perpendicular Projection—Locates the perpendicular projection of the third point you selected on a line specified by the first two points you selected.</li> </ul>
	<ul> <li>Lines Intersection—Locates the intersection of the lines specified by the first two points you select and the last two points you select.</li> </ul>
	• Angle from Horizontal—Finds the counterclockwise angle from the horizontal axis to a line specified by two points.
	• Angle from Vertical—Finds the counterclockwise angle from the vertical axis to a line specified by two points.
	<ul> <li>Angle Defined by 3 Points—Finds the counterclockwise angle between three points, where the second point is the vertex.</li> </ul>
	Angle Defined by 4 Points—Finds the counterclockwise angle between the lines

	<ul> <li>specified by the first two points you select and the last two points you select.</li> <li>Bisecting Line—Finds the line bisecting the counterclockwise angle formed by two lines, where the first two points you select create the first line and the second two points you select create the second line.</li> <li>Mid Line—Finds a line midway between the line specified by the first two points you select. The new line is parallel to the line specified by the first two points you select.</li> <li>Center of Mass—Finds the center of mass of two or more points you select.</li> <li>Area—Computes the area of a polygon, where the vertices are points you select.</li> <li>Line Fit—Fits a straight line to a set of two or more points.</li> <li>Circle Fit—Fits an ellipse to a set of six or more points.</li> </ul>
Available Points	Lists the points you can use to calculate the selected <b>Geometric Feature</b> . Click the points in the order that you want the step to consider them when calculating the geometric feature. You can also use the value of point variables to calculate the geometric feature.

# Limits Tab

The controls in this tab vary depending on the **Geometric Feature** selected on the Main tab. The following controls are available on the Limits tab.

#### Distance

<b>Control Name</b>	Description
Minimum Distance	When enabled, the minimum allowable distance between the selected points for the step to pass.
Maximum Distance	When enabled, the maximum allowable distance between the selected points for the step to pass.

#### Mid Point

<b>Control Name</b>	Description
X Position	When enabled, the minimum and maximum x-coordinate positions in which the midpoint must lie for the step to pass.
Y Position	When enabled, the minimum and maximum y-coordinate positions in which the midpoint must lie for the step to pass.

#### **Perpendicular Projection**

<b>Control Name</b>	Description
X Position	When enabled, the minimum and maximum x-coordinate positions in which the projection point must lie for the step to pass.
Y Position	When enabled, the minimum and maximum y-coordinate positions in which the projection point must lie for the step to pass.
Distance Point Line	When enabled, the minimum and maximum allowable distance between the third point you selected and the line specified by the first two points you selected.

#### Lines Intersection

<b>Control Name</b>	Description
X Position	When enabled, the minimum and maximum x-coordinate

	positions in which the intersection point must lie for the step to pass.
Y Position	When enabled, the minimum and maximum y-coordinate positions in which the intersection point must lie for the step to pass.

## Angle from Horizontal

<b>Control Name</b>	Description
Minimum Angle (Degrees)	When enabled, the minimum counterclockwise angle at which the line can be located from the horizontal axis for the step to pass.
Maximum Angle (Degrees)	When enabled, the maximum counterclockwise angle at which the line can be located from the horizontal axis for the step to pass.

## Angle from Vertical

<b>Control Name</b>	Description
Minimum Angle (Degrees)	When enabled, the minimum counterclockwise angle at which the line can be located from the vertical axis for the step to pass.
Maximum Angle (Degrees)	When enabled, the maximum counterclockwise angle at which the line can be located from the vertical axis for the step to pass.

## Angle Defined by 3 Points

Control Name	Description
Minimum Angle (Degrees)	When enabled, the minimum allowable counterclockwise angle between the lines for the step to pass.
Maximum Angle (Degrees)	When enabled, the maximum allowable counterclockwise angle between the lines for the step to pass.

## Angle Defined by 4 Points

<b>Control Name</b>	Description
Minimum	When enabled, the minimum allowable
Angle	counterclockwise angle between the lines for the step to

(Degrees)	pass.
Maximum Angle	When enabled, the maximum allowable counterclockwise angle between the lines for the step to
(Degrees)	pass.

#### **Bisecting Line**

This geometric feature does not have limits to set.

#### Mid Line

This geometric feature does not have limits to set.

#### **Center of Mass**

<b>Control Name</b>	Description
X Position	When enabled, the minimum and maximum x-coordinate positions in which the center of mass must lie for the step to pass.
Y Position	When enabled, the minimum and maximum y-coordinate positions in which the center of mass must lie for the step to pass.

#### Area

<b>Control Name</b>	Description
Minimum Area	When enabled, the minimum allowable area within the polygon formed by connecting the selected points.
Maximum Area	When enabled, the maximum allowable area within the polygon formed by connecting the selected points.

#### Line Fit

<b>Control Name</b>	Description
Minimum Angle (Degrees)	When enabled, the minimum counterclockwise angle at which the line can be located from the horizontal axis for the step to pass.
Maximum Angle (Degrees)	When enabled, the maximum counterclockwise angle at which the line can be located from the horizontal axis in order for the step to pass.
Allowable Deviation	When enabled, the maximum distance points can deviate from the fitted line.

# (Pixels)

**Circle Fit** 

<b>Control Name</b>	Description
Circle Center X	When enabled, the minimum and maximum x-coordinate positions in which the center of the circle must lie for the step to pass.
Circle Center Y	When enabled, the minimum and maximum y-coordinate positions in which the center of the circle must lie for the step to pass.
Circle Radius	When enabled, the minimum and maximum lengths in which the radius must lie for the step to pass.
Circle Area	When enabled, the minimum and maximum allowable area within the circle for the step to pass.
Allowable Deviation (Pixels)	When enabled, the maximum distance points can deviate from the fitted circle.

# Ellipse Fit

<b>Control Name</b>	Description
Ellipse Center X	When enabled, the minimum and maximum x-coordinate positions in which the center of the ellipse must lie for the step to pass.
Ellipse Center Y	When enabled, the minimum and maximum y-coordinate positions in which the center of the ellipse must lie for the step to pass.
Ellipse Major Axis	When enabled, the minimum and maximum allowable lengths of the major axis of the fitted ellipse.
Ellipse Minor Axis	When enabled, the minimum and maximum allowable lengths of the minor axis of the fitted ellipse.
Ellipse Area	The minimum and maximum allowable area within the ellipse for the step to pass.

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# **Geometry FAQs**

# Q: Why doesn't the Geometry step have a Reposition Region of Interest control like many of the other steps?

The **Geometry** step does not have a region of interest to reposition because the step computes geometric features based on points you define in previous steps.

# Q: How can I get calculations expressed in real-world units instead of pixel units?

Insert a configured **Calibrate Image** step before this step to get distance measurements in real-world units.

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# **Check for Presence**

Checking for the presence or absence of an object or feature is a core component of assembly verification and other types of tests. This palette groups several visual inspection steps whose purpose is determining the presence or absence of a feature. These steps use different features and properties of the image, such as intensities, edges, colors, and patterns. Use the step whose description best represents the feature that you want to detect in your image.

Step Name	Description
Detect Objects	Detects the presence of objects based on their size and range of intensities. In addition to detecting the presence of an object, this step counts the number of objects it finds. Refer to <u>Detect Objects Concepts</u> for related information.
Measure Intensity	Returns the average intensity value of pixels inside a region of interest. Use this step to detect the presence of a part with unique, uniform pixel intensities.
	Another use of the <b>Measure Intensity</b> step is to detect objects or assemblies characterized by intensity levels that vary greatly from surrounding pixels. In such cases, the minimum and maximum intensity values and the standard deviation values can describe the contents of a region of interest. You can use these values to detect the presence or absence of a part without specifying the shape or pattern of the part. Refer to <u>Measure Intensity</u> <u>Concepts</u> for related information.
	Note This step cannot identify between two objects with similarly intense pixel values. Use this step if the lighting conditions of your imaging environment do not vary considerably with the time of day and surrounding lighting conditions.
Count Pixels	Calculates the percentage of pixels in a region

	whose pixel intensities fall within a specified intensity range. Use this step to check for the presence of a part with known pixel values.
Match Colors	Detects the presence of an object by measuring the similarity between the color information of a region of interest and a template color. Use this step in applications such as color identification, color inspection, and other applications that require the comparison of color information to make decisions. Refer to <u>Match Colors Concepts</u> for related information.
Find Edges	Verifies the presence of objects based on the number of edges the step finds. Refer to <u>Find</u> <u>Edges Concepts</u> for related information.
Detect Defects	Compares an image to a template and returns the differences. Use the differences between the two images to identify defects in the inspection image. Refer to <u>Detect Defects Concepts</u> for related information.
Match Pattern	Locates regions of an image that match a predefined template of a pattern. Use this step when the feature you want to locate can only be described by its 2D intensity and edge info. For example, you can use Match Pattern to locate a company logo printed on a container. The Match Pattern step is indifferent to image noise, blur, and uniform lighting changes. Refer to <u>Match</u> <u>Pattern Concepts</u> for related information.
Geometric Matching	Locates regions in an image that match a model, or template, of a reference pattern. <b>Geometric</b> <b>matching</b> is specialized to locate templates that are characterized by distinct geometric or shape information. <b>Geometric Matching</b> finds templates regardless of lighting variation, blur, noise, occlusion, and geometric transformations such as shifting, rotation, or scaling of the template. Refer to <u>Geometric Matching Concepts</u> for related
	information.
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Match Color Pattern	Detects the presence of an object using a color template pattern that describes the edge information and color information of the object. Use this step if the object contains color information that is very different from the background, and you want to find the precise location of the object in the image or count the number of objects present in a region of the image. Also, use this step if the object has grayscale properties that are very difficult to characterize or that are very similar to other objects in the image. Refer to Match Color Pattern Concepts for related information.



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# **Match Colors Concepts**

Color matching quantifies which colors and how much of each color exist in a region of an image and uses this information to check if another image contains the same colors in the same ratio.

Use color matching to compare the color content of an image or regions within an image to a reference color information. With color matching, you select a region in an image that contains the color information you want to use as a reference. The color information in the region may consist of one or more colors. The machine vision software then learns the three-dimensional color information in the region and represents it as a one-dimensional color spectrum. Your machine vision application compares the color information in the entire image or regions in the image to the learned color spectrum, calculating a score for each region. The score relates how closely the color information of the inspection image matches the information represented by the color spectrum.



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**How to Match Colors** 

### **Template Selection Interface**

- 1. Draw a region of interest around an area of the image that contains the reference color or colors. This region becomes the color template.
- 2. Click **OK** to accept the template.

#### Main Tab

- 3. In the **Step Name** control, enter a descriptive name for the step.
- 4. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.



**Note** Hold down the <Ctrl> key to draw additional regions of interest.

- Select a previously defined region of interest from the **Region of Interest** listbox.
- 5. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

## **Template Tab**

- 6. Select the **Color Sensitivity** to set how detailed you want the color matching algorithm to represent the color template.
- 7. Select a **Saturation Threshold** value that distinguishes colors of the same hue value adequately enough for your application needs.
- 8. Enable the **Ignore White** control if you want the step to ignore the white content of the color template. Enable the **Ignore Black** control if you want the step to ignore the black content of the color template.

#### **Settings Tab**

9. Set the Minimum Match Score that a region of interest can have to be valid. Refer to the Matches table to determine this score. The table lists the match score and Pass/Fail status of each region you defined. You can use the Matches table to choose a Minimum Match Score value that finds the number of matches you request but excludes unwanted matches.

### Limits Tab

10. Set the minimum and/or maximum number of matches you expect to find.



**Tip** Use the **Logic Calculator** step or **Calculator** step to make an inspection decision based on the Pass/Fail status of each region of interest in the **Match Colors** step.



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**Match Colors Controls** 

## Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

# Template Tab

The following controls are available on the Template tab.

<b>Control Name</b>	Description
Template	Displays a region of an image containing the reference color set.
Create Template	When clicked, this button launches a dialog box that contains the current image in which you can draw a region of interest. The color contents of this region become the template image.
Template Size	Displays the width and height, in pixels, of the selected template.
Color Sensitivity	Level of sensitivity used to describe the color features in the image. The higher the value, the more detailed the color representation. Refer to Chapter 14, <i>Color</i> <i>Inspection</i> , of the <i>NI Vision Concepts Manual</i> for detailed information about choosing a color sensitivity. The following options are available: • Low • Medium • High
Saturation Threshold	Threshold value that distinguishes two colors that have the same hue value but different saturation values. For example, use this control to distinguish between red, which has a high saturation, and pink, which has a low saturation.
Color Spectrum	Displays a graphical representation of the color information in the template.
Ignore White	When enabled, the white content of the color template is ignored.
Ignore Black	When enabled, the black content of the color template is ignored.

# Settings Tab

The following controls are available on the Settings tab.

<b>Control Name</b>	Description
Minimum Score	Minimum score a color match can have to be considered a valid match. This value can vary between 0 and 1000. A score of 1000 indicates a perfect match.
Number of Matches	Number of regions that match the color template.
Matches	<ul> <li>Displays information about the individual regions of interest.</li> <li>Score—Number ranging from 0 to 1000 that indicates how similar a potential match is to the template image. A score of 1000 indicates a perfect match. A score of 0 indicates no match.</li> <li>Status—Indicates whether there is a match between the color template and the color in each specified region of the image. For each specified region of the image, Status is PASS if its color information has a score greater than or equal to Minimum Score.</li> </ul>

# Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>	Description
Minimum Number of Matches	Minimum number of matches you expect the step to find.
Maximum Number of Matches	Maximum number of matches you expect the step to find.
Number of Matches	Number of regions that match the color template.
Matches	<ul> <li>Displays information about the individual regions of interest.</li> <li>Score—Number ranging from 0 to 1000 that indicates how similar a potential match is to the template image. A score of 1000 indicates a perfect match. A score of 0 indicates no match.</li> <li>Status—Indicates whether there is a match between the color template and the color in each specified region of the image. For each specified region of the image, Status is PASS if its color information matches the input color information.</li> </ul>



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# **Match Colors FAQs**

Q: The Reposition Region of Interest and Reference Coordinate System controls are dimmed. How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.

Q: How do I base the Step Status on the status of individual color matches? For example, I want the step to pass if the first match passes and the second match fails.

You can use either the **Logic Calculator** step or **Calculator** step to compare the Pass/Fail value of each match and create a custom decision rule.

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# **Detect Defects Concepts**

The **Detect Defects** step is based on a technique called golden template comparison. Golden template comparison compares the pixel intensities of an image under inspection to a golden template. A golden template is an image containing an ideal representation of an object under inspection. A pixel in an inspection image is marked as a defect if its intensity does not match the corresponding pixel in the golden template within a specified tolerance.

Inspection based on golden template comparison is a common vision application. Use golden template comparison when you want to inspect for defects, and other methods of defect detection are not feasible. To use golden template comparison, you must be able to acquire an image that represents the ideal inspection image for your application.

Conceptually, inspection based on golden template comparison is simple: Subtract an image from an ideal part and another image of a part under inspection. Any visible defects on the inspected part appear as differences in intensity in the resulting defect image. Figure 1 illustrates this concept.



Figure 1

Figure 1a shows the golden template in a label inspection application. Figure 1b shows the inspection image. Figure 1c shows the resulting defect image. Defect areas in which the inspection image is brighter than the template are overlaid in green. Defect areas in which the inspection image is darker than the template are overlaid in red.

Refer to the *NI Vision Concepts Manual* for more information about golden template comparison.

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How to Detect Defects

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Define the golden template to compare to the inspection image using one of the following methods:
  - To create a new golden template, complete the following steps:
    - a. Click **New Template** to launch the NI Vision Template editor.
    - b. Complete the steps in the NI Vision Template Editor to create a golden template. Refer to the NI Vision Template Editor Help for specific instructions about how to define a golden template.
    - c. Click **Finish** to validate the new template.
    - d. In the Save Template As dialog box, browse to the location where you want to save the template file, enter a **File Name**, and click **OK**.
  - To use an existing image as the golden template, complete the following steps:
    - a. Click Load from File.
    - b. Browse to the image you want to use as the golden template.
    - c. Click **Open**.

If the image you selected is not a valid golden template file, complete the following steps to create a golden template based on the image you selected:

- a. Click **Yes** to launch the NI Vision Template Editor.
- b. Adjust the **Edge Threshold** value until only the edges you want to exclude during the golden template comparison remain.
- c. Click **OK**.
- d. In the Save Template As dialog box, browse to the location where you want to save the template file, enter a **File Name**, and click **OK**.



**Tip** Click **Edit Template** to launch the NI Vision Template Editor and modify the currently selected golden template.

#### **Alignment Tab**

3. If necessary, adjust the position of the region of interest to correspond with the area of the image you want to search for defects.

For rough alignment of the region of interest within the inspection image, use the mouse to adjust the center of the position of the region of interest. For fine adjustments in the position of the region of interest, use the arrow keys or the **Center X**, **Center Y**, and **Angle** controls. The size of the region of interest cannot be adjusted because the size of the region of interest is based on the size of the specified golden template.

4. Verify that the **Reposition Region of Interest** checkbox is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

- 5. Specify a **Scale** value to apply to the golden template if the area in the image you want to compare to the golden template is larger or smaller than the golden template image.
- 6. Select the type of **Alignment Correction** you want to use to when the golden template is applied to the image.

### **Settings Tab**

- 7. Specify the type of defects to detect using the **Look For** control.
- 8. Use the **Intensity**, **Ignore Edge Contours**, and **Edge Thickness** controls to adjust for variations in lighting and minor differences along the edges of the image that you want to ignore.
- 9. Use the **Bright Level** and **Dark Level** controls to set the threshold limits for defects in the image.
- **Tip** Use the **Display** button to show only the defects in the image or show the defects as an overlay on the original image. The green defects represent pixels in the inspection image that are brighter than the corresponding pixels in the golden template image. The red defects represent pixels in the inspection image that are darker than the corresponding pixels in the golden template image.

#### **Filter Tab**

- 10. Select the **Use Filter Criteria** checkbox if you wish to apply an additional filter to the defect image and remove defects you are not interested in detecting.
- 11. Click **Configure** to launch the Configure Object Filter dialog box and define the filter criteria you wish to apply to the image.

#### Limits Tab

12. Set the Maximum Total Defect Area, Maximum Largest Defect Area, Maximum Percent Defect, and/or the Maximum Number of Defects you expect to find. 10

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**Detect Defects Controls** 

## Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Template Image	Image to use as the template.
Template Size	Size of the template image in pixels.
New Template	Launches the NI Vision Template Editor, in which you can learn a template and save the result as a template image file.
Edit Template	Launches the NI Vision Template Editor, in which you can modify a template and save the result as a template image file.
Load from File	<ul> <li>Launches a dialog box in which you can browse to a template image file and specify the file as the template to use.</li> <li>Note When you load a template from file, the template can be any image file. If the template</li> </ul>
	already contains pattern matching and/or geometric pattern matching information, the golden template information will be saved to the same file. If the specified image does not contain any template information, you will be prompted to save the file to a new location.
Template Path	Displays the location of the template image file.

# Alignment Tab

The following controls are available on the Alignment tab.

<b>Control Name</b>	Description
Center X	X-coordinate of the center point in the region of interest.
Center Y	Y-coordinate of the center point in the region of interest.
Angle (deg)	Rotation angle of the region of interest, in degrees.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.
Scale (%)	Scale of the golden template in the inspection image expressed as a percentage.
Alignment Correction	<ul> <li>Specifies the algorithm to use to correct for slight misalignments between the golden template and inspection image. The following options are available:</li> <li>None—No alignment correction.</li> <li>Perspective—Adjusts the inspection image to correct for minor variations in alignment or perspective.</li> </ul>
Display	<ul> <li>Specifies what is displayed in the Main window. The following options are available:</li> <li>Overlay—Displays only the bright and dark defects.</li> <li>Defects—Displays the bright and dark defects as an overlay on the inspection image.</li> </ul>

# Settings Tab

The following controls are available on the Settings tab.

<b>Control Name</b>	Description
Look For	<ul> <li>Specifies the type of defects to search for in the image.</li> <li>All Defects—Searches for areas in the image that are brighter and/or darker than the corresponding area in golden template.</li> <li>Bright Defects—Searches for areas in the image that are brighter than the corresponding area in the golden template.</li> <li>Dark Defects—Searches for areas in the image that are darker than the corresponding area in the golden template.</li> </ul>
Intensity	<ul> <li>Specifies the algorithm used to resolve differences in the intensity of the inspection image compared to the intensity of the golden template.</li> <li>No Change—Does not adjust the intensity of the golden template and the inspection image.</li> <li>Histogram Matching Normalization—Adjusts the inspection image histogram to be similar to the histogram of the golden template.</li> <li>Average Matching Normalization—Adjusts the inspection image so the mean pixel value of the golden template.</li> </ul>
Ignore Edges	Specifies whether edges are ignored during the comparison process. If enabled, you can set the thickness of the edges to ignore using the <b>Edge Thickness</b> control.
Edge Thickness	Specifies the thickness of the edges to ignore.
Bright Level	Threshold value for determining the minimum pixel intensity difference between the golden template and the inspection image used for determining bright defects.

Dark Level	Threshold value for determining the minimum pixel intensity difference between the golden template and the inspection image used for determining dark defects.
Bright Defects	Color used to display bright defects.
Dark Defects	Color used to display dark defects.
Display	<ul> <li>Specifies what is displayed in the main window.</li> <li>Overlay—Displays only the bright and dark defects.</li> <li>Defects—Displays the bright and dark defects as an overlay on the inspection image.</li> </ul>

## **Filter Tab**

The following controls are available on the Filter tab.

<b>Control Name</b>	Description
Use Filter Criteria	Specifies whether you want to use an object filter to remove defects from the golden template comparison results.
Filter Criteria Table	Displays the current object filter settings.
Configure	Launches the Configure Object Filter dialog box, which is used to define the object filter criteria.
Display	<ul> <li>Specifies what is displayed in the main window.</li> <li>Overlay—Displays only the bright and dark defects.</li> <li>Defects—Displays the bright and dark defects as an overlay on the inspection image.</li> </ul>

# Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>	Description
Maximum Total Defect Area	When enabled, the area of the defects in the image must be less than the specified value in order for the step to pass.
Maximum Largest Defect Area	When enabled, the area of the largest defect must be less than the specified value in order for the step to pass.
Maximum Percent Defect	When enabled, the percentage of the image that contains defects must be less than the specified value in order for the step to pass.
Maximum Number of Defects	When enabled, the total number of defects found in the image must be less than the specified value in order for the step to pass.
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# **Detect Defects FAQs**

Q: Reposition Region of Interest and Reference Coordinate System are dimmed? How can I make these options available?

Insert a **Set Coordinate System** step before this step to make the **Reposition Region of Interest** and **Reference Coordinate System** controls available.



# **Identify Parts**

In some vision inspection applications, you identify an object by reading barcodes or text printed on the object. This palette groups visual inspection steps whose purposes are to read 1D and 2D barcodes and read text on an object using optical character recognition (OCR).

Step Name	Description
Read/Verify Text	Identifies an object based on text printed on the object. You can also use this step to perform optical character verification by comparing the characters of the string read in the image to reference characters. Refer to <u>Read/verify Text Concepts</u> for related information.
Classify Objects	Identifies an unknown sample by comparing its shape to classes of known samples. Refer to <u>Classify Objects Concepts</u> for related information.
Read 1D Barcode	Identifies an object based on the values encoded into its 1D barcode. You can compare the decoded data to a reference string or check whether the data contains a specific pattern. Refer to <u>Read 1D Barcode Concepts</u> for related information.
Read Data Matrix Code	Identifies an object based on the values encoded into its Data Matrix code. You can compare the decoded data to a reference string or check whether the data contains a specific pattern. Refer to <u>Read Data Matrix</u> <u>Code Concepts</u> for related information.
Read QR Code	Identifies an object based on the values encoded onto its QR or micro-QR code. You can compare the decoded data to a reference string or check whether the data contains a specific pattern.
Read PDF417 Code	Identifies an object based on the values

encoded into its PDF417 code. You can compare the decoded data to a reference string or check whether the data contains a specific pattern. Refer to <u>Read PDF417 Code</u>
Concepts for related information.

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# **Read/Verify Text Concepts**

The **Read/Verify Text** step is based on a technique called Optical Character Recognition (OCR). OCR consists of three processes:

- A training process during which you teach the software the types of characters and/or patterns you want to detect in the image during the reading procedure.
- A reading process during which Vision Builder AI analyzes an image to determine if the objects match the characters you trained. Vision Builder AI reads characters in an image using the character set that you created during the training process.
- A verification process during which Vision Builder AI compares the characters in the image to reference characters specified in a character set file and returns a score. The verification score indicates how closely the character in the image matches the reference character.

When you click the **Read/Verify Text** step in the **Identify Parts** tab, you can launch the NI OCR Training Interface to train characters. Use the NI OCR Training Interface to learn characters and/or patterns you want to detect. You can access help for the NI OCR Training Interface from within the training interface itself.

After you train for the characters, use the **Read/Verify Text** property page in Vision Builder AI to configure the **Read/Verify Text** step to compare characters in an image to the characters you learned in the NI OCR Training Interface.

Refer to the *NI Vision Concepts Manual* for more information about OCR and the descriptions of the results returned by the **Read/Verify Text** step.

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# How to Read/Verify Text

Use the **Read/Verify Text** step to perform the following operations on an inspection image:

- Read unknown characters in the image, and/or
- Verify the quality of known characters in the image.

Follow these instructions to configure the **Read/Verify Text** step.

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.

Vision Builder AI segments objects in the region of interest by drawing character bounding rectangles around the objects according to the current settings in the **Threshold**, **Size**, and **Options** tabs. Segmented objects appear blue in the image.

3. Verify that the **Reposition Region of Interest** checkbox is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image and you need to adjust the position of the region of interest to match the new location of the object.

4. If you are using a annulus region of interest, use the **Annulus Orientation** control to specify whether you want to use the inside edge or outside edge of the region as the baseline for found characters.

#### Mode Tab

- 5. Choose one of the following methods to specify a character set file to use.
  - If you have trained the software for the character set you want to read, click **Browse** to select a path to the character set file containing that character set. When you have selected the character set file, the path to the file appears in the **Character Set Path** control.
    - Tip Click Edit Character Set File to launch the NI OCR Training Interface and edit the character set file.
  - If you have not trained the software for the character set you want to read, click **New Character Set File** to launch the NI OCR Training Interface. Follow the instructions on the training interface to learn characters and/or patterns you want to detect. Refer to the *NI OCR Training Interface Help* for more information about using the interface.
- 6. Choose to either read and verify text in the image, or to only verify text in the image.
  - If the characters within the specified region of interest are unknown, select **Read Text** to determine the text in the image based on the specified character set and verify the text using the reference characters in the character set.
  - If the text in the image is already known, select **Verify Text** to verify the characters in the image based on reference characters in the specified character set.
- 7. If **Verify Text** is selected, specify the value of the text you want to verify. Otherwise, proceed to step 7.
  - To manually enter the value of the text to verify, select **Constant** from the **Text to Verify** listbox and enter the text in the **Value** field.
  - To use the value of a previous measurement or variable as the text to verify, select the measurement from the **Text to Verify** listbox. The current value of the measurement is displayed in the **Value** field.

# **Threshold Tab**

Configure options in the **Threshold** tab carefully. If you manually set the threshold values, and **Read/Verify Text** cannot detect characters in the region you specified, the training process does not create the character set file correctly. For example, if you select **Fixed Range** from the **Mode** control, and you select a **Max** value that is too low, **Read/Verify Text** cannot correctly detect the characters in the region of interest.

8. Select a threshold type from the **Mode** control.

When you select Linear or Nonlinear, you must set # of Blocks to at least the number of objects in the region of interest. If you selected Fixed Range in Type, use Min and Max or the slider at the bottom of the histogram to determine the threshold values. If you selected Computed, Linear, or Nonlinear in Type, use Characters to indicate the character color in the image. Light on Dark indicates that the image contains light characters on a dark background. Dark on Light indicates that the image contains dark characters on a light background.

- 9. Enable the **Ignore Objects Touching Region Borders** control to ignore objects that touch the border of the region of interest.
- 10. In **Remove Small Objects (# of Erosions)**, select the number of erosions to remove small objects from the region of interest.

#### Size Tab

11. Use the controls in the **Size** tab to indicate the character size and spacing values required for character recognition and verification. **Read/Verify Text** recognizes only those characters in the region of inspection that meet the criteria in the **Size** tab.

# **Options Tab**

Use the **Options** tab to determine how **Read/Verify Text** processes the image to detect characters. The **Options** tab is disabled if **Verify Text** is selected on the **Mode** tab.

- 12. Select a **Read Strategy** and **Read Resolution**.
- 13. Select an **Acceptance Level** value to indicate how closely an object must match a trained character to be a recognized character.
- 14. Enter the **Substitution Character** you want to appear in the string to indicate objects that are not trained and recognized.
- 15. Enable the **Aspect Ratio Dependant** control to read characters regardless of character size. Otherwise, select an **Aspect Ratio** value to indicate the allowable difference between the training and reading character sizes and height/width ratios.
- 16. Complete the following steps to specify a character pattern when you know that the character string to read always has the same pattern. For example, you can specify that you expect the first character to be a letter and the second character to be a digit. Specifying a pattern increases the speed and accuracy of recognition.
  - a. Enable the **Use Text Pattern** control.
  - b. Click **Specify Pattern** to launch the **Pattern Setup** dialog box.
  - c. Click **Add** to enable the first line of the **Pattern Setup** dialog box.
  - d. Select the type of character you expect the first character in the string to be, and enter that character.
  - e. Repeat steps c and d to define the types of characters you expect in the rest of the string.
  - f. Click **OK** to close the **Pattern Setup** dialog box.

#### **Limits Tab**

- 17. Set the conditions that determine whether the inspection step passes or fails. The following list describes common OCR applications and describes how to configure the inspection limits to get the desired result.
  - To compare the recognized characters to a constant, enable the **Text Equals** control and enter a string that the recognized characters must match.
  - To check that the recognized character string contains a specific string, enable the **Text Contains** control and enter the string.
  - To ensure that the verification scores for the characters are above a certain value, select the **Minimum Verification Score** checkbox. The verification score ranges from 0 to 1000 and describes how accurately the character in the inspection image matches the corresponding reference character in the specified character set file. If the character set does not contain a reference character, the step returns a value of 0 for the verification score.
  - To ensure that the classification score for the characters is above a certain value, select the Minimum Classification Score checkbox. The classification score ranges from 0 to 1000 and describes how confident the step is that the recognized character belongs to the assigned character class instead of other character classes in the specified character set file. A score of 1000 indicates that a recognized character is an exact match to the assigned character class.

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# **Read/Verify Text Controls**

Refer to the *NI OCR Training Interface Help* for information about the controls on the NI OCR Training Interface.

# Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description	
Step Name	Name to give the step.	
Region of Interest	The region of interest you want to use for the step.	
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.	
Annulus Orientation	Specifies which edge of an annulus region of interest to use as the baseline of the text to read/verify. The following options are available:	
	<ul> <li>Baseline Inside—Specifies that the imaginary line on which the bottoms of the letters align is closer to the center of the annulus.</li> </ul>	
	• <b>Baseline Outside</b> —Specifies that the imaginary line on which the bottoms of the letters align is closer to the outside of the annulus.	

#### Mode Tab

The following controls are available on the Mode tab.

<b>Control Name</b>	Description
Character Set Path	Path of the character set you want to use to recognize the characters. A character set file contains a unique representation for each trained character, as well as its corresponding value.
New/Edit Character Set File	Creates a new character set file or edits an existing one.
Read Text	Determines the characters in the image based on the specified character set and verifies each character against the corresponding reference character in the character set.
Verify Text	Verifies each character against the corresponding reference character in the character set.
Text to Verify	Source of the expected text. The value can either be a manually entered string, by selecting <b>Constant</b> , a string result from a previous measurement, or the value of a string variable.
Value	If <b>Read Text</b> is selected, <b>Value</b> displays the text read by the OCR engine. If <b>Verify Text</b> is selected, <b>Value</b> specifies the value of the text to verify.

# Threshold Tab

The following controls are available on the Threshold tab.

Control Name	Description	
Mode	<ul> <li>Specifies the type of threshold you want to perform. The following options are available:</li> <li>Fixed Range—Determines the threshold value for the region of interest.</li> <li>Uniform—Calculates a single threshold value for the region of interest.</li> <li>Linear—Divides a region of interest into the number of blocks you specify, calculates a threshold value for the first and last blocks, and then linearly interpolates values for the blocks between the first and last blocks.</li> <li>Nonlinear—Divides the region of interest into the number of blocks you specify and calculates a threshold value for the first and last blocks.</li> </ul>	
Characters	Specifies the relative intensity value of a character with respect to the background of the image. Use character color to specify whether the character set includes light characters on a dark background or dark characters on a light background.	
# of Blocks	Specifies the number of blocks that the region of interest is divided into when you use the <b>Linear</b> or <b>Nonlinear</b> Mode.	
Range Min	Minimum threshold value.	
Range Max	Maximum threshold value.	
Ignore Objects Touching Region Borders	When enabled, ignores objects that are touching the border of the region of interest.	
Remove Small Objects (# of Erosions)	Specifies the number of erosions you want OCR to perform to remove small objects from the region of interest.	

# Size Tab

The following controls are available on the Size tab.

<b>Control Name</b>	Description	
Autosplit	Allows you to configure OCR to handle slanted characters.	
Min Bounding Rect Width	Minimum width limits, in pixels, for the character bounding rectangle.	
Max Bounding Rect Width	Maximum width limits, in pixels, for the character bounding rectangle.	
Min Bounding Rect Height	Minimum height limits, in pixels, for the character bounding rectangle.	
Max Bounding Rect Height	Maximum height limits, in pixels, for the character bounding rectangle.	
Min Character Size	Minimum size requirements, in pixels, for an object in a region to be considered a character that can be trained.	
Max Character Size	Maximum size requirements, in pixels, for an object in a region to be considered a character that can be trained.	
Min Character Spacing	Minimum amount of space, in pixels, that can be between characters. This value must not be less than <b>Max Horizontal Element Spacing</b> .	
Max Horizontal Element Spacing	Maximum amount of space, in pixels, that can be between horizontally adjacent elements, such as in dot- matrix objects. This value must be less than <b>Min</b> <b>Character Spacing</b> .	
Max Vertical Element Spacing	Maximum amount of space, in pixels, that can be between vertically adjacent elements.	

# **Options Tab**

The following controls are available on the Options tab.

<b>Control Name</b>	Description	
Read Strategy	<ul> <li>Specifies how selective the step is in determining if read characters match trained characters. The following options are available:</li> <li>Conservative—Configures OCR to use extensive criteria to determine if read characters match trained characters.</li> <li>Aggressive—Configures OCR to use fewer criteria to determine if read characters match trained characters. The Aggressive strategy processes images faster than the conservative extensive at a strategy processes images faster than the conservative extensive extensive faster than the conservative extension.</li> </ul>	
Read Resolution	Level of character detail the step uses to determine if an object matches a trained character.	
Acceptance Level	Value to indicate how closely an object must match a trained character to be a recognized character. The valid range of values is 0 to 1000. A value of 1000 indicates a perfect match between an object and a trained character.	
Substitution Character	Specifies a character you want the step to use for objects that are not yet trained and recognized.	
Aspect Ratio Dependent	Configures OCR to read characters whose size is between a range.	
Aspect Ratio	Specifies how much larger or smaller, in percentages, the characters can be compared to the trained character. To maintain performance in the OCR process, limit the difference to ±50. Avoid creating character sets whose characters differ only in height and width. Consider separating the characters into different character sets, using valid characters to restrict trained characters, and enforcing the aspect ratio.	
Use Text	Specifies whether you want to define a pattern of	

Pattern	characters that you expect read strings to follow.
Specify Text Pattern	Launches the Pattern Setup dialog box in which you can specify a pattern that you expect the character string being read to follow. You can instruct the OCR engine that the first character expected is a letter, the second character a digit, and so on. Doing so increases the speed and accuracy of recognition.
Value	Displays the text read by the OCR engine.

# Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>	Description		
Text Equals	When enabled, the read text must equal this string in order for the step to pass.		
Text Contains	When enabled, the read text must contain this string in order for the step to pass. You can use the following wildcards:		
	Special Character		
	•	Matches	s any character.
	?	Matches express	s zero or one instances of the ion proceeding ?.
	[] Encloses alternates. For example, [abornatches a, b, or c. The following character have special significance when used with brackets:		es alternates. For example, [abc] s a, b, or c. The following characters ecial significance when used within ekets:
		- (dash)	Indicates a range when used between digits or letters (for example, [0-5], [a-g], or [L-Q])
			The following characters have significance only when they are the first character within the brackets:
		~	Excludes the set of characters, including non-displayable characters. [~0-9] matches any character other than 0 through 9.
		٨	Excludes the set with respect to all the displayable characters (and the space characters). [^0-9] gives the space characters and all displayable characters except 0

	through 9.
Minimum Verification Score	When enabled, the verification score for all characters must be equal to or greater than the specified score.
Minimum Classification Score	When enabled, the classification score for all characters must be equal to or greater than the specified score.
Value	Displays the text read by the OCR engine.

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# **Read/Verify Text FAQs**

# Q: Why is the step not properly recognizing the text inside my region of interest?

Before the **Read/Verify Text** step can read characters in a region of interest, you need to train the software to recognize the characters. If you have not trained for the characters, click **Edit Character Set File** on the **Main** tab to launch the NI OCR Training Interface and train for the characters.

Make sure you selected a **Character Set Path** from the **Main** tab that describes the characters you want to read.

Make sure that each character in the region of interest is tightly bounded by a character bounding rectangle. If each character is not bounded, adjust the parameters in the **Threshold** and **Size** tabs. In particular, enable the **Ignore Objects Touching Region Borders** control in the **Threshold** tab if artifacts touch the character bounding rectangle. Also, adjust the **Max Bounding Rect Width** in the **Size** tab if the characters are slanted and slightly overlap in the vertical direction causing one character bounding rectangle to surround all of the characters. Adjusting this parameter forces the width of the character bounding rectangle.

# Q: I want the Read/Verify Text step to fail if the text read matches a specific string, but the Limits tab does not allow me to do this. How do I configure for this type of pass/fail?

Insert a **Logic Calculator** step after the **Read/Verify Text** step. Perform the following steps to compute this type of pass/fail:

- 1. Do not select any of the limit conditions in the **Limits** tab of the **Read/Verify Text** step. The step will always pass.
- 2. Insert a Logic Calculator step. Select the ID measure of the Read/Verify Text step as the first operand.
- 3. Enter the string that should fail the inspection in the **Constant** control.
- 4. Click **Add** to add the expression to the **Decision** table.
- 5. Click Negate.
- 6. Click **OK** to validate the **Logic Calculator** step.

You can also use the **Calculator** step to create a custom decision rule based on the text read.

#### Q: Why is the step returning a verification score of 0?

In order for the **Read/Verify Text** step to return the proper verification score for a character, each character class found must have a corresponding reference character in the character set. The reference character is the sample character that the step compares to each found character class. If a reference character has not been specified for all of the found character classes, the algorithm returns a score of 0 for the character classes that do not have a reference character. You can edit the character set file to specify reference characters by clicking the **Edit Character Set File** button on the **Mode** tab.

#### Q: How can I increase the accuracy of the character recognition?

If you know the type of characters that are supposed to be read at a specific location, you can specify a text pattern for the string. Specifying a text pattern limits the possible characters the step looks for when performing character recognition. Complete the following steps to specify a text pattern.

- 1. In the Inspection Steps palette, select the **Options** tab.
- 2. Select the **Use Text Pattern** checkbox.
- 3. Click the **Specify Text Pattern** button to launch the Pattern Setup dialog box.
- 4. In the Pattern Setup dialog box, specify a **Type** for each character you expect to find. The number of characters you specify should match the length of the string you expect to find.
- 5. Click **OK** to close the Pattern Setup dialog box.



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# **Classify Objects Concepts**

The **Classify Objects** step identifies an unknown sample by comparing a set of its significant features to a set of features that conceptually represent classes of known samples. Classification involves two phases:

- **Training**—Teaches Vision Builder AI the types of samples you want to classify during the classifying phase. You can train any number of samples to create a set of classes, which you later compare to unknown samples during the classification phase. You store the classes in a classifier file. Training might be a one-time process, or it might be an incremental process you repeat to add new samples to existing classes or to create several classes, thus broadening the scope of samples you want to classify.
- **Classifying**—Identifies an unknown sample in an inspection image into one of the classes you trained. The classifying phase classifies a sample according to how similar the sample features are to the same features of the trained samples.

Typical applications involving classification include the following:

- **Sorting**—Sorts objects of varied shapes. For example, sorting different mechanical parts on a conveyor belt into different bins.
- **Inspections**—Inspects objects by assigning each object an identification score and then rejecting objects that do not closely match members of the training set.



**. 6€** ∭123 How to Classify Objects

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

3. If you have not trained the software for the classes you want to identify, click **New Classifier File** to launch the NI Classification Training Interface. Follow the instructions on the training interface to learn the classes you want to identify.

Refer to the *NI Classification Training Interface Help* for more information about how to train and classify objects in the Classification Training Interface.

- If you have trained the software for the classes you want to identify, click the Browse button to select the path to the classifier file. When you have selected the classifier file, the path to the file appears in the Classifier File Path control.
  - Note Click Edit Classifier File to launch the NI Classification Training Interface and edit the classifier file.
- 5. Draw a region of interest around each sample you want to classify.

Vision Builder AI segments objects in the region of interest by drawing bounding rectangles around the objects found according to the current settings in the **Main**, **Threshold**, and **Options** tabs.

# Threshold Tab

Configure options in the **Threshold** tab carefully. If you manually configure the threshold options, make sure that the classification engine correctly detects the objects in the region you specified. Otherwise, when you run the step, the classification will not find any objects in the region of interest.

- 6. Select a threshold type. When you select **Manual Threshold**, you must set the type of object to look for using the **Look For** control. You must also select the threshold range using the **Min** and/or **Max** control.
- 7. Select the type of objects you want to classify. You can classify **Bright Objects**, **Dark Objects**, or **Gray Objects**.
- 8. Enable the **Ignore Objects Touching Region Borders** control to ignore objects that touch the border of the region of interest.
- 9. In the **Remove Small Objects (# of Erosions)** control, select the number of erosions to remove small objects in the sample from the region of interest.

The classification engine displays segmented objects in blue.

# **Options Tab**

- 10. Use the controls in the **Options** Tab to select the **Method** and **Metric** settings used by the classification engine for object classification.
- 11. Enable the **Scale Dependent** control to determine the relative importance of scale when classifying objects. Enter a numerical scale value between 0 and 1000 in the **Scale Factor** control. If the value is 0, objects are classified independent of scale.
- 12. Enable the **Mirror Dependent** control to determine the relative importance of mirror symmetry when classifying samples. Enter a numerical value of importance between 0 and 1000 for the mirror symmetry in the **Mirror Factor** control. If the value is 0, objects are classified independent of mirror symmetry.

# **Classify Tab**

- 13. Select the checkbox next to the labels you would like to use the minimum classification score and minimum identification score criteria for identifying the objects in the region of interest.
  - Note Objects displayed in a different color with parentheses around them in the Results table are identified as Other because either the score falls below the minimum classification or identification score specified in the Classification Criteria table, or because the class is not selected in the Classification Criteria table.
- 14. Enable the **Classify Only Largest Object** control to classify only the largest object. If this option is not selected, all objects in the region of interest will be classified.
### Limits Tab

15. If you want to specify the maximum and minimum number of objects allowable for a specific class, select the checkbox next to the class of interest and set the minimum and/or maximum number of samples you want to classify.



**Classify Objects Controls** 

### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description			
Step Name	Name to give the step.			
Region of Interest	The region of interest you want to use for the step.			
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.			
Reference Coordinate System	Coordinate system to which you want to link the region of interest.			
Classifier File Path	Path of the classifier file you want to use to classify samples. A classifier file contains a representation for each trained sample as well as its corresponding label.			
New Classifier File	Launches the NI Classification Training Interface so you can create a new classifier file.			
Samples	Indicates the number of samples learned in the selected classifier file.			

### Threshold Tab

The following controls are available on the Threshold tab.

<b>Control Name</b>	Description			
Method	You can choose to perform a manual or automatic threshold. To threshold manually, select <b>Manual Threshold</b> from the <b>Method</b> drop-down menu.			
	For automatic thresholding, the following options are available:			
	<ul> <li>Clustering—Sorts the histogram of the image within a discrete number of classes corresponding to the number of phases perceived in an image. Clustering is the most frequently used automatic thresholding method.</li> <li>Entropy—Detects samples that are present in minuscule proportions on the image.</li> <li>Metric—Calculates a value for each threshold determined by the surfaces representing the initial gray scale.</li> <li>Moments—Use for images that have poor contrast.</li> <li>Inter Variance—Use for images in which classes are not too disproportionate. For best results, the smallest class must be at least 5% of the largest one.</li> </ul>			
Look For	<ul> <li>Specifies the type of objects to search for in the image.</li> <li>The following options are available: <ul> <li>Bright Objects—When selected, the step counts bright pixels whose intensity values range from Lower Value to 255.</li> <li>Dark Objects—When selected, the step counts dark pixels whose intensity values range from 0 to Upper Value.</li> <li>Gray Objects—When selected, the step counts gray pixels whose intensity values range from</li> </ul> </li> </ul>			

	Lower Value to Upper Value.
Range	<ul> <li>Use the following controls to specify the threshold range.</li> <li>Min—The lower value of the threshold range when you use the Manual Threshold method. For automatic thresholding methods, Min displays the value computed by the selected method when Bright Objects is selected in the Look For control.</li> <li>Max—The upper value of the threshold range</li> </ul>
	when you use the <b>Manual Threshold</b> Method. For automatic thresholding methods, <b>Max</b> displays the value computed by the selected method when <b>Dark Objects</b> is selected in the <b>Look For</b> control.
	<ul> <li>Lower Limit—Lower limit of the thresholding range when you use one of the automatic thresholding methods. The automatic thresholding algorithm you select cannot compute a threshold value lower than Lower Limit.</li> </ul>
	• Upper Limit—Upper Limit of the thresholding range when you use one of the automatic thresholding methods. The automatic thresholding algorithm you select cannot compute a threshold value greater than Upper Limit.
lgnore Objects Touching Region Borders	Ignores objects in the sample that are touching the border of the region of interest.
Remove Small Objects (# of Erosions)	Number of erosions you want the classification engine to perform to remove small objects in the sample from the region of interest.

### **Options Tab**

The following controls are available on the Options tab.

Control Name	Description		
Method	Method of classification. The following options are available:		
	<ul> <li>Nearest Neighbor—Most direct approach to classification. In nearest neighbor classification, the distance of an input feature vector of unknown class to another class is defined as the distance to the closest samples that are used to represent that class.</li> <li>K-Nearest Neighbor—More tolerant of noise compared with nearest neighbor classification. In K-nearest neighbor classification, an input feature vector is classified into a class based on a voting mechanism. The NI Classifier finds <i>K</i> nearest samples from all the classes. The input feature vector of unknown class is assigned to the class with majority of the votes in the <i>K</i> nearest samples.</li> </ul>		
	• Minimum Mean Distance—Most effective in applications that have little or no feature pattern variability or other corruptive influences. In minimum mean distance classification, an input feature vector of unknown class is classified based on its distance to each class center.		
Metric	Computes the distance between features in a classification application. The following options are available:		
	• Maximum—Most sensitive to small variations between samples. Use Maximum when you need to classify samples with very small differences into different classes.		

	<ul> <li>Sum—Metric used in most classification applications. Sum is also known as the Manhattan metric or Taxicab metric. This is the default Metric value.</li> <li>Euclidean—Least sensitive to small variations between samples. Use Euclidean when you need to classify samples with small differences into the same class.</li> </ul>			
К	Sets the <i>K</i> value when using the K-Nearest Neighbor method of classification. The default is 3.			
Scale Dependent and Mirror Dependent	Define the dependence of the classification engine on shape, scale, and mirror symmetry. By default, when the <b>Scale Dependent</b> and <b>Mirror Dependent</b> options are disabled, the NI Classifier depends only on variations in shape to classify samples. When <b>Scale Dependent</b> and <b>Mirror Dependent</b> are enabled, the dependence on shape is calculated by the following formula:			
	Shape Dependence = 1000 - (Scale Factor + Mirror Factor) • Scale Factor—Determines the relative			
	importance (between 0 and 1000) of scale when classifying samples. If the value is 0, the samples are classified independent of scale.			
	• <b>Mirror Factor</b> —Determines the relative importance (between 0 and 1000) of mirror symmetry when classifying samples. If the value is 0, the samples are classified independent of mirror symmetry. An example of objects that exhibit mirror symmetry are a lowercase letter <i>p</i> and a lowercase letter <i>q</i> .			

### **Classify Tab**

The following controls are available on the Classify tab.

<b>Control Name</b>	Description				
Classification Criteria	All of the classes associated with the classifier file will be isted in the Classification Criteria table.				
	The first column provides a checkbox so you can specify if you are interested in looking for objects of this class. If the checkbox is selected, the minimum classification score and minimum identification score are used to determine if an object belongs to this class. If the box is not checked, any objects identified as this class will be classified as <b>Other</b> .				
	<ul> <li>Label—The name of the class.</li> <li>Class—The minimum classification score an object can have and still be identified as part of this class.</li> </ul>				
	<ul> <li>Ident—The minimum identification score an object can have and still be identified as part of this class.</li> </ul>				
	Note If a class label is selected, an object of this class must have a classification and identification score higher than the minimum score to be considered part of this class. Objects with a score lower than the minimum are classified as <b>Other</b> .				
Classify Only Largest Object	Specifies whether all objects in the region of interest are classified or only the largest object.				
Results	<ul> <li>Lists the objects are identified in the region of interest.</li> <li>Objects in the Other class are a different color with parentheses around the class label.</li> <li>Label—The name of the class.</li> <li>Class—The Classification Score of the object.</li> <li>Ident—The Identification Score of the object.</li> </ul>				

<ul> <li>X—X-coordinate of the object center of mass.</li> <li>Y—Y-coordinate of the object center of mass.</li> <li>Note If you calibrate the image using the Calibrate Image step, X and Y are returned in the calibration unit you specify. Otherwise, X and Y are returned as uncalibrated units.</li> </ul>
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### Limits Tab

Only classes selected in the **Classify** Tab will appear in the Classification Results table in addition to the **Other** class. When a class is selected, the number of objects of this class in the region of interest must be between the **Minimum** and **Maximum** values in order for the step to pass.



## **Classify Objects FAQs**

# Q: Why is the step not properly recognizing the sample inside my region of interest?

Before the **Classify Objects** step can locate a sample in a region of interest, you need to train the software to recognize the sample. Click **Edit Classifier File** on the **Main** tab to launch the NI Classification Training Interface. Use the Classification Training Interface to train for your sample.

Make sure you selected a **Classifier File Path** from the **Main** tab that describes the sample you want to classify.

### **Read 1D Barcode Concepts**

The Read 1D Barcode step consists of two phases:

- 1. Phase during which you specify an region of interest in the image, which helps to locate the region occupied by the barcode.
- 2. Phase during which the region you specify is analyzed to decode the barcode.

The following table lists the types of barcodes and their characteristics:

Barcode Type	Supported Characters	Length	Different Bar Widths	Checksum
Codabar	0-9, - (dash), : (colon), . (period), \$ (dollar), / (slash), + (plus)	variable	2	optional
Code 39	Uppercase letters A-Z, 0-9, space, - (dash), . (period), \$ (dollar), + (plus), % (percent)	variable	2	optional
Code 93	Uppercase letters A-Z, 0-9, space, - (dash), . (period), \$ (dollar), + (plus), % (percent), * (asterisk)	variable	4	required
Code 128	All ASCII characters and control codes	variable	4	required
EAN 8	Numbers only	7 data and 1 checksum	4	required
EAN 13	Numbers only	12 data and 1 checksum	4	required
Interleaved 2 of 5	Numbers only	variable	2	optional
MSI	Numbers only	variable	2	required

UPC A	Numbers only	11 data and 1 checksum	4	required
Pharmacode	Numbers only	variable	2	none
RSS Limited	Numbers only	2 data and 1 checksum, 46 elements	8	required

The limit conditions are different for barcodes that have two different widths of bars and spaces and for barcodes that have four different widths of bars and spaces.

The following factors can cause errors in the decoding phase:

#### Low Image Resolution

The resolution of an image is determined by the width of the smallest bar and space. These widths must be at least 3 pixels for all barcodes.

### **High Horizontal or Vertical Light Drift**

Light drift is quantified by the difference between the average of the gray level of the left (upper) line and the right (bottom) line of the background of the barcode. Decoding inaccuracies can occur if the light drift is greater than 120 gray levels for barcodes with two different widths of bars and spaces, and it can occur if the light drift is greater than 100 gray levels for barcodes with four different widths of bars and spaces.

#### **Poor Resolution**

In overexposed images, the gray levels of the wide and narrow bars in the barcode tend to differ. Decoding results may not be accurate when the difference in gray levels is less than 80 for barcodes with two different widths of bars and spaces, and less than 100 for barcodes with four different widths of bars and spaces.

Consider the difference in gray levels between the narrow bars and the wide bars. The narrow bars are scarcely visible. If this difference of gray level exceeds 115 on 8-bit images (256 gray levels) for barcodes with two different widths of bars and spaces and 100 for barcodes with four different widths of bars and spaces, the results may be inaccurate.

### **Noise and Reflection**

Noise is defined as the standard deviation of a rectangular region of interest drawn in the background. It must be less than 57 for barcodes with two different widths of bars and spaces and less than 27 for barcodes with four different widths of bars and spaces.

Reflections on the barcode can introduce errors in the value read from the barcode. Bars and spaces that are masked by the reflection produce errors. 

### How to Read a 1D Barcode

Use the **Read 1D Barcode** step to decode a 1D barcode.

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.
- 3. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

### **Settings Tab**

4. Select **Barcode Type** you want to read.

If the barcode type is Codabar, Code 39, or Interleaved 2 of 5 you can enable the **Optional Checksum Coded** control to use the encoded checksum information to validate the results. If the validation fails, the step also fails.

If the barcode type is Codabar, Code 128, EAN 8, EAN 13, or UPCA, you can enable the **Add Special Characters to Code** control to add the special characters of the code to the encoded data. You can also add a checksum to the encoded data, regardless of barcode type, by enabling the **Add Checksum to Code Read** control.

### Limits Tab

5. If you want to compare the decoded data to a constant, enable the **Code Equals** control and enter a string that the decoded data must match. If you want to verify that the barcode contains a specific string, enable the **Code Matching** control and enter the string. **Read 1D Barcode Controls** 

### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description		
Step Name	Name to give the step.		
Region of Interest	The region of interest you want to use for the step.		
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.		
Reference Coordinate System	Coordinate system to which you want to link the region of interest.		

### Settings Tab

The following controls are available on the Settings tab.

<b>Control Name</b>	Description			
Barcode Type	Specifies the type of barcode you want to read.			
Optional Checksum Coded	When enabled, the step calculates the optional checksum data. If the barcode type is Codabar, Code 39, or Interleaved 2 of 5, it is possible for the code to include an optional checksum in the code. Most of the time this checksum is not present, but if a checksum is present, you can enable this option to calculate and apply the checksum. If the checksum fails, the step also fails.			
Add Special Characters to Code Read	When enabled, this step adds the special characters to the encoded data. Only Codabar, Code 128, EAN 8, EAN 13, and UPCA barcodes contain special characters.			
Add Checksum to Code Read	When enabled, this step adds the checksum value read with the barcode to the encoded data. Refer to the following table for the layout of special characters, data, and checksum for each type of barcode.			
	BarcodeSpecialTypeCharacters			
	Codabar	Start character and stop character	<start char=""> <data> <checksum> <stop char&gt;</stop </checksum></data></start>	
	Code 39	None	<data> <checksum></checksum></data>	
Code 93 None			<data> <checksum></checksum></data>	
	Code 128	FNC Number	<fnc> <data> <checksum></checksum></data></fnc>	
	EAN 8	Country character 1 and 2	<country char1=""> <country char2=""> <data> <checksum></checksum></data></country></country>	
	EAN 13	Country	<country char1=""></country>	

		character 1 and 2	<country char2=""> <data> <checksum></checksum></data></country>
	Interleaved 2 of 5	None	<data> <checksum></checksum></data>
	MSI	None	<data> <checksum></checksum></data>
	Pharmacode	None	<data char=""></data>
	RSS Limited	None	<linkage flag=""> <data> <checksum></checksum></data></linkage>
Region Profile	Average intensity of the pixels in the region of interest.		
Code Read	Decoded barcode data.		

### Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>	Description		
Code Equals	When enabled, the decoded barcode data must equal this string in order for the step to pass.		
Code Contains	When enabled, the decoded barcode data must contain the specified string for the step to pass. You can use the following wildcards:		
	Special Character	Special Character Interpretation	
	•	Matches ar	iy character.
	?	Matches zero or one instances of the expression proceeding ?.	
	[]	Encloses alternates. For example, [abc] matches a, b, or c. The following characters have special significance when used within the brackets:	
		- (hyphen)	Indicates a range when used between digits or letters (for example, [0-5], [a-g], or [L-Q])
			The following characters have significance only when they are the first character within the brackets:
		~	Excludes the set of characters, including non-displayable characters. [~0-9] matches any character other than 0 through 9.
		^	Excludes the set with respect to all the displayable characters

	(and the space characters). [^0-9] gives the space characters and all displayable characters except 0 through 9.
Code Read	Decoded barcode data.

## **Read 1D Barcode FAQs**

#### Q: Why is the Code Read control empty?

Make sure **Barcode Type** is set correctly and the region of interest encloses all of the bars.

#### Q: Can I adjust the parameters for finding the bars?

No. The algorithm that **Read 1D Barcode** uses is adaptive and can find the bars even when the image contains a slight light drift along the barcode.

# Q: The string returned by the algorithm does not match the code written below the barcode.

If the type of barcode is Codabar, Code 128, EAN 8, EAN 13, UPCA, or RSS Limited enable the **Add Special Characters to Code** control. You can also enable the **Add Checksum to Code** control. 龖

### **Read Data Matrix Code Concepts**

The Read Data Matrix Code step consists of two phases:

- Phase during which you specify an region of interest in the image, which helps to locate the region occupied by the barcode. This phase is optional, but it can increase the performance of the second phase by reducing the size of the search region.
- 2. Phase during which the region you specify is analyzed to decode the barcode.

The following factors can cause errors in the search and decoding phase:

- Very low resolution of the image
- Very high horizontal or vertical light drift
- Contrast of the modules in the image
- High level of noise or blurring
- Inconsistent printing or stamping techniques—such as misaligned barcode elements—inconsistent element size, or elements with inconsistent borders.
- Quiet zone that is too small or contains too much noise
  - Note The minimum quiet zone for a Data Matrix barcode is equal to one module width on all four sides of the barcode.
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## How to Read a Data Matrix Code

Use the **Read Data Matrix Code** step to locate and decode a 2D Data Matrix code.

### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.
- 3. Verify that the **Reposition Region of Interest** control is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

### **Basic Tab**

- 4. Set the controls on the Basic tab to specify the shape of the Data Matrix code and improve the performance of the step. Select the Suggest Values? control if you want the step to suggest values for the controls when you click the Suggest Values button.
- 5. Select the **Return Grading Results** checkbox if you want the step to return AIM grading metrics for the Data Matrix code. If you do not need grading information for your application, disable the **Return Grading Results** control to decrease the amount of time the step takes to complete.

### Adv. Search Tab

6. Set the controls on the **Adv. Search** tab. Select the **Suggest Values?** control if you want the step to suggest values for the controls when you click the **Suggest Values** button.

## **Cell Sampling Tab**

7. Set the controls on the **Cell Sampling** tab if the step cannot consistently read the Data Matrix code because of variations in lighting or quality. Otherwise, use the default values for the controls on this tab.

#### **Limits Tab**

8. To compare the decoded data to a constant, select the **Code Equals** control and enter a string that the decoded data must match.

To verify that the Data Matrix code contains a specific string, select the **Code Contains** control and enter the string.

To perform character verification on the Data Matrix code and set the step result based on the verification grade, complete the following steps. On the Basic tab, enable the **Return Grading Results** control. On the Limits tab, enable the **Minimum Overall Grade** control and select the minimum grade you want to use.

The decoded characters the step read are shown in the **Code Read** control. Additional information about the Data Matrix code is returned in the **Results** table. 龖

**. 6€** ∭123 **Read Data Matrix Code Controls** 

## Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

## **Basic Tab**

The following controls are available on the Basic tab.

Control Name	Description	
Suggest Value?	When enabled, the step suggests a value for the associated control when the <b>Suggest Values</b> button is clicked.	
ECC	<ul> <li>Specifies the error checking and correction (ECC) scheme used for the Data Matrix. The following options are available:</li> <li>Auto-detect—Sets the step to determine the ECC automatically.</li> <li>ECC 000—Sets the step to read Data Matrix codes of ECC 000 only.</li> <li>ECC 050—Sets the step to read Data Matrix codes of ECC 050 only.</li> <li>ECC 080—Sets the step to read Data Matrix codes of ECC 080 only.</li> <li>ECC 100—Sets the step to read Data Matrix codes of ECC 080 only.</li> <li>ECC 100—Sets the step to read Data Matrix codes of ECC 100 only.</li> <li>ECC 140—Sets the step to read Data Matrix codes of ECC 100 only.</li> <li>ECC 140—Sets the step to read Data Matrix codes of ECC 140 only.</li> <li>ECC 000-140—Sets the step to read Data Matrix codes of ECC 000, ECC 050, ECC 080, ECC 100, and ECC 140 only.</li> <li>ECC 200—Sets the step to read Data Matrix codes of ECC 000, ECC 050, ECC 080, ECC 100, and ECC 140 only.</li> <li>ECC 200—Sets the step to read Data Matrix codes of ECC 200 only.</li> </ul>	
Shape	Specifies whether the matrix is <b>Square</b> or <b>Rectangular</b> .	
Matrix Size	Specifies the size of the matrix to read.	
Barcode Polarity	<ul> <li>Specifies the data-to-background contrast for the matrix. The following options are available:</li> <li>Auto-detect—Sets the step to determine the matrix polarity automatically.</li> <li>Black On White—Sets the step to read</li> </ul>	

	<ul> <li>matrices with dark data on a bright background.</li> <li>White On Black—Sets the step to read matrices with bright data on a dark background.</li> </ul>
Min Barcode Size	Specifies the minimum size, in pixels, of the matrix in the image. If you set this value to 0, the step never excludes a matrix candidate because it is too small.
Max Barcode Size	Specifies the maximum size, in pixels, of the matrix in the image. If you set this value to 0, the step never excludes a matrix candidate because it is too large.
Min Border Integrity %	Minimum percentage of the <u>finder pattern</u> that the step should expect in the Data Matrix. During the location phase, the step ignores possible matrix candidates that do not have at least this level of border integrity.
Deselect/Select All	Disables/Enables all <b>Suggest Value?</b> checkboxes.
Return Grading Results	Specifies whether you want to return grading information about the barcode.
Code Read	Displays the value of the Data Matrix code.
Suggest Values	Detects the best values for parameters that have the <b>Suggest Value?</b> checkbox enabled.

### Adv. Search Tab

The following controls are available on the Adv. Search tab.

Control Name	Description
Suggest Value?	When enabled, the step suggests a value for the associated control after the <b>Suggest Values</b> button is clicked.
Quiet Zone Width	Specifies the expected minimum size, in pixels, of the quiet zone. The step ignores Data Matrix candidates with quiet zones are smaller than this value.
Aspect Ratio	Specifies the ratio of the matrix width (in pixels) divided by the matrix height (in pixels). If you have rectangular matrices, and you set this value to 1, the step appropriately recalculates the aspect ratio. If you set this value to 0, the step automatically determines the aspect ratio.
Rotation Mode	<ul> <li>Specifies the amount of Data Matrix rotation to allow. The following options are available:</li> <li>Unlimited—The step allows for unlimited rotation.</li> <li>0 Degrees—The step allows for no rotation.</li> <li>90 Degrees—The step allows for ±90 degrees of rotation.</li> <li>180 Degrees—The step allows for ±180 degrees of rotation.</li> <li>270 Degrees—The step allows for ±270 degrees of rotation.</li> </ul>
Skew Degrees Allowed	Amount of skew in the matrix to allow. The default is 5 degrees.
Maximum Iterations	Maximum number of iterations the step makes before it stops looking for the matrix. The default is 150.
Initial Search	Number of pixels the step should average together

Vector Width	to determine the location of an edge. You may need to increase this value when the Data Matrix has cells with a low fill percentage.
Edge Threshold	Minimum contrast a pixel must have to be considered part of a matrix cell edge. The lower this value, the more potential edge candidates the step examines during the location phase. Setting this value too low decreases the performance of the step because the step examines too many potential edge candidates. Setting this value too high may also decrease the performance of the step by removing valid edge candidates, making location more difficult. Setting this value too high may also cause the step to fail to identify the matrix because all edge candidates are eliminated.
Deselect/Select All	Disables/Enables all <b>Suggest Value?</b> checkboxes.
Code Read	Displays the value of the Data Matrix code.
Suggest Values	Detects the best values for parameters that have the <b>Suggest Value?</b> checkbox enabled.

## Cell Sampling Tab

The following controls are available on the Cell Sampling tab.

Control Name	Description
Suggest Value?	When enabled, the step suggests a value for the associated control after the <b>Suggest Values</b> button is clicked.
Cell Fill Percentage	<ul> <li>Fill percentage for a cell that is in the On state. The following options are available:</li> <li>Auto-detect—Sets the step to determine the matrix cell fill percentage automatically.</li> <li>&lt; 30%—Sets the step to read matrices with a cell fill percentage of less than 30%.</li> <li>&gt;= 30%—Sets the step to read matrices with a cell fill percentage greater than or equal to 30%.</li> </ul>
Demodulation Mode	<ul> <li>Mode that determines which cells are on and which cells are off in the Data Matrix. The following options are available:</li> <li>Auto-detect—The step tries each demodulation mode and use the one which decodes the Data Matrix within the fewest iterations and utilizes the least amount of error correction.</li> <li>Histogram—The step uses a histogram of all of the matrix cells to calculate a threshold. This threshold determines if a cell is on or off. This is the fastest method but requires images with consistent levels of contrast in the matrix.</li> <li>Local Contrast—The step examines each neighbor of a cell to determine if the cell is on or off. This method is slower but works with images that have inconsistent levels of contrast in the matrix.</li> <li>Combination—The step uses the</li> </ul>

	<ul> <li>histogram of the matrix to calculate a threshold. For cells with pixel values that are sufficiently below or above this threshold, the step uses the threshold to determine if the cell is on or off. If the cell pixel values are close to the threshold, the step uses the Local Contrast method to determine if the cell is on or off. This method is slower but works with images that have extremely low cell fill percentages or gross print growth errors.</li> <li>All—The step tries Histogram first, then Local Contrast, and then Combination, stopping when one mode is successful.</li> </ul>
Cell Sample Size	<ul> <li>Sample size, in pixels, to use to determine if each cell is on or off. The following options are available:</li> <li>Auto-detect—The step tries each sample size and uses the one that decodes the Data Matrix in the fewest iterations using the least amount of error correction.</li> <li>1×1 The step uses a 1×1 sized sample from each cell.</li> <li>2×2—The step uses a 2×2 sized sample from each cell.</li> <li>3×3—The step uses a 3×3 sized sample from each cell.</li> <li>4×4—The step uses a 4×4 sized sample from each cell.</li> <li>5×5—The step uses a 5×5 sized sample from each cell.</li> <li>6×6—The step uses a 6×6 sized sample from each cell.</li> <li>7×7—The step uses a 7×7 sized sample from each cell.</li> </ul>
Cell Filter Mode	Mode the step uses to determine the pixel value for each cell. Note that if Cell Sample Size is $1 \times 1$ , the

Mirror Mode	<ul> <li>Specifies if the matrix appears normally in the image or if the matrix appears mirrored in the image. The following options are available:</li> <li>Auto-detect—Sets the step to determine if the matrix is mirrored automatically.</li> <li>Normal—Sets the step to read matrices that appear normally in the image.</li> <li>Mirrored—Sets the step to read matrices that appear mirrored in the image.</li> </ul>	
Deselect/Select All	Disables/Enables all <b>Suggest Value?</b> checkboxes.	
Code Read	Displays the value of the Data Matrix code.	
Suggest Values	Detects the best values for parameters that have the <b>Suggest Value?</b> checkbox enabled.	

## Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>		C	Description
Code Equals	Step passes if the Data Matrix code matches the specified value.		
Code Contains	When enabled, the decoded Data Matrix code data must contain the specified string for the step to pass. You can use the following wildcards:		
	Special Character Interpretation		
	•	Matches ar	iy character.
	?	Matches ze expression	ero or one instances of the proceeding ?.
	[]	Encloses a matches a, have specia the bracket	Iternates. For example, [abc] b, or c. The following characters al significance when used within s:
		- (hyphen)	Indicates a range when used between digits or letters (for example, [0-5], [a-g], or [L-Q])
			The following characters have significance only when they are the first character within the brackets:
		~	Excludes the set of characters, including non-displayable characters. [~0-9] matches any character other than 0 through 9.
		^	Excludes the set with respect to all the displayable characters

N 4 : :	(and the space characters). [^0-9] gives the space characters and all displayable characters except 0 through 9.		
Minimum Overall Grade	Step passes if the Data Matrix code has an overall grade of at least the specified value.		
Results	<ul> <li>Displays information about the code read. You can use the information in the Results table to optimize the reading process. If the Return Grading Results checkbox on the Basic tab is enabled, the Results table also contains information about the grading values for the read Data Matrix code. The following values are displayed by default: <ul> <li>Binary Data—Displays if the Data Matrix code contains encoded non-ASCII binary Data (True) or ASCII text (False).</li> <li>ECC—Displays the type of Data Matrix code.</li> <li>Matrix Size—Displays the size of the Data Matrix code in cells. For example, a value of 18 × 18 means the Data Matrix code is 18 cells high and 18 cells wide.</li> <li>Barcode Polarity—Displays the polarity of the Data Matrix code.</li> <li>Border Integrity—Displays the percentage of the Data Matrix code.</li> <li>Iterations—Displays the number of iterations the step took to determine the location of the Data Matrix code.</li> </ul> </li> </ul>		

- Min Edge Strength—Displays the minimum strength of the edges the step used to find the location of the Data Matrix code in the image. Use this value as a guideline for setting the Edge Threshold value on the Adv. Search tab.
- **Cell Fill Percentage**—Displays the percentage of the ideal cell size that is filled for each cell in the **On** state.
- **Demodulation Mode**—Displays the demodulation mode the step used to locate the Data Matrix code.
- **Cell Sample Size**—Displays the cell size the step used to locate the Data Matrix code.
- **Cell Filter Mode**—Displays the filter mode the step used to locate the Data Matrix code.
- **Mirror Mode**—Displays if the Data Matrix code appears mirrored (True) or normally (False).
- Errors Corrected—Displays the number of errors corrected using inherent correction.
- **Erasures Corrected**—Displays the number of erasures corrected using inherent correction.

When the **Return Grading Results** checkbox is enabled, the step also returns the following grading information:

- **Overall Grade**—Overall letter grade, which is equal to the lowest of the other five letter grades.
- **Decoding Grade**—Letter grade assigned to a Data Matrix code based on the step's success in decoding the code. The step sets this grade to A if the step could decode the Data Matrix code, otherwise the step sets this grade to F.
- **Symbol Contrast Grade**—Symbol contrast grade for the Data Matrix code.
- **Symbol Contrast**—Raw score representing the percentage difference between the mean of the reflectance of the darkest 10% and lightest 10%

	<ul> <li>of the matrix.</li> <li>Print Growth Grade—Print growth grade for the Data Matrix code.</li> <li>Print Growth—Raw score based on the extent to which dark or light markings appropriately fill their cell boundaries.</li> <li>Axial Nonuniformity Grade—Axial nonuniformity grade for the Data Matrix code.</li> <li>Axial Nonuniformity—Raw score representing the spacing of cell centers in the Data Matrix code. Axial nonuniformity tests for uneven scaling in the code.</li> </ul>
	<ul> <li>Unused Error Correction Grade—Unused error correction grade for the Data Matrix code.</li> </ul>
	<ul> <li>Unused Error Correction—Raw score indicating the extent to which regional or spot damage has eroded the reading safety margin that the error correction provides.</li> </ul>
Code Read	Displays the value of the Data Matrix code.

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# **Read Data Matrix Code FAQs**

#### Q: Why is the Code Read control empty?

Make sure the controls in the **Basic** tab are correct and the region of interest encloses all of the code cells.

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# How to Read a QR Code

Use the **Read QR Code** step to locate and decode a 2D QR code.

### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.
- 3. Verify that the **Reposition Region of Interest** control is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

### **Basic Tab**

4. Set the controls on the **Basic** tab to specify the shape of the QR code and improve the performance of the step. Select the **Suggest Values?** control if you want the step to suggest values for the controls when you click the **Suggest Values** button.

### Adv. Search Tab

5. Set the controls on the Adv. Search tab. Select the Suggest Values? control if you want the step to suggest values for the controls when you click the Suggest Values button.

### Cell Sampling Tab

6. Set the controls on the **Cell Sampling** tab if the step cannot consistently read the QR code because of variations in lighting or quality. Otherwise, use the default values for the controls on this tab.

### Limits Tab

7. To compare the decoded data to a constant, select the **Code Equals** control and enter a string that the decoded data must match.

To verify that the QR code contains a specific string, select the **Code Contains** control and enter the string.

The decoded characters that the step read are shown in the **Code Read** control.

**. 6€** ∭123 **Read QR Code Controls** 

## Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Region of Interest	The region of interest you want to use for the step.
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.
Reference Coordinate System	Coordinate system to which you want to link the region of interest.

## **Basic Tab**

The following controls are available on the Basic tab.

Control Name	Description
Suggest Value?	When enabled, the step suggests a value for the associated control after the <b>Suggest Values</b> button is clicked.
QR Model	<ul> <li>Specifies the QR code model to look for in the image. The following options are available:</li> <li>Auto-detect—Sets the step to determine the QR code model automatically.</li> <li>Micro—Sets the step to read Micro QR codes only. Micro QR codes have only a single target in the top left.</li> <li>Model 1—Sets the step to read Model 1 QR codes only. Model 1 QR codes have targets in all corners except for the bottom right corner and have alignment patterns along the edges.</li> <li>Model 2—Sets the step to read Model 2 QR codes only. Model 2 QR codes have targets in all corners except for the bottom right corner and have alignment patterns along the edges.</li> </ul>
Matrix Size	Sets the size of the QR code to read.
Barcode Polarity	<ul> <li>Specifies the data-to-background contrast for the QR code. The following options are available:</li> <li>Auto-detect—Sets the step to determine the QR code polarity automatically.</li> <li>Black On White—Sets the step to read QR codes with dark data on a bright background.</li> <li>White On Black—Sets the step to read QR codes with bright data on a dark background.</li> </ul>

Min Cell Size	Specifies the minimum size, in pixels, of the matrix in the image. If you set this value to 0, the step never excludes a matrix candidate because it is too small.
Max Cell Size	Specifies the maximum size, in pixels, of the matrix in the image. If you set this value to 0, the step never excludes a matrix candidate because it is too large.
Deselect/Select All	Disables/Enables all <b>Suggest Value</b> checkboxes.
Code Read	Displays the code that the step read.
Elapsed Time	Amount of time the step took to read the code.
Suggest Values	Specifies values for parameters with the <b>Suggest Value?</b> checkbox enabled.
### Adv. Search Tab

The following controls are available on the Adv. Search tab.

<b>Control Name</b>	Description		
Suggest Value?	When enabled, the step suggests a value for the associated control after the <b>Suggest Values</b> button is clicked.		
Rotation Mode	<ul> <li>Specifies the amount of QR code rotation to allow. The following options are available:</li> <li>Unlimited—The step allows for unlimited rotation.</li> <li>0 Degrees—The step allows for no rotation.</li> <li>90 Degrees—The step allows for ±90 degrees of rotation.</li> <li>180 Degrees—The step allows for ±180 degrees of rotation.</li> <li>270 Degrees—The step allows for ±270 degrees of rotation.</li> </ul>		
Skew Degrees Allowed	Amount of skew in the QR code to allow. The default is 5 degrees.		
Edge Threshold	Specifies the minimum contrast a pixel must have to be considered part of a QR code cell edge. The lower this value, the more potential edge candidates the step examines during the location phase. Setting this value too low decreases the performance of the step because the step examines too many potential edge candidates. Setting this value too high may also decrease the performance of the step by removing valid edge candidates, making location more difficult. Setting this value too high may also cause the step to fail to identify the QR code because all edge candidates are eliminated.		
Code Read	Displays the value of the QR code.		
Elapsed Time	Amount of time the step took to read the code.		
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Suggest	Specifies values for parameters with the <b>Suggest</b>	
Values	Value? checkbox enabled.	

### Cell Sampling Tab

The following controls are available on the Cell Sampling tab.

Control Name	Description
Suggest Value?	When enabled, the step suggests a value for the associated control after the <b>Suggest Values</b> button is clicked.
Demodulation Mode	<ul> <li>Specifies the mode that the step uses to determine which cells are on and which cells are off in the QR code. The following options are available:</li> <li>Auto-detect—The step tries each demodulation mode and use the one which decodes the QR code within the fewest iterations and utilizes the least amount of error correction.</li> <li>Histogram—The step uses a histogram of all of the matrix cells to calculate a threshold. This threshold determines if a cell is on or off. This is the fastest method but requires images with consistent levels of contrast in the matrix.</li> <li>Local Contrast—The step uses the neighbor of a cell to determine if the cell is on or off. This method is slower but works with images that have inconsistent levels of contrast in the matrix.</li> <li>Combination—The step uses the histogram of the matrix to calculate a threshold. For cells with pixel values that are sufficiently below or above this threshold, the step uses the threshold to determine if the cell pixel values are close to the threshold to determine if the cell pixel values are close to the threshold, the step uses the Local Contrast method to determine if the cell is on or off. This method is slower but works with images that have extremely low cell fill percentages</li> </ul>

	<ul> <li>or gross print growth errors.</li> <li>All—The step tries Histogram first, then Local Contrast, and then Combination, stopping when one mode is successful.</li> </ul>
Cell Sample Size	<ul> <li>Specifies the cell sample size, in pixels, to use to determine if each cell is on or off. The following options are available:</li> <li>Auto-detect—The step tries each sample size and uses the one that decodes the QR code in the fewest iterations using the least amount of error correction.</li> <li>1×1 The step uses a 1×1 sized sample from each cell.</li> <li>2×2—The step uses a 2×2 sized sample from each cell.</li> <li>3×3—The step uses a 3×3 sized sample from each cell.</li> <li>4×4—The step uses a 4×4 sized sample from each cell.</li> <li>5×5—The step uses a 5×5 sized sample from each cell.</li> <li>5×5—The step uses a 6×6 sized sample from each cell.</li> <li>6×6—The step uses a 7×7 sized sample from each cell.</li> </ul>
Cell Filter Mode	<ul> <li>Specifies the mode the step uses to determine the pixel value for each cell. If Cell Sample Size is 1×1, the value of the single samples pixel always determines the pixel value for the cell. The following options are available:</li> <li>Auto-detect—The step tries all filter modes and uses the one that decodes the QR code within the fewest iterations and utilizing the least amount of error correction.</li> <li>Average—The step sets the pixel value for</li> </ul>

	<ul> <li>image or if the QR code appears mirrored in the image. The following options are available:</li> <li>Auto-detect—Sets the step to determine if the QR code is mirrored automatically.</li> <li>Normal—Sets the step to read QR codes that appear normally in the image.</li> <li>Mirrored—Sets the step to read QR codes</li> </ul>
Mirror Mode	<ul> <li>All Filters—The step thes each litter mode, starting with Average and ending with Very Low Average, stopping once a filter mode decodes correctly.</li> <li>Specifies if the QR code appears normally in the</li> </ul>
	Very Low Average—The step sets the pixel value for the cell to the average value of the ninth of the sampled pixels with the lowest pixel values.
	<ul> <li>Very High Average—The step sets the pixel value for the cell to the average value of the ninth of the sampled pixels with the highest pixel values.</li> </ul>
	• Low Average—The step sets the pixel value for the cell to the average value of the half of the sampled pixels with the lowest pixel values.
	• <b>High Average</b> —The step sets the pixel value for the cell to the average value of the half of the sampled pixels with the highest pixel values.
	<ul> <li>Central Average—The step sets the pixel value for the cell to the average of the pixels in the center of the cell sample.</li> </ul>
	<ul> <li>the cell to the average of the sampled pixels.</li> <li>Median—The step sets the pixel value for the cell to the median of the sampled pixels.</li> </ul>

	that appear mirrored in the image.		
Deselect/Select All Disables/Enables all Suggest Value? check			
Code Read	Displays the value of the QR code.		
Elapsed Time Amount of time the step took to read the code			
Suggest Values	Specifies values for parameters with the <b>Suggest Value?</b> checkbox enabled.		

### Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>	Description			
Code Equals	Step passes if the QR code matches the specified value.			
Code Contains	When enabled, the decoded Data Matrix code data must contain the specified string for the step to pass. You can use the following wildcards: Special Character Interpretation			
	•	Matches an	ly character.	
	?	Matches ze expression	ro or one instances of the proceeding ?.	
	[]	Encloses alternates. For example, [abc] matches a, b, or c. The following characters have special significance when used within the brackets:		
		- (hyphen)	Indicates a range when used between digits or letters (for example, [0-5], [a-g], or [L-Q])	
			The following characters have significance only when they are the first character within the brackets:	
		~	Excludes the set of characters, including non-displayable characters. [~0-9] matches any character other than 0 through 9.	
		٨	Excludes the set with respect to all the displayable characters (and the space characters).	

	[^0-9] gives the space characters and all displayable characters except 0 through 9.
Results	Displays information about the QR code. The following values are displayed: • QR Model • Matrix Size • Polarity • Minimum Edge Strength • Demodulation Mode • Cell Sample Size • Cell Filtered Mode • Mirrored • # Errors Corrected
Code Read	Displays the value of the QR code.
Elapsed Time	Amount of time the step took to read the code.

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# **Read QR Code FAQs**

#### Q: Why is the Code Read control empty?

Make sure the controls in the **Basic** tab are correct and the region of interest encloses all of the code cells.

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### **Read PDF417 Code Concepts**

The Read PDF417 Code step consists of two phases:

- Phase during which you specify an region of interest in the image, which helps to locate the region occupied by the barcode. This phase is optional, but it can increase the performance of the second phase by reducing the size of the search region.
- 2. Phase during which the region you specify is analyzed to decode the barcode.

The following factors can cause errors in the search and decoding phase:

- Very low resolution of the image
- Very high horizontal or vertical light drift
- Contrast along the bars of the image
- High level of noise or blurring
- Inconsistent printing or stamping techniques—such as misaligned barcode elements—inconsistent element size, or elements with inconsistent borders.
- Quiet zone that is too small or contains too much noise
  - Note The minimum quiet zone for a PDF417 barcode is equal to two module widths on all four sides of the barcode.

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### How to Read a PDF417 Code

Use the **Read PDF417 Code** step to decode a PDF417 barcode.

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
  - Select a previously defined region of interest from the **Region of Interest** listbox.
- 3. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

### Limits Tab

4. If you want to compare the decoded data to a constant, enable the **Code Equals** control and enter a string that the decoded data must match. If you want to verify that the barcode contains a specific string, enable the **Code Contains** control and enter the string.

**. 6€** ∭123 **Read PDF417 Code Controls** 

### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description		
Step Name	Name to give the step.		
Region of Interest	The region of interest you want to use for the step.		
Reposition Region of Interest	When enabled, the step dynamically repositions the region of interest based on a coordinate system you built in a previous step.		
Reference Coordinate System	Coordinate system to which you want to link the region of interest.		

### Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>			Description
Code Equals	When enabled, the decoded data must equal this string in order for the step to pass.		
Code Contains	When enabled, the decoded data must contain this string in order for the step to pass. You can use the following wildcards:Special CharacterInterpretation		
		Matche	s any character.
	?	Matche express	s zero or one instances of the sion proceeding ?.
	[]	Encloses alternates. For example, [abc] matches a, b, or c. The following characters have special significance when used within the brackets:	
		- (dash)	Indicates a range when used between digits or letters (for example, [0-5], [a-g], or [L-Q])
			The following characters have significance only when they are the first character within the brackets:
		~	Excludes the set of characters, including non-displayable characters. [~0-9] matches any character other than 0 through 9.
		٨	Excludes the set with respect to all the displayable characters (and the space characters). [^0-9] gives the space characters and all displayable characters except 0

	through 9.		
Code Read	Code that the step read.		
Errors Corrected	Number of <u>substitution errors</u> that the reader corrected using inherent error correction.		
Erasures Corrected	Number of <u>erasures</u> that the reader corrected using inherent error correction.		
Rows	Number of rows in the barcode.		
Columns	Number of columns in the barcode.		

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# Read PDF417 Code FAQs

#### Q: Why is the Code Read control empty?

Make sure **Barcode Type** is set correctly and the region of interest encloses all of the bars.

#### Q: Can I adjust the parameters for finding the code?

No. The algorithm that **Read PDF417 Code** uses is adaptive and can find the code even when the image contains a slight light drift along the barcode.

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# Communicate

This palette groups several steps whose purpose is to facilitate communication between your inspection application and external devices.

Step Name	Description
Read/Write I/O	Reads and writes digital I/O lines on NI Smart Cameras and NI image acquisition devices.
Read/Write I/O (NI-IMAQ I/O)	Reads and writes digital I/O lines and ports on NI CVS-1450 Series Compact Vision System or NI PCI-8254R/PCIe- 8255R IEEE 1394 interface devices with reconfigurable I/O.
Read/Write I/O (NI-DAQmx I/O)	Read and writes digital and analog I/O lines or ports on NI data acquisition (DAQ) devices.
Generate Pulse	Generates a single pulse or a pulse train using the digital output lines on NI Smart Cameras and NI image acquisition devices.
Generate Pulse (NI-IMAQ I/O)	Generates a single pulse or a pulse train using the digital output lines on NI CVS-1450 Series Compact Vision Systems, or NI PCI-8254R/PCIe- 8255R IEEE 1394 interface devices with reconfigurable I/O.
Serial I/O	Communicates with devices, such as a PLC or robot, through serial commands. You can export measurements and pass/fail results to external devices. You can also configure your system to wait for a signal from an external device to start your inspection.
TCP I/O	Communicates with devices through

	TCP commands. You can export measurements and pass/fail results to external devices.
Modbus Slave	Communicates with Modbus Master devices, such as touch screens and other Human Machine Interfaces (HMI) and terminals. Modbus is an application layer messaging protocol that provides client/server communication between devices connected on different types of buses or networks. Vision Builder AI supports both the serial and TCP/IP physical layers. Refer to Modbus Concepts for related information.

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# How to Read or Write I/O

Use the **Read/Write I/O** step to configure the inputs, outputs, and PASS/FAIL LEDs on NI Smart Cameras or NI image acquisition devices.

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Select the digital input lines you want to read.
- 3. Select the digital output lines or LEDs you want to use. Digital output lines and LEDs can be set to drive **Low**, **High**, **Toggle**, or to output <u>system signals</u>, boolean measurement results, or the value of a boolean variable.
- 4. Click **OK** to add the step to the inspection.

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# **Read/Write I/O Controls**

The following controls are available on the property page of the step.

<b>Control Name</b>	Description
Step Name	Name to give the step.

#### **Digital Input Lines**

<b>Control Name</b>	Description
Read	Specifies the digital input lines to read for this step.
Name	Name of the digital input line.
Action	Specifies the behavior of the digital input line. The following option is available:
	<b>Read Line Value</b> —Reads the current value of the digital input line.

#### **Digital Output Lines**

<b>Control Name</b>	Description
Write	Specifies the digital output lines or LEDs you want to write for this step.
Name	Name of the digital output line or LED.
Value	Signal or value you want to output. Digital output lines and LEDs can be set to drive <b>Low</b> , <b>High</b> , or <b>Toggle</b> . Digital output lines and LEDs can also be set to output <u>system signals</u> , boolean measurement results, or the value of a boolean variable.
Polarity	Specifies whether the digital output line or LED is driven high when the signal selected is TRUE, or Pass, or when the signal selected is FALSE, or Fail.

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# **Read/Write I/O FAQs**

#### Q: How can I access digital input results?

The **Read/Write I/O** step logs selected measurements when the step is executed. You can access the measurement results by using a subsequent step that can access measurement results. Examples of steps that can use measurement results are, but not limited to, the **Modbus Slave**, **Serial I/O**, **TCP I/O**, **Run LabVIEW VI**, **Calculator**, **Logic Calculator**, and **Custom Overlay** steps.

# Q: When a digital output line writes a system signal, when is the line updated?

When a <u>system signal</u> is associated with a digital output line, the digital output line is updated whenever the system signal changes. Once a digital output line is associated with a system signal, the line always outputs the current state of the system signal. You can reassign the source for a digital output line using another **Read/Write I/O** step. All other reads and writes occur when the step executes. It is recommended to use a **Read/Write I/O** step in the Setup state for system signal output because once the step is called the configured digital output line updates the system signal while the main inspection runs.



### How to Generate a Pulse

Use the **Generate Pulse** step to configure digital pulse generation on NI Smart Cameras or NI image acquisition devices. The **Generate Pulse** step starts pulse generation, but the step does not wait until a pulse finishes before continuing the inspection.

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. In the **Pulse Settings** table, select the digital output line you want to configure.
- 3. In the **Action** control, specify the behavior you want for the selected digital output line and complete one of the following sets of steps to configure the digital output line:
  - **Do not Update**—Performs no action on the digital output line when the step is run. Select this option if you do not want to use the selected digital output line or if you do not want to change the operation because the line is being used by another **Generate Pulse** or **Read/Write I/O** step in the inspection.
  - **Generate Single Pulse**—Configures the selected digital output line to generate a single pulse. Complete the following steps to configure the single pulse:
    - a. Specify the **Polarity** for the pulse.
    - b. Specify a **Delay** and **Timebase** for the pulse.
    - c. Specify the **Width** of the pulse.
    - d. In the **Single Pulse Settings** control, select whether you want the pulse to **Always pulse when this step runs** or **Pulse when this step runs AND** a specified condition is met. If you select the **Pulse when this step runs AND** option, you must also specify a **Measurement** and value to use to determine if the single pulse is generated when the step runs.
  - **Start/Stop Pulse Generation**—Configures the selected digital output line to generate continuous pulses. Complete the following steps to configure the pulse train:
    - a. Specify the **Polarity** for the pulse.

- b. Specify a **Delay** and **Timebase** for the pulse. For continuous pulses, the **Delay** begins when the pulse completes. For triggered pulses, **Delay** begins when the active edge of a trigger is detected.
- c. Specify the **Width** of the pulse.
- d. In the **Continuous Pulse Settings** control, select whether you want the pulse to be an **Immediate Pulse** or a **Triggered Pulse**. If you select **Immediate Pulse**, a pulse train starts when the step executes. If you select **Triggered Pulse**, a single pulse occurs every time the state of the selected trigger line has the specified polarity.
- 4. Repeat steps 2 and 3 to configure additional pulses.
- 5. Click **Apply** to preview the pulse generation settings.
- 6. Click **OK** to add the step to the inspection.


### **Generate Pulse Controls**

The following controls are available on the property page of the step.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Pulse Settings	Lists all digital output lines available for pulse generation and the current configuration of the lines.
Apply	Immediately starts pulse generation using the settings you specified. You can use this feature to preview the settings before you save them.

#### **Pulse Properties**

<b>Control Name</b>	Description
Action	Action to perform when a trigger is detected on the line. The following options are available:
	• <b>Do not Update</b> —Settings for the selected digital output line are not updated when the step is run.
	<ul> <li>Generate Single Pulse—Begins generating a single pulse.</li> </ul>
	<ul> <li>Start Pulse Generation—Begins generating continuous pulses.</li> </ul>
	<ul> <li>Stop Pulse Generation—Stops generating continuous pulses.</li> </ul>
Polarity	Specifies whether you want the pulse to <b>Drive High</b> or <b>Drive Low</b> when it is generated.
Delay	How long the pulse waits before asserting.
Timebase	Units for <b>Delay</b> . Valid values are <b>milliseconds</b> or <b>Encoder Counts</b> .
	Note The Encoder Counts option is only available for NI Smart Cameras or NI image acquisition devices that support quadrature encoders.
Width	Duration of the Pulse.
Comment	Additional information about the digital output line.

Single Pulse Settings	Specifies when the pulse is generated. You can choose to have the pulse always be generated when the step executes or only generated when the step executes and the specified trigger condition is met.
Continuous Pulse Settings	Specifies whether the generated pulse is an <b>Immediate</b> <b>Pulse</b> or a <b>Triggered Pulse</b> . If you select <b>Immediate</b> <b>Pulse</b> , a pulse train starts when the step executes. If you select <b>Triggered Pulse</b> , a single pulse occurs every time the state of the selected trigger line has the specified polarity.



### **Generate Pulse FAQs**

#### Q: When does the pulse occur?

Single pulses are software triggered and output every time the **Generate Pulse** step is executed and the **Single Pulse Settings** are TRUE. Continuous pulses, or pulse trains, are hardware-timed asynchronous pulses. If the pulse is a **Triggered Pulse**, the pulse begins when there is an edge of the correct polarity on the specified trigger line. Continuous pulses are not reconfigured when the **Generate Pulse** step executes unless the settings for the specified trigger line are different than the current settings for the trigger line.

#### Q: Why do I not see the pulses from the Generate Pulse step?

If you are using single pulse mode and the **Generate Pulse** step is being executed faster than the specified **Delay** and **Width**, the pulse is being reset every time the step executes so you never see the active portion of the pulse. If you are in continuous pulse mode, any triggers that arrive while the pulse is being output are ignored. The next trigger after the pulse finishes will be used.

#### Q: Why does pulse generation continue after I close the inspection?

Pulse generation continues indefinitely until you specify for it to stop. To stop pulse generation, add an **Generate Pulse** step to the inspection with the **Action** control set to **Stop Pulse Generation**. To stop pulse generation when an inspection closes, add an **Generate Pulse** step to the Inspection Cleanup state to stop any pulses that were configured in the Inspection Setup state. Select **View**»**View Complete Inspection Setup** to access the Inspection Setup and Inspection Cleanup states for an inspection.



# How to use Read or Write I/O on NI-IMAQ I/O Devices

Use the **Read/Write (NI-IMAQ I/O)** step to configure the digital inputs and outputs on NI CVS-1450 Series Compact Vision System or NI PCI-8254R/PCIe-8255R IEEE 1394 interface devices with reconfigurable I/O.

1. In the **Step Name** control, enter a descriptive name for the step.

#### **Digital Input Tab**

2. Select the digital lines and port you want to use. The digital input lines can either read the current value or detect edges (Rising, Falling, or Any). If you select one of the edge detection actions, specify an **Edge Detection Filter Width (ms)** to ignore changes that are less than the specified time period.

The isolated port consists of ISO lines 0–4. The latched value corresponds to the value of these lines when a rising edge was detected on ISO 5.

#### **Digital Output Tab**

- Select the digital lines and enable lines you want to write. Digital output lines can be set to drive Low, High, Toggle, or to output system signals, boolean measurement results, or the value of a boolean variable. Enable lines can be set to Enable or Disable. The enable lines can also be controlled by output system signals, boolean measurement results, or the value of a boolean variable.
- 4. Click **OK** to add the step to the inspection.



# **Read/Write (NI-IMAQ I/O) Controls**

The following controls are available on all tabs.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Test Panel	Launches the NI-IMAQ I/O Test Panel. The test panel allows you to monitor the values of the NI-IMAQ I/O lines, isolated port, encoder, and isolated power status. The test panel also allows you to set digital outputs and chart the values of multiple digital I/O lines.

#### **Digital Inputs Tab**

The following controls are available on the Digital Inputs tab.

#### **Digital Input Lines**

<b>Control Name</b>	Description
Read	Specifies the digital input lines to use in your inspection.
Name	Name of the digital input line.
Action	Specifies the behavior of the digital input line.
	<ul> <li>Read Line Value—Reads the current value of the digital input line.</li> </ul>
	<ul> <li>Detect Any Edge—Detects any change in the value of the digital input line.</li> </ul>
	<ul> <li>Detect Rising Edge—Detects when the value of the digital input line changes from Low to High.</li> <li>Detect Falling Edge—Detects when the value of the digital input line changes from High to Low.</li> </ul>
Edge Detection Filter Width (ms)	Specifies the amount of time the line must be in the new state to be considered a change. Any changes that occur for less the specified <b>Edge Detection Filter Width</b> are ignored. Valid values are between 0 and 163 ms.

#### **Digital Input Ports**

<b>Control Name</b>	Description
Read	Specifies the digital input ports to use in your inspection.
Name	Name of the digital input port.

#### **Digital Output Tab**

The following controls are available on the Digital Output tab.

#### **Digital Output Lines**

<b>Control Name</b>	Description
Write	Specifies the digital output lines you want to use in your inspection.
Name	Name of the digital output line.
Value	Signal or value you want to output on the line. Digital output lines can be set to drive <b>Low</b> , <b>High</b> , or <b>Toggle</b> . The digital output lines can also be set to output <u>system</u> <u>signals</u> , boolean measurement results, or the value of a boolean variable.
Polarity	Specifies whether the digital output line is driven high when the signal selected is TRUE, or Pass, or when the signal selected is FALSE, or Fail.

#### **Enable Lines**

<b>Control Name</b>	Description
Write	Specifies the enable lines you want to use in your inspection.
Name	Name of the enable line.
Value	Signal or value you want to use for the enable line. Enable lines can be set to <b>Enable</b> or <b>Disable</b> . The enable lines can also be set to <u>system signals</u> , boolean measurement results, or the value of a boolean variable.
Polarity	Specifies whether the corresponding digital output line is enabled when the value is TRUE (Pass) or FALSE (Fail).



## Read/Write (NI-IMAQ I/O) FAQs

#### Q: How can I access digital input results?

The **Read/Write (NI-IMAQ I/O)** step logs selected measurements when the step is executed. You can access the measurement results by using a subsequent step that can access measurement results. Examples of steps that can use measurement results are, but not limited to, the **Modbus Slave**, **Serial I/O**, **TCP I/O**, **Run LabVIEW VI**, **Calculator**, **Logic Calculator**, and **Custom Overlay** steps.

#### Q: When does the edge detection input get reset?

When a digital input line is configured for edge detection, the specified line is continuously monitored until a change is detected that lasts longer than the filter width. When a change is detected, the digital input line reports the change the next time the **Read/Write (NI-IMAQ I/O)** step is executed. Performing additional reads on the digital input line using other **Read/Write (NI-IMAQ I/O)** steps does not interfere with the edge detection unless the other **Read/Write (NI-IMAQ I/O)** steps reconfigure the line to detect a different type of edge. It is not recommended to have multiple **Read/Write (NI-IMAQ I/O)** steps using the same digital input for different types of edge detection.

# Q: When a digital output line writes a system signal, when is the line updated?

When a <u>system signal</u> is associated with a digital output line, the digital output line is updated whenever the system signal changes. Once a digital output line is associated with a system signal, the line always outputs the current state of the system signal. You can reassign the source for a digital output line using another **Read/Write (NI-IMAQ I/O)** step. All other reads and writes occur when the step executes. It is recommended to use an **Read/Write (NI-IMAQ I/O)** step in the Setup state for system signal output because once the step is called the configured digital output line updates the system signal while the main inspection runs.



# How to Generate a Pulse using an NI-IMAQ I/O Device

Use the **Generate Pulse (NI-IMAQ I/O)** step to configure digital pulse generation on NI CVS-1450 Series Compact Vision System and NI PCI-8254R/PCIe-8255R IEEE 1394 interface devices with reconfigurable I/O. The **Generate Pulse (NI-IMAQ I/O)** step starts pulse generation, but the step does not wait until a pulse finishes before continuing the inspection.

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. In the **Pulse Settings** table, select the digital output line you want to configure.
- 3. In the **Action** control, specify the behavior you want for the selected digital output line and complete one of the following sets of steps to configure the digital output line:
  - Do not Update—Performs no action on the digital output line when the step is run. Select this option if you do not want to use the selected digital output line or if you do not want to change the operation because the line is being used by another Generate Pulse (NI-IMAQ I/O) or Read/Write I/O (NI-IMAQ I/O) step in the inspection.
  - **Generate Single Pulse**—Configures the selected digital output line to generate a single pulse. Complete the following steps to configure the single pulse:
    - a. Specify the **Polarity** for the pulse.
    - b. Specify a **Delay** and **Timebase** for the pulse.
    - c. Specify the **Width** of the pulse.
    - d. In the **Single Pulse Settings** control, select whether you want the pulse to **Always pulse when this step runs** or **Pulse when this step runs AND** a specified condition is met. If you select the **Pulse when this step runs AND** option, you must also specify a **Measurement** and value to use to determine if the single pulse is generated when the step runs.
  - **Start/Stop Pulse Generation**—Configures the selected digital output line to generate continuous pulses.

Complete the following steps to configure the pulse train:

- a. Specify the **Polarity** for the pulse.
- b. Specify a **Delay** and **Timebase** for the pulse.
- c. Specify the **Width** of the pulse.
- d. In the **Continuous Pulse Settings** control, select whether you want the pulse to be an **Immediate Pulse** or a **Triggered Pulse**. If you select **Immediate Pulse**, a pulse train starts when the step executes. If you select **Triggered Pulse**, a single pulse occurs every time the state of the selected trigger line has the specified polarity.
- 4. Repeat steps 2 and 3 to configure additional pulses.
- 5. Click **Apply** to preview the pulse generation settings.
- 6. Click **OK** to add the step to the inspection.



## **Generate Pulse (NI-IMAQ I/O) Controls**

The following controls are available on the property page of the step.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Pulse Settings	Lists all NI-IMAQ I/O digital output lines available for pulse generation and the current configuration of the lines.
Test Panel	Launches the NI-IMAQ I/O Test Panel. The test panel allows you to monitor the values of the NI-IMAQ I/O lines, isolated port, encoder, and isolated power status. The test panel also allows you to set digital outputs and chart the values of multiple digital I/O lines.
Apply	Immediately start pulse generation using the settings you specified. You can use this feature to preview the settings before you save them.

#### **Pulse Properties**

<b>Control Name</b>	Description
Action	Action to perform when a trigger is received by the line. The following options are available:
	<ul> <li>Do not Update—Settings for the selected digital output line are not updated when the step is run.</li> </ul>
	<ul> <li>Generate Single Pulse—Begins generating a single pulse.</li> </ul>
	<ul> <li>Start Pulse Generation—Begins generating continuous pulses.</li> </ul>
	<ul> <li>Stop Pulse Generation—Stops generating continuous pulses.</li> </ul>
Polarity	Specifies whether you want the pulse to <b>Drive High</b> or <b>Drive Low</b> when it is generated.
Delay	How long the pulse waits before asserting.
Timebase	Units for <b>Delay</b> . Valid values are <b>milliseconds</b> or <b>Encoder Counts</b> .

Width	Duration of the Pulse.
Comment	Additional information about the digital output line.
Single Pulse Settings	Specifies when the pulse is generated. You can choose to have the pulse always be generated when the step executes or only generated when the step executes and the specified trigger condition is met.
Continuous Pulse Settings	Specifies whether the generated pulse is an <b>Immediate</b> <b>Pulse</b> or a <b>Triggered Pulse</b> . If you select <b>Immediate</b> <b>Pulse</b> , a pulse train starts when the step executes. If you select <b>Triggered Pulse</b> , a single pulse occurs every time the state of the selected trigger line has the specified polarity.



### Generate Pulse (NI-IMAQ I/O) FAQs

#### Q: When does the pulse occur?

Single pulses are software triggered and output every time the **Generate Pulse (NI-IMAQ I/O)** step is executed and the **Single Pulse Settings** are TRUE. Continuous pulses, or pulse trains, are hardware-timed asynchronous pulses. If the pulse is a **Triggered Pulse**, the pulse begins when there is an edge of the correct polarity on the specified trigger line. Continuous pulses are not reconfigured when the **Generate Pulse (NI-IMAQ I/O)** step executes unless the settings for the specified trigger line are different than the current settings for the trigger line.

# Q: Why do I not see the pulses from the Generate Pulse (NI-IMAQ I/O) step?

Verify that the TTL line is enabled. Click **Test Panel** to launch the NI-IMAQ I/O Test Panel and Monitor and verify that the TTL line you are using is enabled.

If you are using single pulse mode and the **Generate Pulse (NI-IMAQ I/O)** step is being executed faster than the specified **Delay** and **Width**, the pulse is being reset every time the step executes so you never see the active portion of the pulse. If you are in continuous pulse mode, any triggers that arrive while the pulse is being output are ignored. The next trigger after the pulse finishes will be used.

#### Q: Why does pulse generation continue after I close the inspection?

Pulse generation continues indefinitely until you specify for it to stop. To stop pulse generation, add an **Generate Pulse (NI-IMAQ I/O)** step to the inspection with the **Action** control set to **Stop Pulse Generation**. To stop pulse generation when an inspection closes, add an **Generate Pulse (NI-IMAQ I/O)** step to the Inspection Cleanup state to stop any pulses that were configured in the Inspection Setup state. Select **View»View Complete Inspection Setup** to access the Inspection Setup and Inspection Cleanup states for an inspection.

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# How to Read or Write I/O using NI-DAQmx Devices

Use the **Read/Write I/O (NI-DAQmx)** step to configure the I/O used in your inspection. The **Read/Write I/O (NI-DAQmx)** step uses NI-DAQmx Global Virtual Channels, which are configured using Measurement & Automation Explorer (MAX). Refer to the *DAQ Assistant Help* in MAX for instructions on creating an NI-DAQmx Global Virtual Channel.

1. In the **Step Name** control, enter a descriptive name for the step.

#### **Digital Input Tab**

2. Select the digital lines and ports you want to read.

#### **Digital Output Tab**

3. Select the digital lines and ports you want to write. Digital output lines can be set to drive **Low**, **High**, **Toggle**, or to output <u>system</u> <u>signals</u> or boolean measurement results. Digital ports can drive constants or output numeric measurement results.

#### Analog Input Tab

4. Select the analog channels you want to read.

#### **Analog Output Tab**

- 5. Select the analog channels you want to write. Analog output channels can write numeric constants or numeric measurement results.
- 6. Click **OK** to add the step to the inspection.

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# Read/Write I/O (NI-DAQmx) Controls

The following controls are available on all tabs.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Test Panel	Launches the NI-DAQmx Test Panel. The test panel displays the current value of all available NI-DAQmx channels. The test panel also allows you to set digital and analog outputs and chart the values of multiple digital I/O lines and analog input lines.

#### **Digital Input Tab**

The following controls are available on the Digital Input tab.

#### **Digital Input Lines**

<b>Control Name</b>	Description
Read	Specifies the digital input lines you want to use in your inspection.
Name	Name of the digital input line.

#### **Digital Input Ports**

<b>Control Name</b>	Description
Read	Specifies the digital input ports you want to use in your inspection.
Name	Name of the digital input port.

#### **Digital Output Tab**

The following controls are available on the Digital Output tab.

#### **Digital Output Lines**

<b>Control Name</b>	Description
Write	Specifies the digital output lines you want to use in your inspection.
Name	Name of the digital output line.
Value	Signal or value you want to output on the line. Digital output lines can be set to drive <b>Low</b> , <b>High</b> , or <b>Toggle</b> . The digital output lines can also be set to output <u>system</u> <u>signals</u> , boolean measurement results, or the value of a boolean variable.
Polarity	Specifies whether the digital output line is driven high when the signal selected is TRUE, or Pass, or when the signal selected is FALSE, or Fail.

#### **Digital Output Ports**

<b>Control Name</b>	Description
Write	Specifies the digital output ports you want to use in your inspection.
Name	Name of the digital output port.
Value	Signal or value you want to output on the port. Digital output ports can be set to output a constant numeric value, a numeric result from a previous measurement, or the value of a numeric variable.e
Constant	Specifies a numeric value to output if <b>Value</b> is set to <b>Constant</b> .

#### Analog Input Tab

The following controls are available on the Analog Input tab.

#### Analog Inputs

<b>Control Name</b>	Description
Read	Specifies the analog inputs you want to use in your inspection.
Name	Name of the analog input.

#### Analog Output Tab

The following controls are available on the Analog Output tab.

#### Analog Outputs

<b>Control Name</b>	Description
Write	Specifies the analog outputs you want to use in your inspection.
Name	Name of the analog output.
Value	Value you want to output on the line. Analog output lines can be set to output a constant numeric value, a numeric result from a previous measurement, or the value of a numeric variable.
Constant	Specifies a numeric value to output if <b>Value</b> is set to <b>Constant</b> .

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## Read/Write I/O (NI-DAQmx) FAQs

# Q: When a digital output line writes a system signal, when is the line updated?

When a digital output line is associated with a <u>system signal</u>, the line is updated whenever the system signal changes. Once a line is associated with a system signal, the line always outputs the current state of the system signal. All non-system signals are updated when the step is run.

#### Q: How can I access the digital and analog input results?

The **Read/Write I/O (NI-DAQmx)** step logs all of the selected measurements when it is executed. The measurements can then be accessed from any future step that can use previous measurement results and is in the same state as the **Read/Write I/O (NI-DAQmx)** step. <u>Create</u> a variable and use the **Set Variable** step to access measurement results from other inspection states.

#### Q: Why can I not read analog output values?

The **Read/Write I/O (NI-DAQmx)** step does not support reading analog output values. This is because reading analog output values is not currently supported by the NI-DAQmx driver software.

# Q: What happens if I try to write a value to an analog output line that is outside of the voltage range of the channel?

When you attempt to write a value that is outside of the range, Vision Builder AI coerces the value to the nearest valid value. The coerced value is then output on the analog output line and the *Analog Output Name* **Coerced** measurement result is set to TRUE to indicate that the value was coerced. *Analog Output Name* is the name of the analog output line to which the value is output.


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## How to Communicate using Serial I/O

In order to support serial communication, Vision Builder AI requires NI-VISA driver version 3.4.1 or later and a serial port.



**Tip** Click **Show Terminal** to open the Serial Communication Terminal. The Serial Communication Terminal displays the data sent and received on the serial port. You can use the Serial Communication Terminal to debug serial communications in your inspection.



**Note** The Serial Communication Terminal is not available to monitor serial commands on a remote targets.

**Tip** To remove unwanted bytes from the serial line, Click **Flush Port** to clear the serial port before sending or receiving data.



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## Serial I/O Controls

The following controls area available on the property page of the step.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Command List	<ul> <li>List of all the commands to send and receive through serial communication. The following information is displayed for each command:         <ul> <li>Port—Name of the serial port to which an external device is connected. This name corresponds to the Ports (Serial &amp; Parallel) names defined in the Devices and Interfaces list in Measurement &amp; Automation Explorer (MAX).</li> <li>Direction—Specifies whether the command is input or output.</li> <li>Command—Command you want to send or receive.</li> <li>Comment—Comments about the command.</li> </ul> </li> <li> <ul> <li>Tip Right-click a command in the Command List and calact aither Measurement to and the command to the c</li></ul></li></ul>
	change the order of commands in the list.
Send Command	Launches a dialog box in which you configure a command to send.
Wait for String	Launches a dialog box in which you configure your system to wait for an incoming command.
Flush Port	Launches a dialog box in which you configure your system to clear the serial communication line.
Wait	Launches a dialog box in which you configure your system to wait before sending or receiving additional serial commands.
Edit	Launches a dialog box in which you can edit the selected command.
Delete	Deletes the selected command.
Delete All	Deletes all the commands in the Command List.

Test	Executes all the commands in the Command List.
Show Terminal	Launches a Communication Terminal that lists all of the terminals and displays the commands that are sent and received.
Step fails in case of error or timeout	Sets the step status to FAIL when there is an error or timeout during communication.

# **Send Serial Command**

Use this dialog box to configure your system to send a command through serial communication lines.

- 1. Select the port on whose line you want to send a command from the **Port** drop-down list.
- 2. Type the command you want to send.
- 3. Click **Insert HEX** to insert the hexadecimal characters you want to include in the command.
- 4. Click **Insert Result** to insert the result of a previous inspection step or value of a variable in the command to send.
- 5. Select the display type.
- 6. Select the termination character you want to signal the end of the command from the **Termination Character** drop-down list.
- 7. Type a comment about the command you want to send.

## **Control Descriptions**

The following controls are found on the Send Serial Command dialog box.

<b>Control Name</b>	Description
Port	Name of the serial port on whose line you want to send a command.
Command	Command you want to send.
Insert HEX	Launches a dialog box in which you enter the hexadecimal characters you want to insert in the command.
Insert Result	Launches a dialog box in which you select the result of a previous inspection step or variable.
<u>Display Types</u>	Specifies the format to use to display the command.
Termination Character	<ul> <li>Character that indicates the end of a command. The following options are available:</li> <li>None—No termination character</li> <li>NULL (\00)—Null character</li> <li>CR (\0D)—Carriage return</li> <li>LF (\0A)—Line feed</li> <li>CR/LF (\0D\0A)—Carriage return/line feed</li> <li>Comment—Comment about the command you want to send.</li> </ul>
Comment	Comment about the command you want to send.

# **Insert Result (Serial)**

Use this dialog box to insert the result of a previous inspection step in the command you want to send.

- 1. Select the result to send from the Measurements list.
- 2. Select the data format of the result to send. If you select **String**, set the available **String Format** options.
- 3. Select the display type to verify what you want to see displayed.

## **Control Descriptions**

The following controls are found on the Insert Result dialog box.

Control Name	Description
Measurements	Displays a list of step results and variables you can send.
Data Format	<ul> <li>Data format of the step result to send. The following options are available:</li> <li>String.</li> <li>I8—Signed 8-bit integer.</li> <li>U8—Unsigned 8-bit integer.</li> <li>I16—Signed 16-bit integer.</li> <li>U16—Unsigned 16-bit integer.</li> <li>I32—Signed 32-bit integer.</li> <li>U32—Unsigned 32-bit integer.</li> <li>Single (4 bytes)—Single-precision floating-point number with 32-bit IEEE single-precision format.</li> <li>Double (8 bytes)—Double-precision floating-point number with 64-bit IEEE single-precision format.</li> <li>Extended (16 bytes)—Extended-precision number with 128-bit format.</li> </ul>
String Format	<ul> <li>Numbering system you want to use when expressing your serial command. The options are available:</li> <li>Decimal—Base 10 numbering system in which each digit can be 0–9.</li> <li>Hexadecimal—Base 16 numbering system in which each digit can be 0–F.</li> <li>Octal—Base 8 numbering system in which each digit can be 0–7.</li> <li>Fractional—Fractional notation, such as 4.91.</li> </ul>
Width	Width of the string.
Precision	Number of digits after the decimal point.

True String	String to send when the Boolean result is True.
False String	String to send when the Boolean result is False.
Display Types	Specifies the format to use to display the string.
String	Previews the string to send.

# Wait for String (Serial)

Use this dialog box to configure your system to wait for an incoming command.

- 1. Select the port on whose line you want to receive a command from the **Port** drop-down list.
- 2. Select whether you want to wait for a fixed number of bytes or a termination character.
- 3. If you selected **Termination Character**, select the character you want to signal the end of the command from the drop-down list. Enable the **Add Termination Character to Result String** to add the selected **Termination Character** to the string result.
- 4. Type the number of milliseconds to wait for the command before timing out.
- 5. Select the Pass condition for the step. If you want the inspection to pass only when a specific string is received, select **String received before timeout matches**, and enter the expected string. Also, enable the **Inspection fails in case of error or timeout** control located on the Serial I/O property page.

$\mathbf{Q}$	Tip You can use the following wildcard characters in the
-	expected string:

Character	Description
%d	match decimal integer
%0	match octal integer
%x	match hexadecimal integer
%b	match binary integer
%e	match scientific real number
%f	match floating-point real number
%g	match floating-point or scientific real number
%%	match a single % character

6. Type a comment about the command you expect to receive.

## **Control Descriptions**

The following controls are found on the Wait for String dialog box.

<b>Control Name</b>	Description
Port	Name of the serial port from which you expect to receive a command.
Wait For	<ul> <li>Specifies how long the step waits for a command. The following options are available:</li> <li>Fixed Number of Bytes—When enabled, the step waits for the specified number bytes from the device specified in Port.</li> <li>Termination Char—When enabled, the step waits for the character that indicates the end of a command. The following options are available: <ul> <li>None—No termination character</li> <li>NULL (\00)—Null character</li> <li>CR (\0D)—Carriage return</li> <li>LF (\0A)—Line feed</li> <li>CR/LF (\0D\0A)—Carriage return/line feed</li> </ul> </li> </ul>
	- Add Termination Character to Result String—When enabled, appends the selected Termination Character to the received string.
Timeout	Number of milliseconds to wait for the string before timing out.
Pass Inspection If	<ul> <li>Specifies the Pass condition for the step. The following options are available:</li> <li>Any string is received before timeout—Step passes if a string is received, regardless of the value, before the specified Timeout.</li> <li>String received before timeout matches— Step passes if the value of the string received before the specified Timeout matches the specified value. You may also specify how to</li> </ul>

	display the string.
Comment	Comment about the command you expect to receive.

## **Flush Serial Port**

Use this dialog box to clean data out of a serial communication line before you send or receive new commands.

- 1. Select the serial port whose line you want to clear from the **Flush Port** drop-down list.
- 2. Type a comment about your reason for flushing the line.

## **Control Descriptions**

The following controls area available on the Flush Serial Port dialog box.

<b>Control Name</b>	Description
Flush Port	Name of the serial port whose line you want to clear.
Comment	Comment about clearing the line.

# Wait (Serial)

Use this dialog box to configure your system to wait before sending or receiving commands.

- 1. Type the number of milliseconds to wait.
- 2. Type a comment about your reason for waiting.

## **Control Descriptions**

The following controls are found on the Wait dialog box.

<b>Control Name</b>	Description
Wait For	Number of milliseconds to wait.
Comment	Comment about your reason for waiting.

# **Serial Communication Terminal**

Use the Serial Communication Terminal to debug the serial communications in your inspection.

- 1. On the Serial I/O property page, click **Show Terminal** to launch the Serial Communication Terminal.
- 2. On the Serial I/O property page, click **Test**. Notice that the Serial Communication Terminal shows the commands being sent and received on the serial ports.
  - **Tip** You can resize the Serial Communication Terminal and the widths of the table columns if you cannot see all of the information in the table.
- 3. In the Serial Communication Terminal, select the type of <u>display</u> you want from the **View** menu.

You can perform the following tasks from the Serial Communication Terminal:

- Select File»Save As to save the contents of the table to a text file.
- Select Edit»Clear to clear the table of serial commands.
- Select **Edit**»Log History to modify the number of records shown in the table. By default, the Serial Communication Terminal logs 1024 entries. The oldest entries above 1024 are erased as new commands are logged.
- 4. Select File»Close to close the Serial Terminal window.



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# Serial I/O FAQs

#### Q: Why is my device not responding to the serial commands?

On your PC, make sure that your serial port settings in Measurement & Automation Explorer (MAX) match the serial settings for your device. Follow these instructions to configure your serial port settings:

- 1. Launch MAX.
- 2. Expand **Devices and Interfaces**.
- 3. Expand Ports (Serial & Parallel).
- 4. Right-click your serial port name in the configuration tree to configure your port.

When using a remote target, you can setup the **Serial Port Settings** by selecting **Target»Target Options**, and choosing the **Serial Port Tab**.



**Note** You must have NI-VISA installed to communicate with serial devices.

Check your device manual for the type of serial cable you need to communicate with the device. Some devices require straight-through cables while others require crossover cables.

Make sure you select the serial port connected to your device when sending and receiving commands.

#### Q: How can I verify that my serial port is working correctly?

Refer to <u>Serial Communication Starting Point</u> for information and troubleshooting tips.

# Q: How do I send a serial command based on the result of an inspection?

At the end of your inspection diagram, add a **Logic Calculator** step that computes the AND of all the step statuses. Then, add a **Serial I/O** step after the **Logic Calculator** step to send a serial command based on the **Step Status** of the **Logic Calculator** step.



**Note** The AND of all the step statuses equals the **Inspection Status**.

Q: How can I set up my remote target serial port configuration?

Navigate to Target»Target Options»Serial Port.

# Q: Why are commands not executed when I click the step in the State Configuration window?

In Configuration mode, commands are executed only when you click one of the following buttons:

- 🔤 Run Inspection Once
- 🖻 Run Inspection in Loop
- 🛤 Run Inspection until Failure

Vision Builder AI does not execute the step when you click on the step to avoid potential timeouts associated with the step.

TCP B. D.

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## How to Communicate using TCP I/O

Declare all TCP/IP devices in the Communication Device Manager before inserting a **TCP I/O** step.



**Tip** Click **Show Terminal** to open the TCP Communication Terminal. The TCP Communication Terminal displays data sent and received on the specified TCP port. You can use the TCP Communication Terminal to debug TCP communications in your inspection.



**Note** The TCP Communication Terminal is not available to monitor TCP commands on a remote targets.

**Tip** To remove unwanted bytes from the TCP buffer, Click **Flush Buffer** to clear the TCP port before sending or receiving data. TCP B. D.

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# **TCP I/O Controls**

The following controls area available on the property page of the step.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Command List	<ul> <li>List of all the commands to send and receive through TCP communication. The following information is displayed for each command:</li> <li>Device—Name of the external communication device.</li> <li>Direction—Specifies whether the command is input or output.</li> <li>Command—Command you want to send or receive.</li> <li>Comment—Comments about the command.</li> </ul>
	Tip Right-click a command in the Command List and select either Move Up or Move Down to change the order of commands in the list.
Send Command	Launches a dialog box in which you configure a command to send.
Wait for String	Launches a dialog box in which you configure your system to wait for an incoming command.
Flush Buffer	Launches a dialog box in which you configure your system to clear the TCP communication buffer.
Wait	Launches a dialog box in which you configure your system to wait before sending or receiving additional TCP commands.
Edit	Launches a dialog box in which you can edit the selected command.
Delete	Deletes the selected command.
Delete All	Deletes all the commands in the Command List.
Test	Executes all the commands in the Command List.
Show	Launches a Communication Terminal that lists all of the

Terminal	terminals and displays the commands that are sent and received.
Step fails in case of error or timeout	Sets the step status to FAIL when there is an error or timeout during communication.

# Send TCP Command

Use this dialog box to configure your system to send a TCP command.

- 1. Select the device you want to communicate with from the **Device Name** drop-down list.
- 2. Type the command you want to send.
- 3. Click **Insert HEX** to insert the hexadecimal characters you want to include in the command.
- 4. Click **Insert Result** to insert the result of a previous inspection step or value of a variable in the command to send.
- 5. Select the display type.
- 6. Type a comment about the command you want to send.

## **Control Descriptions**

The following controls are found on the Send TCP Command dialog box.

<b>Control Name</b>	Description
Device	Name of the device to which you want to send a command.
Command	Command you want to send.
Insert HEX	Launches a dialog box in which you enter the hexadecimal characters you want to insert in the command.
Insert Result	Launches a dialog box in which you select the result of a previous inspection step or variable.
<u>Display Types</u>	Specifies the format to use to display the command.
Comment	Comment about the command you want to send.

# Insert Result (TCP)

Use this dialog box to insert the result of a previous inspection step in the command you want to send.
- 1. Select the result to send from the Measurements list.
- 2. Select the data format of the result to send. If you select **String**, set the available **String Format** options.
- 3. Select the display type to verify what you want to see displayed.

## **Controls Descriptions**

The following controls are found on the Insert Result dialog box.

Control Name	Description		
Measurements	Displays a list of step results and variables you can send.		
Data Format	<ul> <li>Data format of the step result to send. The following options are available:</li> <li>String.</li> <li>I8—Signed 8-bit integer.</li> <li>U8—Unsigned 8-bit integer.</li> <li>I16—Signed 16-bit integer.</li> <li>U16—Unsigned 16-bit integer.</li> <li>I32—Signed 32-bit integer.</li> <li>U32—Unsigned 32-bit integer.</li> <li>Single (4 bytes)—Single-precision floating-point number with 32-bit IEEE single-precision format.</li> <li>Double (8 bytes)—Double-precision floating-point number with 64-bit IEEE single-precision format.</li> <li>Extended (16 bytes)—Extended-precision number with 128-bit format.</li> </ul>		
String Format	<ul> <li>Numbering system you want to use when expressing your serial command. The options are available:</li> <li>Decimal—Base 10 numbering system in which each digit can be 0–9.</li> <li>Hexadecimal—Base 16 numbering system in which each digit can be 0–F.</li> <li>Octal—Base 8 numbering system in which each digit can be 0–7.</li> <li>Fractional—Fractional notation, such as 4.91.</li> </ul>		
Width	Width of the string.		
Precision	Number of digits after the decimal point.		

True String	String to send when the Boolean result is True.			
False String	String to send when the Boolean result is False.			
Display Types	Specifies the format to use to display the string.			
String	Previews the string to send.			

# Wait for String (TCP)

Use this dialog box to configure your system to wait for an incoming command.

- 1. Select the device you want to receive a command from the **Device Name** drop-down list.
- 2. Select whether you want to wait for a fixed number of bytes or a specified termination character or character set.
- 3. If you selected **Termination Character**, enter the termination character or character set you want to signal the end of the command. Enable the **Add Termination Character to Result String** to add the selected **Termination Character** to the string result.
  - **Tip** Change the Display type to enter the termination character in hexadecimal or \ codes.
- 4. Type the number of milliseconds to wait for the command before timing out.
- 5. Select the Pass condition for the step. If you want the inspection to pass only when a specific string is received, select String received before timeout matches, and enter the expected string. Also, enable the Inspection fails in case of error or timeout control located on the TCP I/O property page.

Character	Description			
%d	match decimal integer			
%0	match octal integer			
%x	match hexadecimal integer			
%b	match binary integer			
%e	match scientific real number			
%f	match floating-point real number			
%g	match floating-point or scientific real number			
%%	match a single % character			

**Tip** You can use the following wildcard characters in the expected string:

6. Type a comment about the command you expect to receive.

## **Control Descriptions**

The following controls are found on the Wait for String dialog box.

<b>Control Name</b>	Description			
Device Name	Name of the device from which you expect to receive a command.			
Wait For	<ul> <li>Specifies how long the step waits for a command. The following options are available:</li> <li>Fixed Number of Bytes—When enabled, the step waits for the specified number bytes from the device specified in Device Name.</li> <li>Termination Char—Character that indicates the end of a command.</li> <li>Add Termination Character to Result String—When enabled, appends the selected Termination Character to the received string.</li> </ul>			
Timeout	Number of milliseconds to wait for the string before timing out. For TCP slave devices, if a timeout occurs, the step returns the characters received before the timeout. For TCP master devices, if a timeout occurs, no characters are returned.			
Pass Inspection If	<ul> <li>Specifies the Pass condition for the step. The following options are available:</li> <li>Any string is received before timeout—Step passes if a string is received, regardless of the value, before the specified Timeout.</li> <li>String received before timeout matches— Step passes if the value of the string received before the specified Timeout matches the specified value. You may also specify how to display the string.</li> </ul>			
Comment	Comment about the command you expect to receive.			

## Flush TCP Buffer

Use this dialog box to remove data from the TCP buffer before you send or receive new commands.

- 1. Select the device whose buffer you want to flush from the **Device Name** drop-down list.
- 2. Type a comment about your reason for flushing the TCP buffer.

## **Control Descriptions**

The following controls are found on the Flush TCP Buffer dialog box.

Control Name Description			
Device Name	Name of the device whose line you want to clear.		
Comment	Comment about clearing the TCP buffer.		

# Wait (TCP)

Use this dialog box to configure your system to wait before sending or receiving commands.

- 1. Type the number of milliseconds to wait.
- 2. Type a comment about your reason for waiting.

## **Control Descriptions**

The following controls are found on the Wait dialog box.

<b>Control Name</b>	Description	
Wait For	Number of milliseconds to wait.	
Comment	Comment about your reason for waiting.	

## **TCP Communication Terminal**

Use the TCP Communication Terminal to debug the TCP communications in your inspection.

- 1. In the TCP I/O property page, click **Show Terminal** to launch the TCP Communication Terminal.
- 2. In the TCP I/O property page, click **Test**. Notice that the TCP Communication Terminal shows the commands being sent and received.
  - **Tip** You can resize the TCP Communication Terminal and the widths of the table columns if you cannot see all of the information in the table.
- 3. In the TCP Communication Terminal, select the type of <u>display</u> you want from the **View** menu.

You can perform the following tasks from the TCP Communication Terminal:

- Select File»Save As to save the contents of the table to a text file.
- Select Edit»Clear to clear the table of TCP commands.
- Select **Edit**»Log History to modify the number of records shown in the table. By default, the TCP Communication Terminal logs 1024 entries. The oldest entries above 1024 are erased as new commands are logged.
- 4. Select File»Close to close the Serial Terminal window.

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# TCP I/O FAQs

#### Q: Why is my device not responding to the TCP commands?

Complete the following steps to ensure that your device is configured correctly:

- 1. Verify that your device is connected to the network.
- 2. If your device is a master device (initiates communication), verify that the device is defined as a master TCP/IP device in the Communication Device Manager and that the TCP server is running.
- 3. If your device is a slave device (receives communication), verify that the device is defined as a slave TCP/IP device in the Communication Device Manager and that the IP Address and TCP Port are correct.

# Q: Why are commands not executed when I click the step in the State Configuration window?

In Configuration mode, commands are executed only when you click one of the following buttons:

- 💷 Run Inspection Once
- 🕙 Run Inspection in Loop
- 🛤 Run Inspection until Failure

Vision Builder AI does not execute the step when you click on the step to avoid potential timeouts associated with the step.



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## **Modbus Concepts**

The common language used by many controllers is the Modbus protocol. Modbus is an application layer messaging protocol that provides client/server communication between devices connected on different types of buses or networks. Vision Builder AI supports Modbus serial and Modbus TCP.

The Modbus protocol defines the process a controller uses to request access to another device, how it will respond to requests from other devices, and how errors will be detected and reported. The Modbus protocol establishes a common format for the layout and contents of message fields.

During communications on a Modbus network, the protocol determines how each controller will know its device address, recognize a message addressed to it, determine the kind of action to be taken, and extract any data or other information contained in the message.

Controllers communicate using a master-slave technique in which only one device, the master, can initiate transactions, or queries. The other devices, slaves, respond by supplying the requested data to the master, or by taking the action requested in the query. Typical master devices include host processors and programming panels. Typical slaves include programmable controllers.

Controllers can be set up to communicate on standard Modbus serial networks using either of two transmission modes: ASCII or RTU. Vision Builder AI supports both modes. Vision Builder AI also supports the TCP/IP physical layer.

Using the Modbus protocol, a device can read and write data to a set of registers.

Refer to the following table for descriptions of the register sets implemented in the Modbus protocol.



**Note** For each of the four primary tables, the protocol allows individual selection of 65536 data items.

Tables	Description
Discrete	Single bit—Read only. This type of data can be provided by
Input	an I/O system.

Coils	Single bit—Read/Write. This type of data can be alterable by an application program.
Input Registers	16-bit Word—Read only. This type of data can be provided by an I/O system.
Holding Registers	16-bit Word—Read/Write. This type of data can be alterable by an application program.



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## How To Use Modbus Slave

In order to support serial communication, Vision Builder AI requires NI-VISA driver version 3.4.1 or later and a serial port.



**Note** Declare your device in the Communication Device Manager before inserting the **Modbus Slave** step.

- 1. Launch the Communication Device Manager by selecting **Tools**»Communication Device Manager.
- 2. Declare your Modbus device.
- 3. Launch the Modbus server.



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## **Modbus Slave Controls**

The following controls are available on the property page of the step.

Control Name	Description			
Step Name	Name to give the step.			
Command List	<ul> <li>List of all the commands to send and receive through Modbus communication. The following information is displayed for each command:</li> <li>Measurement—Measurement or variable to write to from the local Modbus register.</li> <li>Register Address—Address of the local Modbus register to write to or read from.</li> <li>Value—Value written to or read from the register.</li> </ul>			
	<ul> <li>Hex Value—Binary value written to or read from the register.</li> </ul>			
Write Registers	Launches a dialog box in which you configure the data written to a local Modbus register.			
Read Registers	Launches a dialog box in which you configure the data to read from a local Modbus register.			
Edit	Launches a command dialog in which you can edit the command selected in the <b>Command List</b> table.			
Delete	Deletes the currently selected command.			
Delete All	Deletes all the commands in the Command List.			
View Local Registers	Launches a dialog box where you can view the content of the local Modbus registers.			
Step Fails in Case of Error or Timeout	Sets the step status to FAIL when there is an error or timeout during communication.			

## Write Local Register

Use this dialog box to configure your system to write data to local registers.

- 1. Select the type of data to write.
  - If you select **Boolean Constant**, enable or disable the corresponding checkbox to write the corresponding value to the register.
  - If you select **Numeric Constant**, enter the value of the numeric constant to write to the register.
  - If you select **String Constant**, enter the string to write to the register.
  - If you select **Measurement**, select a measurement or variable from the **Measurements** list to write to the register.
- 2. In **Write to Local Register**, select the register table to which you want to write. The options are Discrete Input, Coils, Input Registers, or Holding Registers.
- 3. Specify the start address of the registers to write.
- 4. Specify the type of data to write. If the output type is different from the input type, specify the measurement formatting.
- 5. Type a comment about the data to write.

## **Control Descriptions**

The following controls are available on the Write Local Register dialog box.

Control Name	Description				
Data to Write to Local Register	<ul> <li>Specifies the type of data to write.</li> <li>Boolean Constant—When selected, writes a Boolean constant to the register. The value of the Boolean to write is specified by the corresponding checkbox.</li> <li>Numeric Constant—When selected, writes a numeric constant to the register. Specify the value to write in the corresponding control.</li> <li>String Constant—When selected, writes a string constant to a set of registers. Specify the string to write in the corresponding control.</li> </ul>				
	• <b>Measurement</b> —When selected, writes a measurement or variable value to a register. Select the measurement to write from the Measurements list.				
Write to Local Register	<ul> <li>Specifies the register to write.</li> <li>Table—Type of register to which you want to write.</li> <li>Start Address—Address of the register to write.</li> <li>Type—Type of data to write to the register.</li> <li>Number of Registers—When you write a string whose type is ASCII, you can choose the number of registers to which you want to write.</li> </ul>				
Measurement Formatting	Specifies how you want to format the data if the output type is different from the input type.				
	input Type	Output Type	Formatting		
	Numeric	Boolean	No formatting necessary. Value sent is True if numeric is different than 0.		
	Numeric	String	Width is the number of digits		

Comment	String	Boolean	Specify the string that corresponds to a True Value.
	String	Numeric	No formatting necessary. Vision Builder AI converts the string to a double.
	Boolean	String	Specify the string to send when the Boolean is True (True String) and when the Boolean is False (False String).
	Boolean	Numeric	Specify the value to read if the Boolean is False (False Value) and if the Boolean is True (True Value).
			to use. Precision is the number of digits after the decimal point of the output string.

# **Read from Local Register**

Use this dialog box to configure your system to read data from local registers.

- 1. Select the registry table from which to read data.
- 2. Select the memory address from which you want to start reading.
- 3. Select the type of data to read. If you choose ASCII, enter the number of registers to read.
- 4. Enter a name for the data you want to read.
- 5. Select the data type format in which you want to store the read data. If the output type is different from the input type, select Measurement Formatting.
- 6. Type a comment about the command you want to send.

## **Control Descriptions**

The following controls are available on the Read Local Register dialog box.

<b>Control Name</b>	Description			
Read From Local Register	<ul> <li>Specifies the register to read.</li> <li>Table—Type of register from which you want to read.</li> <li>Start Address—Address of the register to read.</li> <li>Type—Type of data to read from the register.</li> <li>Number of Registers—When you read a string whose type is ASCII, you can choose the number of registers to which you want to read.</li> </ul>			
Store in Measurement	<ul> <li>Measurement to use to store the data.</li> <li>Name—Name of the measurement you want to create to store the data.</li> <li>Type—Data type format in which you want to store the data.</li> </ul>			
Formatting	type is differ	Specifies how you want to format the data if the output type is different from the input type.		
	Input Type	Output Type	Formatting	
	Numeric	Boolean	No formatting necessary. Value sent is True if numeric is different than 0.	
	Numeric	String	Width is the number of digits to use. Precision is the number of digits after the decimal point of the output string.	
	Boolean	Numeric	Specify the value to read if the Boolean is False (False Value) and if the Boolean is True (True Value).	
	Boolean	String	Specify the string to send	

			when the Boolean is True (True String) and when the Boolean is False (False String).
	String	Numeric	No formatting necessary. Vision Builder AI converts the string to a double.
	String	Boolean	Specify the string that corresponds to a True Value.
Comment	Comment about the data to read		



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## Modbus Slave FAQs

# Q: Why is my Modbus device timing out and not receiving responses from Vision Builder AI?

First, Make sure that your Modbus device is declared in the Communication Device Manager. Then, make sure that your serial port settings match the serial settings for the Modbus device. If you are running Vision Builder AI on a PC, complete the following steps to configure your serial port settings.

- 1. Launch Measurement & Automation Explorer (MAX).
- 2. Expand **Devices and Interfaces**.
- 3. Expand Ports (Serial & Parallel).
- 4. Click your serial port name in the configuration tree.
- 5. Click the **Port Settings** tab.
- 6. Configure your serial port settings.

If you are running Vision Builder AI on remote target, complete the following steps to configure your serial port settings.

- 1. Launch Vision Builder AI.
- 2. Select the remote target you want to configure.
- 3. Select Target»Target Options.
- 4. Click the **Serial Port** tab.
- 5. Configure your serial port settings.
- Note You must have NI-VISA installed to communicate with serial devices.

Check your device manual for the type of serial cable you need to communicate with the device. Some devices require straight-through cables while others require crossover cables.

Tip Make sure you select the serial port connected to your device when sending and receiving commands. Also, make sure that the Modbus server is running in the <u>Communication Device Manager</u>. Select Tools»Communication Device Manager to launch the Communication Device Manager.

### Q: How can I verify that my serial port is working correctly?

Refer to <u>Serial Communication Starting Point</u> for information and troubleshooting tips.

# Q: How do I set the value of a local Modbus register based on the result of an inspection?

At the end of your inspection diagram, add a **Logic Calculator** step that computes the AND of all the step statuses. Then, add a **Serial I/O** step after the **Logic Calculator** step to send a serial command based on the Step Status of the **Logic Calculator** step.

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**Note** The AND of all the step statuses equals the Inspection Status.

#### Q: The register values are not being updated on the Modbus device or in Vision Builder AI, but the Modbus device is not timing out. What could be the reason for this?

Make sure that you specify the correct address in the Modbus device configuration software for the register you want to use in Vision Builder AI. In most Modbus device configuration software, you must enter a name for the register you want to use. Per Modbus convention, the register address of the slave device is calculated by subtracting 1 from the register name that you specify in the master device configuration software. Vision Builder AI expects register addresses, not register names, so you may have to subtract 1 from the address you defined in the Modbus device configuration software. For example, a register name defined as 2 in a Modbus configuration device translates to register address 1 in the Vision Builder AI Holding Registers table.

Modbus Device	Holding Register Name = 2
Vision Builder Al	Holding Register Address = 1

The Modbus data model is based on a series of four tables: Discrete Inputs, Coils, Input Registers, and Holding Registers. These tables do not overlap in Vision Builder AI. Some Modbus devices use the following start addresses for these tables.

- 0x00000 for the Coils
- 0x10000 for the Discrete Inputs
- 0x30000 for the Input Registers
- 0x40000 for the Holding Registers

Because the tables do not overlap in Vision Builder AI, ignore the first digit of the start addresses when entering the addresses in Vision Builder AI. For example, a register name defined as 0x40000 in a Modbus configuration device translates to register address 0 in the Vision Builder AI Holding Registers table.

Modbus Device	Holding Register Name = 0x40000
Vision Builder Al	Holding Register Address = 0

Sometimes you need to subtract 1 from the register name that you specify in the master device configuration software and ignore the first digit of the start address to ensure proper register addressing. For example, a register name defined as 0x40008 in a Modbus configuration device translates to register address 7 in the Vision Builder AI Holding Registers table.

Modbus Device	Holding Register Name = 0x40008
Vision Builder Al	Holding Register Address = 7


# **Use Additional Tools**

This palette groups several additional steps whose purposes are to help you make pass/fail decisions based on previous step results, provide a method by which you can communicate measurements and pass/fail results through serial communication to other devices in your vision inspection system, and add a delay between inspection steps.

Step Name	Description
Set Inspection Status	Updates the value of the Inspection Status system variable.
Calculator	Combines measurements from previous steps to compute new results or pass/fail decisions. You can select any measurement from previous steps and perform numeric, Boolean, or string operations to create new results. Refer to <u>Calculator Concepts</u> for related information.
Logic Calculator	Computes pass/fail decisions based on individual step measurements and results obtained from previous steps. You can also base a calculation result on the combination of results from multiple steps. Refer to Logic Calculator Concepts for related information.
Set Variable	Updates the value of variables.
Index Measurements	Selects a single measurement result from a previous inspection step that returns an array of measurement results.
Run LabVIEW VI	Runs a LabVIEW VI from within Vision Builder AI.
Custom Overlay	Creates a user-defined overlay to add to the current image.
Display Image	Displays an image at any point of the inspection. You can also specify a custom overlay, including test results, and shapes on the displayed image. Refer to <u>Display Image Concepts</u> for related information.

Delay	Waits for a fixed time period before executing the next step in an inspection, or for a fixed amount of time since the last time this step was called.
Data Logging	Saves measurement results to a file on either the local host or an FTP server.
Image Logging	Saves inspection images to file.
Update Inspection UI	Updates indicator values on user-defined interface in Inspection mode.
User Input	Creates a custom dialog box that allow users to input strings, numbers, or boolean data that can be used in an inspection.
Select Inspection	Maps Vision Builder AI inspections to numeric or string values. This allows you to configure Vision Builder AI to automatically choose which inspection to run based on the value of a numeric or string result from an I/O, <b>Run</b> <b>LabVIEW VI</b> , or <b>User Input</b> step.



### How To Set the Inspection Status

Use the **Set Inspection Status** step to set the value of the Inspection Status system variable.

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Select the method you want to use to update the Inspection Status. You may also choose to set the Inspection Status to **PASS** or **FAIL** directly.
- 3. Select **Update Number of Parts Inspected** if you want this step to increment the number of parts inspected. This also increments the *#* Pass and *#* Fail variables.



**Set Inspection Status Controls** 

### Main Tab

The following controls are available on the Main tab.

Control Name	Description
Step Name	Name to give the step.
Inspection Status	<ul> <li>Specifies the method used to update the Inspection Status variable. The following options are available:</li> <li>FAIL if any previous step fails—Sets the Inspection Status variable to FAIL if any of the previous steps in the state fail.</li> <li>Equals specified measurement—Sets the Inspection Status variable to the value of the</li> </ul>
	<ul> <li>PASS—Sets the Inspection Status variable to PASS.</li> <li>FAIL—Sets the Inspection Status variable to FAIL.</li> </ul>
Update Number of Parts Inspected	Specifies whether the step updates the # Pass, # Fail, and # Parts Inspected variables based on the Inspection Status variable value.



### **Set Inspection Status FAQs**

# Q: When do the # Pass, # Fail, and # Parts Inspected variables get updated?

The # Pass, # Fail, and # Parts Inspected system variables are updated when the Inspection Status system variable is set and **Update Number of Parts Inspected** is TRUE. If there is no **Set Inspection Status** step in your inspection, the # Pass, # Fail, and # Parts Inspected will not be updated.



## **Calculator Concepts**

To solve some vision inspection applications, you may need to combine results that Vision Builder AI steps output. For example, you may need to perform arithmetic operations on numeric results output by a step to create a new result.

Using the **Calculator** step, you can create new results and set their values by performing arithmetic, Boolean, or string operations on results previously computed by other steps. The **Calculator** step uses a graphical representation and functions represented as icons to compute new results. The flow of data between the input results, the operators you use, and the outputs you create determine the execution of the step.



### How to Use the Calculator

Use the **Calculator** step to combine measurements from previous steps to compute new results. The new results can be the outcome of a numeric computation, comparison or logical operation, or a string manipulation.

### **Calculator Setup Wizard**

1. Follow the instructions in the Calculator Setup Wizard to select the inputs and outputs you want to use in the calculation.

### Main Tab

- 2. In the **Step Name** control, enter a descriptive name for the step.
- 3. Select numeric, comparison, Boolean, and string operators from the Functions palette and place them on the Calculation diagram. If the Functions palette is not visible, enable **Show Functions Palette**.
  - **Tip** Enable **Show Help Window** for information about the numeric, comparison, Boolean, and string controls.
- 4. Wire the inputs to the outputs using the following technique:
  - a. Use the Wiring tool to move the cursor over an output terminal of a Input Measurement. When you move the Wiring tool over the terminal, the terminal blinks.
  - b. Use the Wiring tool to click the terminal and release the mouse. As you move the cursor across the Calculator diagram, the **Calculator** step draws a wire between the terminal and the Wiring tool as though the wire were unwinding from a spool.
  - c. Without holding down the mouse button, move the cursor to an input terminal of a numeric, comparison, Boolean, or string control. The second terminal blinks.
  - d. Use the Wiring tool to click the second terminal.
  - e. Wire the output terminal of the numeric, comparison, Boolean, or string control to the input terminal of an Output Result.
  - f. Repeat this process to wire together all of the Input Measurements, controls, and Output Results.
    - Note Click Edit Inputs/Outputs if you need to change the inputs and outputs that you selected using the Calculator Setup Wizard. Follow the instructions on the tabbed dialog box that appears.
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Note Broken wires may appear in the diagram, for example when trying to connect an input terminal to an output terminal of a different data type. Click
Remove Broken Wires to remove all broken wires in the diagram.

#### **Measurements Tab**

5. Click **Compute Results** to compute the results of the diagram and display them in this tab.

### **Limits Tab**

- 6. Enable **Step Result Output is True** to require the following conditions in order for the inspection to pass:
  - The Calculator step finds all of the Input Measurements.
  - The result of the computations wired to the **Step Result** output terminal is True (Pass).
    - Note By default, the Step Result value is False (Fail) because no wire is connected to the Step Result output.



**Calculator Controls** 

### Main Tab

The following controls are available on the Main tab.

Control Name	Description
Step Name	Name to give the step.
Edit Inputs/Outputs	Launches a tabbed dialog box in which you can change the inputs and outputs to use in the calculation.
Remove Broken Wires	Removes broken wires in the calculation diagram.
Show Functions Palette	Displays the palette that contains the numeric, comparison, Boolean, and string controls necessary to develop a calculation diagram.
Show Help Window	Displays a window that contains information about the numeric, comparison, Boolean, and string controls.

### **Measurements Tab**

The following control is available on the Measurements tab.

<b>Control Name</b>	Description
Compute Results	Computes the results of the diagram and displays the results in the table.

### Limits Tab

The following control is available on the Limits tab.

<b>Control Name</b>	Description
Step Result Output is True	Specifies that the inspection passes only when the specified Input Measurements are found and the result of the computation connected to the <b>Step Result</b> output terminal is True.



# **Calculator FAQs**

# Q: How can I make the Calculator Step Result the result for the entire inspection?

Complete the following steps to set the result of a **Calculator** step as the result of the entire inspection:

- 1. Insert a Set Inspection Status step.
- 2. Select **Result of step** option for the **Inspection Status** control.
- 3. Select the **Calculator** step from the listbox.
- 4. Click **OK** to add the step to the inspection.



## **Logic Calculator Concepts**

By default, the Pass/fail decision that Vision Builder AI makes is the logical AND of the Pass/fail result of all the steps in the inspection.

Using the **Logic Calculator** step, you can create a Boolean result that is based on the results of the previous inspection steps. Vision Builder AI also can take this Boolean result into account when making the final Pass/fail decision. Vision Builder AI can log the Logic Calculator Boolean in the results list for classification purposes. For example, you can use the logged result to set the level of a digital output line or send a specific string to a serial line.



### How to Make Pass/Fail Decisions

Use the **Logic Calculator** step to define Boolean expressions and combine them to form a decision rule.

### **Defining an Expression**

Follow these instructions to define an expression:

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. In the **First Operand** frame, select the inspection step or variable type from the **Source** list you want to be the first operand in your expression.
- 3. In the **First Operand** frame, select the result from the **Measure** list that you want to use as the first operand. The **Current Value** indicator displays the value of the measurement based on the current image.
- 4. Select the **Operator** you want to use to compare the first operand to the second operand.
  - **Tip** You can negate the operator after you add the expression to the **Expression** table by selecting the expression and clicking **Negate**.
- 5. In the **Second Operand** frame, select whether the second operand is a constant or the result of another inspection step or a variable value by clicking the appropriate radio button.
  - If you select **Constant**, enter a value in the corresponding control.
  - If you select **Source**, select the inspection step or variable type you want to be the second operand in your expression. Also select the operand you want to use.
    - Note The Source list in the Second Operand frame contains only those steps or variables whose measurement types are compatible with the measurement type you selected in the **First Operand** frame.
- 6. Click Add, Insert, or Modify to update the Expression table.

### **Grouping Expressions**

Expressions in the **Expression** table are grouped with the binary operators AND and OR. By default, the operator AND groups two consecutive expressions. Click **AND/OR** to change the binary operator.

The AND operator has precedence over the OR operator. If you want to change the precedence of the operators, you can group several expressions using parentheses.

Follow these instructions to group expressions inside a set of parentheses:

- 1. In the **Expression** table, select the first expression you want to group.
- 2. Hold down the <Shift> key and select the last expression you want to group.
- 3. Click the () button to group all the highlighted expressions by enclosing them in parentheses.

### **Ungrouping Expressions**

Follow these instructions to ungroup expressions by removing a set of parentheses:

- 1. In the **Expression** table, select the first expression in the group. The expression should have an opening parenthesis in the first column of the table.
- 2. Hold down the <Shift> key and select the corresponding last expression in the group. The expression should have a closing parenthesis in the sixth column of the table.
- 3. Click the () button to ungroup the highlighted expressions and remove their parentheses.

### **Deleting an Expression**

To delete an expression from the **Expression** table, select the expression and click **Delete**.



# **Logic Calculator Controls**

The following controls are available on the property page for the step.

<b>Control Name</b>	Description
Step Name	Name to give the step.

#### Operands

<b>Control Name</b>	Description
First Operand	<ul> <li>Specifies the measurement or variable to use for a pass/fail decision. Use the following controls to specify the value to use in the expression:</li> <li>Source—Step or variable to use in the expression.</li> <li>Measure—Measurement or variable value to use in the expression.</li> <li>Current Value—Displays the current value of the selected measurement or variable.</li> </ul>
Operator	Specifies the condition that the second operand must meet for the expression to be true.
Second Operand	<ul> <li>Specifies the value to which you want to compare to the First Operand. The following options are available:</li> <li>Constant—Specific value to compare to the First Operand.</li> <li>Source—Step or variable to use in the expression.</li> <li>Measure—Measurement or variable value to use in the expression.</li> <li>Current Value—Displays the current value of the selected measurement or variable.</li> </ul>
Add	Adds the expression to the end of the <b>Expression</b> table.
Insert	Inserts the expression before the selected expression.
Replace	Applies a change to the selected expression.
Result	Displays the boolean result of the operation between the

### first operand and the second operand.

### Expression

<b>Control Name</b>	Description
<b>Expression</b> Table	Lists the expressions to consider in a pass/fail decision. The following information is displayed for each expression:
	<ul> <li>First Operand—Measurement on which you want to base a pass fail decision.</li> </ul>
	<ul> <li>NOT—Indicates that the Operator is negated.</li> </ul>
	• <b>Operator</b> —Condition that Operand 2 must meet in order for the expression to be true.
	<ul> <li>Second Operand—Value to which the operator compares the First Operand.</li> </ul>
	<ul> <li>Result—Boolean result of the operation between the First Operand and the Second Operand.</li> </ul>
	<ul> <li>AND/OR—Displays the logical operator used to combine two expressions.</li> </ul>
Logic Result	Displays the boolean result of the complete expression.
AND/OR	Changes the logical operator used to combine two expressions.
Negate	Logically negates the selected expression.
0	Combines the selected expressions so that the step considers them as one logical unit.
Delete	Removes the selected expression from the <b>Expression</b> table.

#### Mode

<b>Control Name</b>	Description
Mode	Specifies how the result of the step is determined. The following options are available:
	<ul> <li>Step passes inspection when Logic Result is TRUE—Logic Calculator step result is based on the Logic Result.</li> </ul>

<ul> <li>Step passes inspection if the Logic Result can be evaluated—Logic Calculator step passes if the decision can be evaluated, regardless of the result of the evaluation. Select this mode when you want to classify parts based on the result of one or many Logic Calculator steps.</li> <li>Step Status—Pass/fail decision of the step. If This step passes inspection when Logic Result is TRUE is selected, Step Status is always TRUE (pass), unless one expression refers to a measurement that could not be evaluated.</li> </ul>
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## **Logic Calculator FAQs**

# Q: When I click the () button, parentheses do not appear in the Expression table around the expressions I highlighted. Why?

You cannot set parentheses if the expressions you want to group contain an odd number of parentheses. For example, you cannot group a set of expressions if one of the members is already grouped with another set of expressions outside the set you want to group.

# Q: When I select a set of parentheses and click the () button to remove them, why do the parentheses remain in the table?

If the opening and closing parentheses you select are not a pair, you cannot remove them.

#### Q: When would I use the second Mode in the Logic Calculator step?

The second Mode is useful when you need to classify objects and you want the **Logic Calculator** step to always pass. For example, assume you have Part A with one hole and Part B with two holes. Both Part A and Part B need to pass inspection if they meet all other inspection criteria.

You can create a **Logic Calculator** step that uses the second **Mode** so that the **Logic Calculator** step passes regardless of whether Part A or B is under inspection. You can use the **Logic Result** to qualify which class the part under inspection belongs to. The **Logic Result** value changes depending on the class of the part, but the **Step Status** equals **PASS** if all the data to make the decision is available.

Note You need a Logic Calculator step for each class you need to identify.

# Q: How can I select the Logic Calculator Step Results as the result for the entire inspection?

Select Tools»Configure Global Decision Making. In the Global Decision Making Setup dialog, select the Inspection Equals Specified Logic Calculator Step Result mode, and specify the appropriate Logic Calculator step.



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## How To Configure Variables

Use the **Set Variable** step to update the value of variables in an inspection. Variables are defined in the Variable Manager available from **Tools»Variable Manager**. Variables can be used by any step that supports measurement results.

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Select the variable you want to update from the Variables table.
- 3. Select a value for the variable using the **Operation** controls. Numeric variables can also be set to increment or decrement by one when they are updated.
- 4. Repeat steps 2 and 3 for all the variables you want to update.
- **Tip** Click **Edit Variables** to launch the Variable Manager, which you can use to create new variables, or edit the name or initial value of existing variables.



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## **Set Variable Controls**

The following controls are located on the property page for the step.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Variables	Displays a list of the variables available in the inspection. The following information is displayed for each variable:
	<ul> <li>Scope—Displays the scope of the variable. Inspection variables are available only in the current inspection, System variables are available for any inspection on the computer, and network variables are available to any device on the network that supports LabVIEW variables.</li> </ul>
	<ul> <li>Current Value—Current value of the variable. The current value is not displayed for Network variables to prevent delays caused when a network source is unavailable.</li> <li>Operation—Describes how the variable will be updated. The description that is shown is based on the settings configured for the Operation controls.</li> <li>New Value—Value of the variable after an update occurs.</li> </ul>
Operation	<ul> <li>Specifies what action to perform to update the value of the selected variable. The following options are available:</li> <li>Do Not Set—Does not modify the variable when the step executes.</li> <li>Set to Constant—Sets the value of the selected variable to a user-specified constant.</li> <li>Set to Measurement—Sets the value of the selected variable to the value of a previous</li> </ul>

	measurement result from a step in the same state as the <b>Set Variable</b> step. Only previous measurement results that are of the same type as the variable can be selected.
	<ul> <li>Increment—Increases the value of the selected variable by one. This control is only available for numeric variables.</li> </ul>
	<ul> <li>Decrement—Decreases the value of the selected variable by one. This control is only available for numeric variables.</li> </ul>
Comment	Allows you to enter information about the purpose and behavior of the variable.
Edit Variables	Launches the Variable Manager, which is used to create and configure variables.



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## Set Variable FAQs

#### Q: What are variables used for?

Variables can be used to store data so the data is accessible from any state in an inspection. A common use of variables is to implement a For Loop. Variables allow you to initialize a counter variable in one state and loop another inspection state that increments the counter variable. When you transition out of the inspection state, the counter variable has a value of *N*, where *N* is the number of times the inspection state executed.

Variables can also be used to pass data between states of an inspection. For example, you may have a state in your inspection that is run several times, but you only want to display an overlay when certain criteria are met. You can put the **Custom Overlay** and **Display** steps in a separate state and set the inspection state to transition to the overlay and display state when certain criteria are met. The **Custom Overlay** step can then use a variable to overlay the results of the inspection state.

# Q: How can I use the variable values that are updated by Vision Builder AI?

Variables are accessible from any step in any state that can use measurement results. Variables can also be accessed to trigger transitions from the state diagram Edit Transition dialog box.

Network variables can be used to access data from other devices on the network that support LabVIEW variables. Network variables can also be bound to a hardware resource to expand the I/O if your system.

The **Set Variable** step is not required to access variables, it is only required when you want to update a variable that may be used in a different state.

#### Q: Why am I unable to update the value for some system variables?

Vision Builder AI uses a few system variables to store information about the current inspection. Because these built-in system variables are used internally by Vision Builder AI, you are not able to update the value of the variables using the **Set Variable** step. You can, however, read the value of the variable using any step that allows you to set the value of a control to a variable value.

The following is a list of the built-in system variables used by Vision Builder AI:

- Device Name
- IP Address
- Device Start Date
- Device Start Time
- Current Date
- Current Time
- Inspection Name
- Inspection Start Date
- Inspection Start Time
- Inspection Iteration Counter
- Active Time
- Idle Time
- Inspection Rate
- Inspection Status
- # Pass
- # Fail
- # Parts Inspected
- Yield



### **How To Index Measurements**

Use the **Index Measurements** step to access a specific measurement result from steps that produce collections of measurements. Refer to <u>Index Measurements FAQs</u> for a list of steps that return collections of results.

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. In the Measurements tree, select the measurements from the step you want to index.
- 3. Enter a value for the **Index**, or select a previous measurement or variable to use as the **Index**.



**Index Measurements Controls** 

### Main Tab

The following controls are available on the Main tab.

Control Name	Description
Step Name	Name to give the step.
Measurements	Displays measurement results for the inspection that can be indexed.
Index	Index to use to access an element of the collection.
Value	Displays the current index value.



## **Index Measurements FAQs**

# Q: What Vision Builder AI steps produce collections of measurement results?

The following steps produce collections of measurement results:

- Adv. Straight Edge
- <u>Classify Objects</u>
- Detect Objects
- Find Edges
- <u>Geometric Matching</u>
- <u>Match Color Pattern</u>
- <u>Match Colors</u>
- <u>Match Pattern</u>
- <u>Read/Verify Text</u>

## Q: Why aren't all of my measurements listed in the Measurements tree?

The Measurements tree only lists measurements from steps that produce collections of measurement results, such as **Find Edges**, **Match Pattern**, and **Detect Objects**. Only measurements within collections are listed. Measurements that cannot be indexed, measurements from steps that have not executed, or measurements from steps that did not produce indexable results upon execution are not listed.

#### Q: Why can't I index measurements logged by multiple steps?

The **Index Measurements** step only allows you to specify one index. Since the number of elements in each collection may vary, the step does not allow you to index measurements from multiple steps. Insert an **Index Measurements** step in the state for each measurement result you want to index.



How to Run a LabVIEW VI

### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Click E Browse to select the path to the VI you want to run.
- Note The Run LabVIEW VI step works only with VIs saved using LabVIEW 8.5. To run a VI on a remote target, you must first <u>save</u> the VI for distribution, and download the VI to the remote target.

### **VI Controls Tab**

- 3. Click the **Configure** button to launch the Select VI Value window.
- 4. Select a VI control name from the VI Controls list.
- 5. Specify a value for the control.
- 6. Repeat steps 4 and 5 as necessary.
- 7. Click **OK** to save the specified values and close the Select VI window.

### Limits Tab

8. Select the VI Indicator that you want to use to determine if the step passes.



**Run LabVIEW VI Controls** 

### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
VI Path	File Path of the VI to run.

### **VI Controls Tab**

The following controls are available on the VI Controls tab.

<b>Control Name</b>	Description
VI Controls	Displays the labels and current values of the VI controls.
Configure	Launches the Select VI Value window where you can set or modify the values of the VI controls.
VI Indicators	Displays the labels and current values of the VI indicators.
Debug Mode	When enabled, this option runs the VI from within the LabVIEW Environment, which allows you to use highlight execution, breakpoints, and other LabVIEW debugging techniques.
Test	Runs the selected VI to test your configuration.

### Limits Tab

The following controls are available on the Limits tab.

<b>Control Name</b>	Description
VI Indicator	When enabled, this option specifies that the inspection passes only when the VI runs successfully and the value of the selected VI indicator is True.



## **Run LabVIEW VI FAQs**

### Q: What types of controls and indicators can I use in my VI?

There are no restrictions about the types of controls or indicators used in the VI. However, to use the value of a variable or measurements from a previous Vision Builder AI step for the value of a control, the control data types must be numerics (I8, I16, I32, U8, U16, U32, DBL, SGL, or EXT), strings, boolean values, NI Coordinate Systems, or NI Image controls. Indicators must be numerics, strings or boolean values to be accessible in future steps.

# Q: Do I need to update the connector pane for this step to use my indicators or controls?

No, the **Run LabVIEW VI** step detects all controls and indicators on the front panel regardless of whether they are linked to the VI connector pane.

# Q: How do I use the current image from Vision Builder AI and modify the image so subsequent steps use the modified image?

In the **VI Controls** Tab, click the **Configure** button. If you have an NI Image control on the specified VI, select **Current Image »Image** as the value for the NI Image control. Once the current image is associated with your image control, you will have access to the current Vision Builder AI image. Any modification to the image is reflected in the resulting image after the VI is run.

Because the image passed in is the same one that will be modified, using an image display control can produce confusing results because it may not be clear if the image displayed is the original passed from Vision Builder AI or the modified version after the VI has run. It is recommended to use the NI Image control instead of the NI Image Display control to avoid confusion.



**Note** If you pass the current Vision Builder AI image to your VI, overlay calibration information and any other vision information in the image is preserved.

# Q: How do I use a Coordinate System from a previous step in my VI?

In the **VI Controls** Tab, click the **Configure** button. If you have an NI Coordinate System control on your VI, you can select a coordinate system from a previous **Set Coordinate System** step as the value for the NI Coordinate System Control. If the **Set Coordinate System** step does not find a coordinate system, the Measurement System controls in the Coordinate System cluster on your VI will display NaN for the control values.

# Q: Why does Vision Builder AI appear unresponsive when I run a VI?

The **Run LabVIEW VI** step waits for the specified VI to complete before executing additional steps in your application. If the VI runs continuously or requires a user interaction to stop the VI, the step will wait indefinitely. To avoid this situation, make sure that the selected VI can complete without user interaction.

# Q: Why do I get an error about my VI or one of the subVIs being broken?

You need to save the VI for distribution to ensure that all the VI dependencies are available. Refer to <u>Saving a VI for Distribution</u> for instructions about saving a VI for distribution. When running an inspection on a remote target, make sure to copy the VI and all of the dependencies to the remote target before running the inspection.

# Q: Why do I get an error about by VI being missing when the VI is in the correct location?

If the VI is not compiled for the remote target where you want to run the VI, you will receive this error. Complete the steps listed in <u>Saving a VI</u> for <u>Distribution</u> to ensure that the VI is correctly compiled for the remote target.



### How to Create a Custom Overlay

Use the **Custom Overlay** step to display the current image and overlay shapes, text, and additional images on an image without modifying the image data.

Complete the following steps to create an overlay:

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Select whether or not you want to clear any existing overlays before adding the custom overlay.

#### **Custom Overlay Tab**

- 3. Select the type of overlay you want to add to the image from the tools palette.
- 4. Draw the overlay on the image.
  - Note To remove an overlay from the image, select the element from the **Overlay Elements** listbox and click the **Delete** button.

You can adjust the size and position of the element by using the **Selection Tool** or by modifying the element **Parameters**.

- 5. Set the overlay color.
- 6. Set any **Parameters** specific to the element you created, such as the overlay text.

#### Layer Management Tab

 Use the Layer Management controls to set the order in which Vision Builder AI overlays the elements on the image. The Overlay Elements table lists all of the elements in the overlay. The first element in the table is the topmost layer.

To move an element up or down the stack of layers, select an element in the list and use the **Reorder** buttons to move the element. To delete an element from the overlay, select the element and click the **Delete** button.



**Custom Overlay Controls** 

### Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Clear Previous Overlay	Removes any overlays created by previous steps in the inspection when the step executes.

### **Custom Overlay Tab**

The following controls are available on the Custom Overlay tab.

<b>Control Name</b>	Description
13	Selects an overlay element in the image.
+	Overlays a crosshair identifying a point on the image.
/	Overlays a line on the image.
	Overlays a rectangle on the image.
$\Diamond$	Overlays a rotated rectangle on the image.
0	Overlays an oval or circle on the image. Hold down the <shift> key while dragging to draw a circle.</shift>
	Overlays a boolean indicator on the image.
	Overlays an image file on the image.
Αα	Overlays text on the image.
Overlay Elements	Displays the individual components that make up the custom overlay.
Delete	Removes the element currently selected in <b>Overlay Elements</b> .

#### Parameters



**Note** The available parameters vary according to the type of overlay selected in **Overlay Elements** 

#### Point

<b>Control Name</b>	Description
Point Coordinates	Specifies whether the position of the overlay is user- defined, the value of a variable, or the result of a previous measurement.
X	X-coordinate of the point.
Υ	Y-coordinate of the point.
X Offset	X offset to the position defined by the selected variable or previous measurement.
Y Offset	Y offset to the position defined by the selected variable or previous measurement.
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Color	Color of the overlay.

Line

<b>Control Name</b>	Description
Start Point	Specifies whether the start point of the line is user- defined, the value of a variable, or the result of a previous measurement.
End Point	Specifies whether the end point of the line is user- defined, the value of a variable, or the result of a previous measurement.
X	X-coordinate of the point.
Υ	Y-coordinate of the point.
X Offset	X offset to the position defined by the selected variable or previous measurement.
Y Offset	Y offset to the position defined by the selected variable or previous measurement.
Color	Color of the overlay.

## Rectangle

<b>Control Name</b>	Description
Top Left Point	Specifies whether the top left point of the rectangle is user-defined, the value of a variable, or the result of a previous measurement.
Bottom Right Point	Specifies whether the bottom right of the rectangle is user-defined, the value of a variable, or the result of a previous measurement.
X	X-coordinate of the point.
Υ	Y-coordinate of the point.
X Offset	X offset to the position defined by the selected variable or previous measurement.
Y Offset	Y offset to the position defined by the selected variable or previous measurement.
Y Offset	X offset to the position defined by the selected variable or previous measurement. Y offset to the position defined by the selected variable or previous measurement.

Stroke	Color of the rectangle border.
Fill	Fill color of the rectangle.

### **Rotated Rectangle**

<b>Control Name</b>	Description
Center Point	Specifies whether the center of the rectangle is user- defined, the value of a variable, or the result of a previous measurement.
X	X-coordinate of the point.
Υ	Y-coordinate of the point.
X Offset	X offset to the position defined by the selected variable or previous measurement.
Y Offset	Y offset to the position defined by the selected variable or previous measurement.
Width	The width of the rectangle.
Height	The height of the rectangle.
Angle	Rotation angle, in degrees, of the rectangle with the center of the rectangle as the point of rotation.
Stroke	Color of the rectangle border.
Fill	Fill color of the rectangle.

### Oval

<b>Control Name</b>	Description
Center Point	Specifies whether the center of the oval is user-defined, the value of a variable, or the result of a previous measurement.
X	X-coordinate of the point.
Υ	Y-coordinate of the point.
X Offset	X offset to the position defined by the selected variable or previous measurement.
Y Offset	Y offset to the position defined by the selected variable or previous measurement.
Width	The width of the oval.

Height	The height of the oval.
Stroke	Color of the oval border.
Fill	Fill color of the oval.

### **Boolean Indicator**

<b>Control Name</b>	Description
Top Left Point	Specifies whether the top left point of the boolean indicator is user-defined, the value of a variable, or the result of a previous measurement.
X	X-coordinate of the point.
Υ	Y-coordinate of the point.
X Offset	X offset to the position defined by the selected variable or previous measurement.
Y Offset	Y offset to the position defined by the selected variable or previous measurement.
Width	The width of the boolean indicator.
Height	The height of the boolean indicator.
Value	Measurement value to use for the value of the boolean indicator.
True Text	Text to display when the result is TRUE.
False Text	Text to display when the result is FALSE.
Text	Color of the text
Fill	Fill color of the boolean indicator.

### Image

<b>Control Name</b>	Description
Top Left Point	Specifies whether the top left point of the overlay image is user-defined, the value of a variable, or the result of a previous measurement.
X	X-coordinate of the point.
Y	Y-coordinate of the point.
X Offset	X offset to the position defined by the selected variable or previous measurement.

Y Offset	Y offset to the position defined by the selected variable or previous measurement.
Image File Path	Complete file path to the image file to overlay.
Set Color to be Transparent	Enable the checkbox to make areas of the image matching the color specified in <b>Color</b> appear transparent.
Color	Color in the overlay image that you want to be transparent.

### Text

<b>Control Name</b>	Description
Insertion Point	Specifies whether the bottom left point of the first character of the overlay text is user-defined, the value of a variable, or the result of a previous measurement.
X	X-coordinate of the point.
Υ	Y-coordinate of the point.
X Offset	X offset to the position defined by the selected variable or previous measurement.
Y Offset	Y offset to the position defined by the selected variable or previous measurement.
Text	Text to overlay
	Launches the Select Inspection Data dialog box where you can specify a measurement result to display as an overlay.
A <sub>A</sub>	Launches a dialog box containing options for configuring how the text appears in the overlay.
Text Color	Color of the text.
Fill	Color of the text background.

## Layer Management Tab

The following controls are available on the Layer Management tab.

<b>Control Name</b>	Description
Overlay Elements	Lists the overlay elements that make up the custom overlay. The following information is available for each element:
	<ul> <li>Name—Name of the overlay element</li> </ul>
	<ul> <li>Fill—Fill color of the overlay element</li> </ul>
	<ul> <li>X—X-coordinate of the first point of the overlay element.</li> </ul>
	<ul> <li>Y—Y-coordinate of the first point of the overlay element.</li> </ul>
Up	Moves the selected overlay element earlier in the drawing order.
Down	Moves the selected overlay element later in the drawing order.
Delete	Removes the currently selected element from the overlay.



# **Custom Overlay FAQs**

# Q: I can only select one overlay element in the image. How can I select another overlay element?

Only the overlay element selected in the **Overlay Elements** listbox can be moved or modified. If you want to modify another overlay element,

use the Selection Tool to click on the element you want to modify, or select the element you want to modify from the Overlay Elements listbox.

**Tip** For precise control of the location of an overlay element, specify the location of the element using the **Parameters** control.



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## **Display Image Concepts**

By default, if a state contains an image processing step, Vision Builder AI displays the image that results after the state is run. You can override this behavior by disabling the **Display Result Image for this State** checkbox or adding one or more **Display Image** steps to the state. The **Display Image** steps to the state. The **Display Image** step displays the current image at any point in the inspection.



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# How To Display Images

Use the **Display Image** step to display the current image at any point in the inspection. Complete the following steps to display an image:

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Select the **Display Condition**. You can choose to display all the images or only images that pass/fail inspection.
- Note Use the <u>Custom Overlay</u> step to create a custom overlay for the image.



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**Display Image Controls** 

## Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Display Images	Specifies which images to display. The following options are available:
	<ul> <li>Always—Displays all inspected images.</li> <li>If Inspection Status is PASS—Displays only those images that passed inspection.</li> <li>IF Inspection Status is FAIL—Displays only those images that failed inspection.</li> </ul>



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# **Display Image FAQs**

Q: How do I set up the display settings of my NI CVS-1450 Series device?

Select **Target »Target Options»Video Mode** and configure the display settings.

#### Q: Why don't I see the images displayed when I expect to see them?

When in configuration mode, the image is always displayed at the end of a state. Use inspection mode to see the actual displayed results.

When connected to remote target there may be discrepancies between the host display and the remote target display. In cases of a discrepancy, the remote target always displays correct information in either Inspection mode or Configuration mode. •

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## How to Add a Delay or Fixed Wait Period Between Steps

Use the **Delay** step to wait for a fixed time before executing the next step in an inspection, or for a fixed amount of time since the last time this step was called.

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Select whether to **Delay** or wait for a **Fixed Time Lapse** period since the last time this step was called.
  - If **Delay** is selected, use the **Delay (ms)** control to specify the number of milliseconds you want Vision Builder AI to wait before executing the next step.
  - If Fixed Time Lapse is selected, use the Period (HH:MM:SS) control to specify the amount of time the step should wait from the last time the step was called before continuing.
  - Note If you select **Fixed Time Lapse**, the first time the step runs, the step will not wait. The fixed time lapse will occur after the first time the step runs.

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**Delay Controls** 

## Main Tab

The following controls are available on the Main tab.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Delay	If selected, the step will wait for the number of milliseconds specified in <b>Delay (ms)</b> before continuing to the next step.
Fixed Time Lapse	If selected, the step will wait for the time period specified in <b>Period (HH:MM:SS)</b> . While execution is stopped, a dialog box appears displaying the amount of time remaining until execution resumes.
Delay (ms)	Number of milliseconds to wait before running the next step in the inspection.
Period (HH:MM:SS)	Time period to wait before resuming execution.

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# **Delay FAQs**

# Q: What is the difference between the Delay mode and the Fixed Time Lapse mode?

The **Delay** mode always waits for the specified amount of time before moving to the next step. The **Fixed Time Lapse** mode takes into account the last time the step was called so that next step is always executed after the specified period of time.

# Q: What if the inspection takes longer to run that the specified time lapse period?

The step will not wait and the countdown dialog box will not be displayed.

# Q: Why does the inspection continue after the Stop button is pressed

The inspection continues because the **Stop** button has not been configured. Vision Builder AI allows you to configure what happens when the **Stop** button is pressed. To prevent an inspection from continuing when the **Stop** button is pressed, complete the following steps:

- 1. Add a new state to the inspection.
- 2. Create a transition to the new state from the state containing the **Delay** step.
- 3. Edit the transition to occur when **Delay Stop Button Pressed** is **True**.

Once the inspection is in the new state you created, click the **Stop Inspection** button on the Vision Builder AI toolbar to stop the inspection.



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## How to Log Inspection Results

Complete the following steps to configure the **Data Logging** step:

1. In the **Step Name** control, enter a descriptive name for the step.

### **Measurements Logged Tab**

2. Select the measurement results or variables you want to log from the **Measurements** tree. If you select a measurement result that can produce multiple results, you must also specify the number of results to log.

Click **Select All** to log all the measurements or variable values from the inspection. Click **Deselect All** to clear all the selected measurements.

- Tip You can expand or collapse all the items in the Measurements tree by right-clicking the tree and selecting the appropriate option.
- 3. Select whether you want to **Log All Measurements** or **Log Measurements Only When Inspection Fails**. Logging measurements to a file is time intensive and reduces the maximum rate at which the inspection can be run. Consider only logging the results that correspond to failed inspections.

Note You must have a <u>Set Inspection Status</u> step before this step in your inspection to correctly Log Measurements Only When Inspection Fails.

### **Destination Tab**

4. Vision Builder AI allows you to save inspection measurements to a local drive, an FTP server, or to send the measurements to a TCP device. Complete one of the following sets of steps to specify where you want to save the measurement results.

### Log Measurements to a Local Drive

- a. In the Log Location control, select Log to Local Drive.
- b. Click the Browse button and navigate to the folder where you want to save the log file.
- c. Enter a **File Name** to use for the log file, or select the result of a previous step from the drop-down list.
  - Tip You can use the File Name control to specify subdirectories. When using the File Name control to specify subdirectories, you must use a \ to separate directories.
- d. Specify the File Type to use for the log file.
- e. In the **Substitute on Fail** control, enter the characters to enter when a measurement result is not available.
- f. Select whether to create a **Single File** or **Multiple Files**. If you choose to create multiple data log files, you must also specify how often a new data log file should be created using the **Start a New Log File Every** control.

If you select **Multiple Files**, Vision Builder AI appends a timestamp to the specified **File Name** to distinguish each log file.

 g. To overwrite any log files created prior to the inspection being run, select the Overwrite any file(s) created prior to this inspection before logging data checkbox. Otherwise, the step appends the latest results to the existing log file.

#### Log Measurements to an FTP Server

- a. In the Log Location control, select Log to FTP Server.
- b. Enter the **IP Address** of the FTP server where you want to save the log file.

- c. Enter the **User Name** and **Password** to use to log onto the FTP server.
- d. Click **Test Login** to verify that the login information you entered is correct.
- e. In the **Folder Path** control, enter the file path to the folder where you want to save the log file.
- f. Enter a **File Name** to use for the log file, or select the result of a previous step from the drop-down list.
  - Tip You can use the File Name control to specify subdirectories. When using the File Name control to specify subdirectories, you must use a / to separate directories.
- g. Disable the **Log as a Background Task** checkbox if you do not what to perform data logging as a background task. For example, with very fast inspections, background data logging may not be able to keep up with the inspection, resulting in missing data. To ensure that all inspection data is logged, disable the **Log as a Background Task** checkbox.

By default, Vision Builder AI performs data logging as a background task to allow the inspection to continue while data is being logged. However, when logging data to an FTP server, certain applications may require that data logging occur inline with the rest of the inspection.

- h. Specify the File Type to use for the log file.
- i. In the **Substitute on Fail** control, enter the characters to enter when a measurement result is not available.
- j. Select whether to create a **Single File** or **Multiple Files**. If you choose to create multiple data log files, you must also specify how often a new data log file should be created using the **Start a New Log File Every** control.

If you select **Multiple Files**, Vision Builder AI appends a timestamp to the specified **File Name** to distinguish each log file.

k. To overwrite any log files created prior to the inspection being run, select the **Overwrite any file(s) created prior** 

**to this inspection before logging data** checkbox. Otherwise, the step appends the latest results to the existing log file.

#### Send Measurements to a TCP Device

- Note Before you can log data to a TCP device, you must configure the TCP device using the <u>Communication Device</u> <u>Manager</u>.
  - a. In the Log Location control, select Send to TCP Device.
  - b. Select the TCP device where you want to send the measurement results from the **Device Name** control.
  - c. If necessary, adjust the **Timeout** period for the TCP device.
  - d. Use the **Header** and **Footer** controls to enter the strings to use to identify the beginning and end of the measurement data. You can use <u>\ codes</u> to format the string or enter non-printable characters.
  - e. In the **Substitute on Fail** control, enter the characters to log when a measurement result is not available.
  - f. In the **Separator** control, enter the character to use to separate measurement values.
- 5. Click **OK** to add the step to the inspection.



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# **Data Logging Controls**

The following control is located on the property page for the step.

<b>Control Name</b>	Description
Step Name	Name to give the step.

## Measurements Logged Tab

The following controls are available on the Measurements Logged tab.

Control Name	Description
Measurements	The measurements and variables available for logging.
Log All Measurements	All of the measurements selected in <b>Measurements Selection</b> are logged when the step executes.
Log Measurements Only When Inspection Fails	Measurements selected in <b>Measurements</b> <b>Selection</b> are logged if the current state fails when the step executes.

## **Destination Tab**

The following controls are available on the Destination tab.

<b>Control Name</b>	Description
Log Location	Specifies the location of the computer where the results are saved. The following options are available:
	<ul> <li>Log to Local Drive—Measurement results are saved to a local storage device.</li> </ul>
	<ul> <li>Log to FTP Server —Measurement results are saved to an FTP server.</li> </ul>
	<ul> <li><u>Send Data to TCP Device</u>—Measurement results are transferred to a TCP device.</li> </ul>

### Log to Local Drive

Control Name	Description
Local Path	The file path to the directory where you want to save the measurement results.
File Name	If <b>Single File</b> is selected, <b>File Name</b> is the name of the log file. If <b>Multiple Files</b> is selected, <b>File</b> <b>Name</b> is used as a prefix before the time stamp in the log file name.
File Type	Specifies the format of the log file. The following options are available:
	<ul> <li>Tab Delimited Text File</li> </ul>
	<ul> <li>Comma Separated Value File</li> </ul>
Substitute on Fail	Specifies a string value to log when a measurement is not available. You can use <u>\</u> codes to format the string or enter non-printable characters.
Single File	One data log file is created for all measurement results.
Multiple Files	Data log files are created at regular intervals. If you select to create multiple log files, you must specify how often to create a new log file using the <b>Start a New Log File Every</b> controls.

Overwrite any	When enabled, existing log files with the same
file(s) created prior	name will be overwritten. Otherwise, the latest
to this inspection	measurement results are appended to the existing
before logging	log file.
data	

## Log to FTP Server

Control Name	Description
IP Address	IP Address or network address ( <i>FTPServerName</i> ) of the FTP server where you want to save the measurement results.
User Name	Name to use to log onto the FTP server.
Password	Password to use to log onto the FTP server.
Test Login	Verifies that the specified <b>User Name</b> and <b>Password</b> successfully log on to the FTP Server specified by <b>IP Address</b> .
Folder Path	The file path to the directory where you want to save the measurement results.
File Name	If <b>Single File</b> is selected, <b>File Name</b> is the name of the log file. If <b>Multiple Files</b> is selected, <b>File</b> <b>Name</b> is used as a prefix before the time stamp in the log file name.
Log as a Background Task	When enabled, allows the data logging process to be performed as a background task to allow the inspection to continue while data is being logged to the specified FTP server.
File Type	Specifies the format of the log file. The following options are available: • Tab Delimited Text File • Comma Separated Value File
Substitute on Fail	Specifies a string value to log when a measurement is not available. You can use <u>\</u> <u>codes</u> to format the string or enter non-printable characters.
Single File	One data log file is created for all measurement

	results.
Multiple Files	Data log files are created at regular intervals. If you select to create multiple log files, you must specify how often to create a new log file using the <b>Start a New Log File Every</b> controls.
Overwrite any file(s) created prior to this inspection before logging data	When enabled, existing log files with the same name will be overwritten. Otherwise, the latest measurement results are appended to the existing log file.

### Send Data to TCP Device

<b>Control Name</b>	Description
Device Name	TCP device where you want to send the data.
Timeout	Number of milliseconds to wait before timing out.
Header	Specifies the string used to identify the beginning of the measurement data.
Footer	Specifies the string used to identify the end of the measurement data.
Include Labels	When enabled, the label associated with each measurement value is included.
Substitute on Fail	Specifies a string value to log when a measurement is not available. You can use <u>\ codes</u> to format the string or enter non-printable characters.
Separator	Specifies the character used to separate measurement values.



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### **Data Logging FAQs**

## Q: How do I configure my inspection to log measurement results from a remote target to a local machine?

You must have an FTP server running on the local machine you want to log the results. Then, configure the **Data Logging** step to log measurements to the FTP server running on the local machine.

## Q: What are the advantages/disadvantages of background FTP data logging?

When information is logged in the background, the logging step has a shorter execution time because the step sends the information to a background task and allows the inspection to continue executing without having to wait for the FTP write operation to complete. A possible disadvantage to background logging is that you can lose information if the background logging task is unable to keep up with the inspection.



#### How to Log Inspection Images

Complete the following steps to configure the **Image Logging** step:

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Select a step from the Image Logging table from which to log images.
- 3. Enable the **Enable Image Logging** control.
- 4. Select the **Log Location** for the step. You can choose to log images to either a local drive or to an FTP server.
  - Note Logging to a local drive is not supported for NI Smart Cameras.
    - To log images to a file on a local drive, complete the following steps:
      - a. Select Log to Local Drive for the Log Location.
      - b. Click the Browse button and navigate to the folder where you want to save images.
    - To log images to a file on an FTP server, complete the following steps:
      - a. Select Log to FTP Server for the Log Location.
      - b. Enter the **IP Address** of the FTP server where you want to log images.
      - c. Enter the **User Name** and **Password** you want to use to log onto the FTP server.
      - d. Click **Test Login** to verify that the login information you entered.
      - e. Enter the **Folder Path** to the location where you want to same images.
- 5. Enter a **File Name** for the image, or select the result of a previous step from the drop-down list.
  - **Tip** You can use the **File Name** control to specify subdirectories. When using the **File Name** control to specify subdirectories, you must use a \ to separate directories when logging to a local drive, and a / to separate directories when logging to an FTP server.

- 6. If you do not want to add a timestamp to the specified **File Name**, disable the **Append Timestamp** control.
- 7. If you are logging to an FTP server, disable the **Log as a Background Task** checkbox if you do not what to perform image logging as a background task. By default, Vision Builder AI performs image logging as a background task to allow the inspection to continue while images are being logged. However, when logging images to an FTP server, certain applications may require that image logging occur inline with the rest of the inspection.
- 8. Specify the File Format Options you want to use to log images.

Some file formats support compression. To log images with compression, use the **Image Quality**, **Compress BMP File**, **Compression Ratio**, and/or **Use Lossless Compression** controls to specify the compression options to use. Refer to <u>Image Options</u> for a complete list of the options available for each file format.



- 9. If you want to save any overlay information with the images, enable the **Merge Overlay** control.
- 10. Select whether you want to **Log all Images** from the selected step, or to **Log Image Only When Inspection Status Fails**.
  - **Tip** Logging images to file is time intensive and reduces the maximum rate at which you can run the inspection. Therefore, you may want to log only images that correspond to parts that fail inspection.



- 9. Enable the Limit Number of Logged Images control and specify the Max Number of Logged Images to limit the number of images logged from the selected step. When the limit value is reached, the oldest image is replaced by the next logged image.
- 10. Click **OK** to add the step to the inspection.



### Image Logging Controls

The following controls are available on the property page for the step.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Image Logging Table	<ul> <li>Lists information about the available images. The following information is available:</li> <li>State—Name of the state where the step that produces the image is located.</li> <li>Step that Created Image—Name of the step that produces the image.</li> <li>File Path—File path to the location where the images will be saved.</li> <li>Log Limit—Maximum number of images to log.</li> <li>Format—File format for the saved image.</li> </ul>
Enable Image Logging	When enabled, saves the images produced by the step selected in the <b>Image Logging Table</b> .
Log Location	<ul> <li>Specifies the location of the computer where the images are saved. The following options are available:</li> <li>Log to Local Drive—Images are saved to a local drive. This option is not available for NI Smart Cameras.</li> <li>Log to FTP Server—Images are saved to an FTP server.</li> </ul>
IP Address	IP Address or network address ( <i>FTPServerName</i> ) of the FTP server where you want to save the images.
User Name	Name to use to log onto the FTP server.
Password	Password to use to log onto the FTP server.
Test Login	Verifies that the specified <b>User Name</b> and <b>Password</b> successfully log on to the FTP Server specified by <b>IP Address</b> .
Folder Path	The file path to the directory where you want to save the measurement results.

File Name	Name of the image file. If <b>Append Timestamp</b> is selected, <b>File Name</b> is used as a prefix before the timestamp.
Append Timestamp	When enabled, a timestamp is added to the end of the specified <b>File Name</b> .
Log as a Background Task	When enabled, allows the image logging process to be performed as a background task to allow the inspection to continue while images are being logged to the specified FTP server.
File Format	<ul> <li>File format to save the image as. Vision Builder AI allows you to save images using the following formats:</li> <li>BMP—Windows Bitmap.</li> </ul>
	TIFF—Tagged Image File Format.
	<ul> <li>JPEG—File Interchange Format.</li> <li>JPEG2000—File Interchange Format. This format is not available for NI Smart Cameras.</li> </ul>
	• <b>PNG</b> —Portable Network Graphics. Refer to <u>Image Options</u> for a complete list of the options available for each file format.
Merge Overlay	Combines the current overlay(s) and inspection image into one image. If <b>Merge Overlay</b> is not selected, overlay information is not preserved. If <b>Merge Overlay</b> is selected, the image is saved as a color image.
Compress BMP File	Specifies whether or not to use compression when a BMP image is saved.
Use Lossless Compression	Specifies whether or not to use lossless compression when the image is saved. <b>Lossless</b> is only available for images saved as JPEG2000 files.
Image Quality	Specifies the quality of the saved image. Valid values range from 0 to 1000. <b>Image Quality</b> is only available for images saved as JPEG or PNG files.
Compression Ratio	Specifies the amount of compression to use when the image is saved. Valid values range from 0 to 1000. <b>Compression Ratio</b> is only available for images saved

	as JPEG2000 files.
Log Image	Specifies the images to log. The following options are available:
	<ul> <li>Log Image—The selected image in the Image Logging Table is saved when this step executes regardless of the current state of the inspection.</li> </ul>
	• Log Image Only when Inspection Status Fails —The selected image in the Image Logging Table is saved when this step executes and the current state of the inspection is FAIL. Use the <u>Set Inspection Status</u> step to update the inspection status during an inspection.
Limit Number of Logged Images	When enabled, restricts the total number of images logged by the currently selected step. The specified limit only applies to the current instance of the <b>Image</b> <b>Logging</b> step.
Max Number of Logged Images	Specifies the maximum number of images that will be logged from the selected step.



### Image Logging FAQs

#### Q: Why does the Image Logging step log the wrong image?

If you set the Image Logging step to Log Images Only When Inspection Status Fails, the Image Logging step must be placed after a Set Inspection Status step in the inspection. Otherwise, the value of the Inspection Status will not be set for the current image when the Image Logging step executes and the image may not be logged.

## Q: What are the disadvantages of using lossless compression for image files?

Lossless compression allows for smaller image file sizes, but takes longer to save the image because of complex calculations that take time to process. If the amount of time it takes to save the image is important for your application, disable lossless compression.

## Q: Why are the Limit Number of Logged Images and Max Number of Logged Images controls not available?

The controls are grayed out when the value specified for the **File Name** is a constant and the **Append Timestamp** control is not enabled. In this case, since the name of the logged image file will be the same for each logged image, it is not possible to log more than one image because each new image overwrites the existing image file. To log more than one image, either enable the **Append Timestamp** control or set the **File Name** to use a dynamic result from a previous step in the inspection.

## Q: What are the advantages/disadvantages of background FTP data logging?

When information is logged in the background, the logging step has a shorter execution time because the step sends the information to a background task and allows the inspection to continue executing without having to wait for the FTP write operation to complete. A possible disadvantage to background logging is that you can lose information if the background logging task is unable to keep up with the inspection.



#### How to Update a Custom Inspection Interface

Complete the following steps to configure the **Update Inspection UI** step:

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. If the selected custom Inspection Interface VI contains executable code, enable the **Run the VI After Updating Indicators** control to run the code when the step executes.
- 3. Select the Inspection Interface indicator you want to update from the Inspection Interface Indicators table.
- 4. Select the **Operation** you want to use to update the indicator.
- 5. Repeat steps 2 and 3 for each additional indicator you want to update.
- 6. Click **OK** to add the step to the inspection.



### **Update Inspection UI Controls**

<b>Control Name</b>	Description
Step Name	Name to give the step.
Run the VI After Updating Indicators	When enabled, the selected custom Inspection Interface VI runs when the <b>Update Inspection Interface UI</b> step executes. The <b>Run the VI After Updating Indicators</b> control is only available if the selected custom Inspection Interface VI contains code on the block diagram.
Inspection Interface Indicators	<ul> <li>Displays information about the indicators on the Inspection Interface. The following information is shown for each indicator:</li> <li>Label—Name of the indicator.</li> <li>Value—Displays the value that is used to update the indicator.</li> </ul>
Operation	<ul> <li>Specifies how the currently selected indicator is updated. The following options are available:</li> <li>Do not Change Current Value—Does not change the indicator value when the step executes.</li> <li>Set to Constant—Sets the indicator value to the specified constant value.</li> <li>Set to Measurement—Sets the indicator value to the value of the selected measurement or variable.</li> </ul>
Configure Inspection Interface	Launches the Configure Inspection Interface dialog box, which is used to select the Inspection Interface to use for the inspection.
Show Inspection Interface	Displays the currently selected Inspection Interface.

The following controls are located on the property page for the step.



### **Update Inspection UI FAQs**

#### Q: Why do controls on the custom Inspection Interface not appear in the Inspection Interface Indicators table?

The Inspection Interface Indicators table only contains indicators because the **Update Inspection UI** step is used to update the indicator values displayed on the selected custom Inspection Interface. Numeric, string, and boolean controls on a custom Inspection Interface can be accessed by any step that supports variables or previous measurement results.

#### Q: Why are some of the indicators on the custom Inspection Interface not listed in the Inspection Interface table?

The Inspection Interface table only displays indicators that can be updated by the **Update Inspection UI** step. Currently, Vision Builder AI supports numeric, string, boolean, and image display datatypes.

## Q: How do I deploy an inspection using a custom Inspection Interface?

Once you select an Inspection Interface template or VI as the Inspection Interface for an inspection, the template or VI becomes part of the inspection file. If you make any changes to the selected interface, you must re-add the file to the inspection for the changes to take affect.

## Q: Why does the custom Inspection Interface behave differently on the development computer than it does on the remote target?

When you are connected to a remote target, Vision Builder AI uses a local copy of the custom Inspection Interface VI on the remote target. This VI is not run, so any attributes that change when the VI executes or any control values that change programmatically, will not be reflected in the interface shown on the development computer. Connect to the remote target using a <u>Web server</u> to fully view the inspection behavior on the remote target.



#### How to Create a User Input Dialog Box

Use the **User Input** step to create a dialog box to interact with Vision Builder AI and provide feedback that can be used in an inspection.

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. In the **Window Title** control, enter a descriptive name for the title of the dialog box.
- 3. In the **Message to Display** control, enter a message to display in the dialog box.
- 4. Click **Add** to add a control to the dialog box.
- 5. Enter a descriptive name for the control.
- 6. Select the **Input Data Type** for the control.
- 7. Repeat steps 4-6 until you have created all the necessary controls for the user input dialog box.
  - **Tip** Use the **Move Up**, **Move Down**, and **Delete** buttons to reorder or delete controls on the user input dialog box.
- 8. In the **First Button Name** control, enter a descriptive label for the first button.
- 9. Select a keystroke that, when pressed, performs the same action as clicking the *First Button Name* button from the **Keyboard Shortcut** listbox.
- 10. Enable the **Display Second Button** checkbox if you want to add a second button to the user input dialog box.
  - a. In the **Second Button Name** control, enter a descriptive label for the second button.
  - b. Select a keystroke that, when pressed, performs the same action as clicking the *Second Button Name* button from the **Keyboard Shortcut** listbox.
- 11. Click **Preview** to view the dialog box that will appear when the step executes.



### **User Input Controls**

The following controls are available on the property page of the step.

<b>Control Name</b>	Description
Step Name	Name to give the step.
Preview	Displays the dialog box that the user will see when the step executes.

#### Window Text

Control Name	Description
Window Title	Title of the dialog box.
Message to Display	Text displayed inside the dialog box.

#### Inputs

<b>Control Name</b>	Description
Input Name	Name of the control. Each control name must be unique and cannot be left blank. The control name is used as the label for the control that appears on the user input dialog box.
Input Data Type	Data type of the control. The following options are available: • Number • Checkbox • Text Box
Add	Adds a new control to the dialog box.
Move Up	Moves the currently selected control up in the <b>Inputs</b> table.
Move Down	Moves the currently selected control down in the <b>Inputs</b> table.
Delete	Removes the currently selected control from the <b>Inputs</b> table.

#### **Buttons to Display**

Control Name	Description

First Button Name	Label of the first button displayed in the dialog box.
Keyboard Shortcut	The keystroke that, when pressed, performs the same action as clicking the button.
Display Second Button	Specifies whether or not to display a second button on the dialog box.
Second Button Name	Label of the second button displayed in the dialog box.



### **User Input FAQs**

## Q: How can I use the values that a user inputs within Vision Builder AI?

The **User Input** step produces measurement results that correspond to the values of the controls on the user input dialog box. These results can be used to trigger a transition to another inspection state, or by other steps that can use previous measurement results.



# How to Automatically Select which Inspection to Run

Use the **Select Inspection** step to map Vision Builder AI inspections to numeric or string values. This allows you to configure Vision Builder AI to automatically choose which inspection to run based on the value of a numeric or string result from an I/O, **Run LabVIEW VI**, or **User Input** step.

The Select Inspection state applies to the system on which Vision Builder AI is installed, not to individual inspections.



**Note** The **Select Inspection** step is only available in the Select Inspection state. Select **View»View Complete Inspection Setup** and click **Select Inspection** to access the Select Inspection state.



**Note** The **Select Inspection** step *must* be the last step in the Select Inspection state.

- 1. In the **Select Inspection Source** control, select the source you want to use to select the inspection to run.
- 2. Click **Add** to add a value to the Inspections table.
- 3. Use the **Value** control to specify a value from the specified **Select Inspection Source** to use to select a new inspection.
- 4. In the **Inspection** control, browse to the inspection you want to correspond to the specified **Value**, and click **Select**.
- 5. If necessary, repeat steps 2–4 to add additional values to the Inspections table.
- 6. Select the **Enable Inspection Selection** checkbox to use Inspection Selection the next time an inspection is run in the Inspection Interface.
- 7. Click **OK** to add the step to the Select Inspection state.



### **Select Inspection Controls**

The following controls are available on the property page of the step.

<b>Control Name</b>	Description
Select Inspection Source	Specifies the source of the values used for Inspection Selection.
Inspections	<ul> <li>Lists the values from the specified Select Inspection</li> <li>Source that are configured for Inspection Selection and the inspections that correspond to each value. The following information is available for each configured value:</li> <li>Use—Specifies the values you want to use for inspection selection.</li> <li>Value—Displays the value that triggers Vision Builder AI to switch the active inspection.</li> <li>Inspection—Displays the name of the inspection to run for the specified Value.</li> </ul>
Value	Specifies the value that triggers Vision Builder AI to switch the active inspection.
Inspection	File path of the inspection to run for the specified Value.
Add	Adds a new value to the Inspections table.
Delete	Removes the currently selected value from the Inspections table.
Sort	Sorts the values in the Inspections table.
Enable Inspection Selection	Enables Inspection Selection when an inspection is run in the Inspection Interface.



## **Select Inspection FAQs**

Currently, there are no FAQs associated with this step.

## **Simulating Remote Targets**

Simulating remote targets allows you to develop and edit Vision Builder Al inspections for a remote target using a desktop computer. In addition to the standard Vision Builder Al inspection steps, the following targetspecific steps are available in simulation mode:

- Acquire Image (IEEE 1394)
- Acquire Image (Smart Camera)
- Read/Write I/O
- Generate Pulse
- Read/Write I/O (NI-IMAQ I/O)
- Generate Pulse (NI-IMAQ I/O)

To use Vision Builder AI with a simulated remote target, complete the following steps:

- 1. On the Vision Builder AI Welcome screen, expand the **Execution Target** listbox, and select one of the **Emulator** options.
- 2. Click Configure Inspection.
- 3. Add and configure steps from the Inspection Steps palette to create your application.

#### **Editing an Existing Inspection**

When you open an existing inspection that has been configured for a remote target, simulation mode allows you to view and modify the inspection settings. When the inspection is redeployed to a remote target, the inspection uses the modified settings.

#### **Creating a New Inspection**

When you create a new inspection for a remote target, simulation mode allows you to specify values for controls that can be set without connecting to a remote target. For example, while simulating an NI CVS-1450 Series Compact Vision System, the **Acquire Image (IEEE 1394)** step allows you to specify a **Step Name** and **Acquisition Mode**, but the step does not allow you to specify camera attribute values because Vision Builder AI does not know which camera is connected to the NI CVS-1450 device where the inspection will run.

When you deploy a new inspection for the first time, the inspection appears broken and Vision Builder AI prompts you to configure any hardware specific settings that were unavailable in simulation mode.

### How to Configure NI Vision Builder AI Remote Targets

NI Vision Builder AI remote targets are field programmable devices that you add to a subnet and run remotely. You configure a remote target from a host machine on the same subnet, defining settings such as the target name and description, network settings, and software revisions. Complete the steps in the following sections to configure a Vision Builder AI remote target.

- 1. Click Start»All Programs»National Instruments»Vision Builder Al.
- 2. In Execution Target control, select Select Network Target.
- 3. In the Select Remote Target dialog box, select the remote target with a MAC address that corresponds to the MAC address on the label of the remote target you want to configure.
  - **Tip** If the remote target you want to configure is on a different subnet than the development computer, it may not appear in the list of available targets. Click **Add Target**, enter the IP address of the remote target you want to configure, and click **OK** to add the target to the table.
- 4. Click **Configure**. If the remote target is password-protected, Vision Builder AI prompts you to enter the password.
- 5. Enter a **Name** and **Description** for the remote target, and click **Next**.

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

6. Select an IP address.

If your remote target is on a network that has a DHCP server, you may be able to automatically obtain an IP address from the DHCP server. A DHCP server allocates an IP address to the remote target each time the target is restarted. If you select the DHCP Server option, you do not need to specify other information, such as the **Subnet Mask**. If you do not know if the network has a DHCP server, check with a network administrator for assistance.

To automatically obtain an IP address, select **Obtain IP address** from DHCP Server.

To assign a static IP address to the remote target, select **Edit the IP Settings** and enter the following information:

- IP Address
- Subnet Mask
- Gateway
- DNS Server
  - Note Consult a network administrator before modifying these parameters.

If you want to set the IP address without a DHCP server but are uncertain about what to set, click **Suggest Values**. Vision Builder AI attempts to detect the appropriate settings. Click **Reset to Default** to revert to the original settings.

- 7. If you want to prevent other users from configuring the remote target, select **Enable Password** and click **Set Password** to set up password protection for the execution target.
- 8. Click Next.
- 9. Update the software on the remote target.
  - a. Enable the **Update Target Software** checkbox.
  - b. Click the Browse button next to the Software Image to Install on the Target control. The Open dialog box opens.
  - c. Navigate to the Vision Builder AI software image you want to use, and click **OK**.
  - d. Optional, enable the **Format Target Before Installing Software** control to remove any existing software, inspections, images, and log files currently on the remote target before installing the new software.



Caution Formatting removes all data stored on the remote target. Backup any important data from the remote target before enabling the Format Target Before Installing Software control.



**Note** If the remote target supports the Reliance

file system, Vision Builder AI uses Reliance to format the target. Otherwise, the target is formatted using the FAT file system.

10. Click **OK** to install the software on the remote target.

#### **Review Execution Target Information**

To review the properties of an execution target to ensure that it is the remote target you want to connect to and/or to determine if it is configured correctly, click **Properties** and review the identification information, network settings, and installed software for the remote target.
#### **Backup Execution Target Information**

Vision Builder AI allows you to create a target image of a remote target. target images contain all of the current configuration settings for a remote target and all of the inspections currently installed to the remote target. Target images are useful to backup configuration settings or to deploy the same configuration settings to multiple remote targets. Complete one of the following sets of steps to create an image of a remote target:

- If you are currently connected to a remote target—Select Target»Create Target Image to launch the Create Target Image dialog box. Enter information about the inspection and the location where you want to save the image, and click OK.
- If you are not currently connected to a remote target—On the Vision Builder AI Welcome screen, select Select Network Target from the Execution Target listbox. In the Select Remote Target dialog box, right-click the target for which you want to create an image. Enter information about the inspection and the location where you want to save the image, and click OK.

## **Vision Builder AI Remote Target Options**

You can set global Vision Builder AI options to customize how remote targets handle inspections. To set these options, select **Target»TargetOptions**.



**Note** The **Target** menu is only available when Vision Builder AI is connected to a remote target.

#### Startup

The following controls are available for the Startup category.

Control Name	Description
Start Inspection When Launched	When enabled, the specified inspection begins running automatically when the remote target restarts. Select an item from the <b>Inspection</b> list to specify the inspection to run automatically.
Inspection	Inspection you want the run when a remote target restarts. This option is available only when <b>Start Inspection When Launched</b> is enabled
Run Setup and Cleanup States when	Specifies when you want Vision Builder AI to run the Inspection Setup and Inspection Cleanup states. The following options are available:
	• <b>Open/Close Inspection</b> (default)—Runs the Inspection Setup state only when an inspection opens and runs the Inspection Cleanup state when an inspection closes.
	• <b>Start/Stop Inspection</b> —Runs the Inspection Setup state when an inspection starts running and runs the Inspection Cleanup state when an inspection stops running.
Initialize all inspection steps when the target starts	When enabled, Vision Builder AI loads all the inspection steps into memory when the remote target starts. Otherwise, inspection steps are loaded on first use.

#### Video Mode

The Video Mode category applies only to NI CVS-1450 devices. The following controls are available for the Video Mode category.

<b>Control Name</b>	Description
Screen Resolution	Resolution for the display connected to the remote target. Refer to the display documentation for information about the maximum supported screen resolution.
Color Quality	Number of bits used to represent a screen pixel.
Screen Refresh Rate	Refresh frequency you want to use on the display connected to the remote target. Refer to the display documentation for information about maximum refresh rate frequencies.
Test	Tests the specified video settings using the connected display.

#### Image Display

The following controls are available for the Image Display category.

<b>Control Name</b>	Description
Image Display Palette	<ul> <li>Changes the display palette used to display the images.</li> <li>The following options are available: <ul> <li>Gray Levels—Gradual gradation from black to white.</li> </ul> </li> <li>Binary—16 cycles of 16 different colors. The binary palette is designed especially for binary images.</li> <li>Gradient—Gradation from red to white with a prominent range of light blue in the upper value range. 0 is black and 255 is white.</li> <li>Rainbow—Gradation from blue to red with a prominent range of greens in the middle value range. 0 is blue and 255 is red.</li> <li>Temperature—Gradation from light brown to dark brown. 0 is black and 255 is white.</li> <li>Extended Rainbow—Complete rainbow gradation from black to violet, blue, green, red, and white. 0 is black and 255 is white.</li> <li>Iron—Display palette traditionally used for thermal imaging. The color gradation matches the changing hues of iron when heated: black to purple, red, orange, yellow, and white. 0 is black and 255 is white.</li> </ul>
Mapping Method	<ul> <li>Enables the mapping technique used when displaying a 16-bit grayscale image. The following options are available:</li> <li>Full Dynamic—Full dynamic range of the 16-bit image is mapped to an 8-bit (256 grayscale values) scale. 16-bit images are displayed by scaling the data to 8 bits, calculated as a function of the dynamic range from the image source. The minimum value (min) and the</li> </ul>

	<ul> <li>maximum value (max) are calculated automatically. Then the following formula is applied to each pixel: Display(x, y) = (Src(x, y) - min) × 255/(max - min)</li> <li>Downshift—16-bit image pixels are shifted to the right the number of times specified by the # Shifts cluster member.</li> <li>Given Range—Pixel values in the range specified by Minimum Value and Maximum Value are mapped to an 8-bit scale.</li> <li>90% Dynamic—Dynamic range containing the middle 90% of the cumulated histogram of the image is mapped to an 8-bit (256 grayscale values) scale.</li> <li>Given Percent Range—Pixel values in the relative percentage range (0 to 100) of the cumulated histogram specified by Minimum Value and Maximum Value are mapped to an 8- bit scale.</li> </ul>
Minimum Value	Minimum value used for Given Range and Given Percent Range. When Mapping Method is set to Given Range, Minimum Value represents the value that is mapped to 0. When Mapping Method is set to Given Percent Range, Minimum Value represents the percentage of the range used to compute the pixel value mapped to 0.
Maximum Value	Maximum value used for <b>Given Range</b> and <b>Given</b> <b>Percent Range</b> . When <b>Mapping Method</b> is set to <b>Given</b> <b>Range</b> , <b>Maximum Value</b> represents the value that is mapped to 255. When <b>Mapping Method</b> is set to <b>Given</b> <b>Percent Range</b> , <b>Maximum Value</b> represents the percentage of the range used to compute the pixel value mapped to 255.
# Shifts	Number of bits to right-shift the pixel values for the <b>Downshift</b> conversion method.

#### Shutdown States

The Shutdown States category applies only to NI CVS-1450 devices. The following controls are available for the Shutdown States category.

<b>Control Name</b>	Description
Enable Shutdown	Enables the remote target to handle fault conditions and detect user shutdown. When enabled, this control allows you to specify shutdown states for the digital I/O lines on the NI CVS-1450 device. The following options are available for each I/O line:
	Caution When Enable Shutdown is selected and the shutdown input signal, ISO Input 11, turns off, NI CVS-1450 devices register an external shutdown condition. When this fault occurs, the <b>POWER OK</b> LED turns red and all device operations halt. To resume operation, you must reset the device.
	Note Make sure the shutdown input signal, ISO Input 11, is turned on before enabling the shutdown on an NI CVS-1450 device.
	TTL Output Lines
	<ul> <li>Drive Low</li> <li>Drive High</li> <li>Tri-State (default)</li> </ul>
	ISO Output Lines
	Drive Low (default)
	Drive High

#### **Serial Port**

The following controls are available for the Serial Port category.

<b>Control Name</b>	Description
Baud Rate	Rate of transmission. The default value is 9600.
Data Bits	Number of bits in the incoming data. The value of <b>data bits</b> is between five and eight. The default value is 8.
Parity	Specifies the parity used for every frame to be transmitted or received.
Stop Bits	Specifies the number of stop bits used to indicate the end of a frame.
Flow Control	Sets the type of control used by the transfer mechanism.
Termination Character	Calls for termination of the read operation. The read operation terminates when the <b>termination char</b> is read from the serial device. 0xA is the hex equivalent of a linefeed character (\n). Change the <b>termination char</b> to 0xD for message strings that terminate with a carriage return (\r).
Enable Termination Char	Prepares the serial device to recognize <b>Termination</b> <b>Char</b> . If True (default), the VI_ATTR_ASRL_END_IN attribute is set to recognize the termination character. If False, the VI_ATTR_ASRL_END_IN attribute is set to 0 (None) and the serial device does not recognize the <b>Termination Char</b> .
Timeout	Sets the timeout value for the write and read operations.

#### **Time Server**

The Time Server category applies only to NI Smart Cameras. The following controls are available for the Time Server category.

<b>Control Name</b>	Description
Synchronize to SNTP Server	Enable this control to synchronize the NI Smart Camera internal clock to a Standard Network Time Protocol (SNTP) server.
IP Address	Specifies the IP address of the SNTP server.
Time Zone	Specifies the time zone for the date and time.

#### Date & Time

The Date & Time category applies only to NI CVS-1450 devices. The following controls are available for the Date & Time category.

<b>Control Name</b>	Description
New Date and Time	<ul> <li>Specifies the new date and time. Click Set Date Time to apply the new settings.</li> <li>Note After updating the Date &amp; Time settings, you must restart the remote target to begin using the new settings.</li> </ul>
Time Zone	Specifies the time zone for the date and time.

#### Web Server

The Web Server is used to display a custom Inspection Interface. The following controls are available for the Web Server category.

<b>Control Name</b>	Description
Enable Web Server	Specifies whether you want to provide access to an inspection using a custom Inspection Interface through a Web Server.
Browser Access List	Lists browser addresses that have access to the Web Server. Two green checkmarks appear to the left of the item when you allow viewing and controlling of the front panel, a single green checkmark appears when you allow only viewing of the front panel, and a red X appears when you deny access. If an entry does not have a green checkmark or a red X by its name, the syntax for the entry is incorrect.
Browser Address	Enter a browser address to list in the <b>Browser Access</b> <b>List</b> . You can use <u>wildcards</u> in the browser address you enter.
Allow Viewing and Controlling	Allows the browser address selected in the <b>Browser</b> <b>Access List</b> access to the Web Server for viewing and controlling an inspection remotely.
Allow Viewing	Allows the browser address selected in the <b>Browser</b> <b>Access List</b> access to the Web Server for viewing inspections. This option is selected by default.
Deny Access	Denies the browser address selected in the <b>Browser</b> <b>Access List</b> access to the Web Server.
Add	Adds a new browser address to the <b>Browser Access</b> <b>List</b> . The new address appears below the selected address in the <b>Browser Access List</b> .
Remove	Removes the selected browser address from the <b>Browser Access List</b> .

#### Secondary Ethernet

The Secondary Ethernet category applies only to NI Smart Cameras. The following controls are available for the Secondary Ethernet category.

<b>Control Name</b>	Description
Secondary Ethernet Port	Specifies the behavior and IP address for the secondary Ethernet port. The following options are available:
Settings	<ul> <li>Disabled—When enabled, the secondary Ethernet port on the remote target is disabled.</li> </ul>
	<ul> <li>Use Static IP Address—When enabled, Vision Builder AI assigns the specified IP address to the remote target. Use the following controls to specify the IP address:</li> </ul>
	<ul> <li>IP Address—Specifies the IP address for the secondary Ethernet port.</li> </ul>
	<ul> <li>Subnet Mask—Specifies the subnet mask for the secondary Ethernet port.</li> </ul>
	• Use Link-Local IP Address—When enabled, Vision Builder AI uses the specified IP Address to assign an IP address in the link-local range to the remote target. Use the following control to specify the IP address:
	<ul> <li>IP Address—Specifies the link-local IP address for the secondary Ethernet port.</li> </ul>

# Managing Inspections Between the Host and Remote Target

Complete the following steps to copy inspections between host and remote targets:

- 1. Click **Target**»Add/Retrieve Inspections to launch the Inspection Manager dialog box.
  - Note This menu item is available only when you are connected to a remote target.

The Inspection Manager dialog box contains a list of inspections on the host computer, a list of inspections on the remote target, and details about the selected inspection.

- 2. Select the inspection you want to copy or delete in the **This Computer** list or the **Remote Device** list.
- 3. Click Copy or Delete.
- 4. Click **Done** to close the Inspection Manager dialog box.

## **Communication Device Manager**

Use the Communication Device Manager to define Modbus and/or Ethernet devices. Select **Tools**»**Communication Device Manager** to launch the Communication Device Manager.

#### How to Use

- 1. Click **New Device** to open the **New Communication Device** dialog box.
- 2. Set the parameters in the **New Communication Device** dialog box. Refer to <u>New Communication Device</u> for instructions about setting these parameters.
- 3. Click **OK** to close the **New Communication Device** dialog box.
- 4. If you want to communicate with a Modbus master device, set the Vision Builder AI Modbus Slave Address for the machine.
- 5. If the status of the server you want to run is stopped, click **Start Server** to start running the corresponding server on the machine.
- 6. Click **OK**.

#### **Control Descriptions**

The following controls are available on the Communication Device Manager dialog box.

<b>Control Name</b>	Description
Devices	Displays information about currently configured communication devices. The following information is displayed for each device:
	<ul> <li>Name—Name of the communication device connected to your system.</li> </ul>
	<ul> <li>Protocol—Physical layer used by the device to communicate. Vision Builder AI supports Modbus serial, Modbus TCP, and TCP/IP protocols.</li> </ul>
	<ul> <li>Parameters—COM port used for communication with a serial device, or IP address and TCP/IP listening port for an TCP/IP device.</li> </ul>
	<ul> <li>Type—Whether the device you are defining is a master or slave. Currently, Vision Builder Al supports only Modbus master devices and both master and slave TCP/IP devices.</li> </ul>
New Device	Launches a dialog box in which you set the parameters for a new communication device.
Edit	Launches a dialog box in which you can edit parameters of the selected communication device.
Delete	Deletes the selected communication device.
Start/Stop Server	Starts and stops the Modbus or TCP server.
Vision Builder Al Modbus Slave Address	The slave ID when you use Vision Builder AI as a Modbus slave device.

## Variable Manager

Use the Variable Manager to create and manage Vision Builder Al variables. There are three types of variables in Vision Builder AI: Inspection, system, and network variables.

The main difference between the variable types is the scope of the variable. Inspection variables are limited to the inspection for which they are created. System variables are limited to the device on which an inspection is deployed. Multiple inspections may access the same system variable as long as the inspections are deployed on the same device. Network variables can be accessed by any device on the network that supports LabVIEW variables.

Use the <u>Set Variable</u> step to update the value of any variable except builtin system variables. Use the <u>Set Inspection Status</u> step to update the Inspection Status system variable.

Creating a New Variable

Editing an Existing Variable

#### Creating a New Variable

Complete one of the following sets of steps to create a new variable:

- Inspection Variable
  - 1. Click the Inspection Variables tab.
  - 2. Click **Add** to launch the Add Inspection Variable dialog box.
  - 3. Enter a descriptive **Name** for the variable.
  - 4. Specify a **Type** for the variable.
    - Note Numeric variables are defined as doubleprecision floating point numbers. Point variables consist of two numeric values, one for the xcoordinate value and one for the y-coordinate value.
  - 5. Specify an **Initial Value** for the variable.
  - 6. Click **OK** to close the dialog box and create the variable.

#### • System Variable

- 1. Click the System Variables tab.
- 2. Click **Add** to launch the Add System Variable dialog box.
- 3. Enter a descriptive **Name** for the variable.
- 4. Specify a **Type** for the variable.
  - Note Numeric variables are defined as doubleprecision floating point numbers. Point variables consist of two numeric values, one for the xcoordinate value and one for the y-coordinate value.
- 5. Specify an Initial Value for the variable.
- Enable the Publish on Network control if you want to access the variable from another device on the same network. Use the Use Buffering and Buffer Size controls to specify the buffer settings for system variables published on a network.
- 7. Click **OK** to close the dialog box and create the variable.
- Network Variable
  - 1. Click the **Network Variables** tab.

- 2. Click Add to launch the Add Network Variable dialog box.
- 3. Enter a descriptive **Name** for the variable.
- 4. Click the Select Source Item button and select the source to use for the value of the network variable.
- 5. Specify a **Type** for the variable.
  - Note Numeric variables are defined as doubleprecision floating point numbers. Point variables consist of two numeric values, one for the xcoordinate value and one for the y-coordinate value.
- 6. Specify the **Access Type** for the variable.
- 7. If necessary, enable the **Use Buffering** control to buffer the value of the variable.
- 8. Specify the **Timeout** to use when communicating with the variable.
- 9. Click **OK** to close the dialog box and create the variable.

#### **Editing an Existing Variable**

- 1. Select the variable you want to edit from the Variable Manager.
- 2. Click **Edit** to launch the edit variable dialog box.
- 3. Modify the variable control settings.
- 4. Click **OK** to close the dialog box and update the variable settings.

## **Configure Inspection Interface**

Use the Configure Inspection Interface dialog box to configure the Inspection Interface to use when the inspection is run in <u>Inspection</u> mode.

Complete the following steps to configure the Inspection Interface.

#### **Inspection Interface Tab**

- 1. Select the Inspection Interface to use for the inspection. A preview of the selected Inspection Interface is displayed in the **Preview** window. The following options are available:
  - Use Built-in Inspection Interface—Uses the built-in Inspection Interface.
  - Create New Custom Inspection Interface—Allows you to select either an existing Inspection Interface template, or a LabVIEW VI.
  - Use Current Custom Inspection Interface—Uses the currently configured custom Inspection Interface.

#### Interface Initial Values Tab

- 2. In the **Initial Values** table, select a control or indicator.
- 3. In the **Value** control, specify the initial value for the selected control or indicator.
- 4. repeat steps 2 and 3 for the remaining controls or indicators.
- 5. Click **OK** to close the dialog box and apply the Inspection Interface settings

#### **Additional Considerations**

When specifying a LabVIEW VI as the Inspection Interface, the VI must be saved in LabVIEW 8.5 and not broken or currently running. The VI must also not have any dependencies, such as sub VIs or DLL calls, or be located inside an LLB. The VI may use LabVIEW primitives, such as For loops, string operations, arithmetic operations, and array operations.

You can specify the initial value for any string, numeric, or boolean controls on the **Interface Initial Values** tab. Strip charts may also be used, however, you cannot specify the initial value for a strip chart. Use the **Update Inspection UI** step in your inspection to update the values of indicators on the custom Inspection Interface. Controls on the custom Inspection Interface can be accessed by any inspection steps that support previous measurements or variables.

## I/O Test Panel

Use the I/O Test Panel to read the current values of all I/O lines, quadrature encoders, and LEDs on NI frame grabbers or Smart Cameras. You can chart the values of the I/O signals by double-clicking on the signals of interest and clicking **Start** on the Monitor tab.

#### FAQs

#### Q: Why is my digital line not responding in the I/O Test Panel?

The digital line could not be responding if one of the following conditions is present:

- The output line is currently being used for pulse generation and the pulse is too fast to display the changing state.
- The output value for the digital output line is being overwritten by another step in the inspection. Verify that the digital output line is not being used by any other **Read/Write I/O** or **Generate Pulse** step in the inspection.

## Q: Why does the quadrature encoder value for my NI PCI-1426 not appear in the test panel?

The value of the quadrature encoder for the NI PCI-1426 cannot be read.

### **NI-IMAQ I/O Test Panel**

Use the NI-IMAQ I/O Test Panel to monitor the current values of all NI-IMAQ I/O lines, the isolated port, quadrature encoder, and isolated power status. The digital outputs on your NI-IMAQ I/O device can also be controlled using the NI-IMAQ I/O Test Panel. You can chart the values of the NI-IMAQ I/O signals by double-clicking on the signals of interest and clicking **Start** on the Monitor tab.

#### FAQs

## Q: Why is my digital output line not responding when I change the value of the line using the NI-IMAQ I/O Test Panel?

The digital output line could not be responding if one of the following conditions is present:

- The output line is not enabled. Launch the NI-IMAQ I/O Test Panel (Tools»NI-IMAQ I/O Test Panel and Monitor) to verify that the output line is enabled.
- The output line is currently being used for pulse generation. Verify that the digital output line is not also being used by an Generate Pulse (NI-IMAQ I/O) step in the inspection.
- The output value for the digital output line is being overwritten by another step in the inspection. Verify that the digital output line is not being used by any other Read/Write I/O (NI-IMAQ I/O) or Generate Pulse (NI-IMAQ I/O) step in the inspection.

### **NI-DAQmx Test Panel**

The NI-DAQmx Test Panel allows you to monitor the current values of all NI-DAQmx digital I/O lines, ports, and analog input lines. The digital and analog outputs can also be controlled using the NI-DAQmx Test Panel. You can chart the values of your NI-DAQmx signals by double-clicking on the signals of interest and clicking **Start** on the Monitor tab.

#### FAQs

#### Q: Why are the digital inputs and outputs toggling when they are not set to toggle, or why do the digital output always revert to the previous value when I write a value to the output?

This behavior can occur when multiple NI-DAQmx Global Virtual Channels are defined on the same line or port with different directions. It is recommended to only have one NI-DAQmx Global Virtual Channel defined for each digital resource.

## **Modbus Local Registers Terminal**

Use this dialog box to read the values stored in the Vision Builder AI local Modbus register.

#### How to Use

- 1. In the **Modbus Slave** property page, click **View Local Registers** to launch the **Modbus Local Registers Terminal**.
  - Note You can also launch the registers terminal by selecting Tools»Modbus Local Registers Terminal.
  - **Tip** You can resize the registers terminal and the widths of the table columns if you cannot see all of the information in the table.
- 2. In the **Modbus Local Registers Terminal**, select the <u>register</u> table you want to display from the **View** menu.
- 3. Select **File**»Close to close the register terminal.

## **Viewing Inspection Results**

Select **Tools**»**View Measurements** to view a list of all the measurements logged for each step in the inspection. Use the controls at bottom of the Results table to filter the displayed results.

To view only specific inspection results complete the following steps:

- 1. In the Inspection Measurements dialog box, click the **Monitor Selected Results** tab.
- 2. Click **Select** to launch the Select Results to Monitor dialog box.
- 3. In the Select Results to Monitor dialog box, select the measurements you want to view.
- 4. Click **OK** to close the Select Results to Monitor dialog box.

The measurements you selected should now appear in the Inspection Measurements dialog box.

## Migrating an Inspection to LabVIEW

You can migrate an inspection to the LabVIEW programming environment, creating a LabVIEW application that performs the same inspection task as the you configured in Vision Builder AI.



**Note** You must have launched LabVIEW at least once on your computer before migrating an inspection properly.



**Note** You must have LabVIEW 8.5 or later and the NI Vision Development Module 8.6.1 or later installed on your computer to migrate an inspection to LabVIEW.

- 1. Select **Tools**»**Migrate Inspection to LabVIEW** to migrate the current inspection diagram to a LabVIEW VI. Vision Builder AI opens the **LabVIEW VI Creation** dialog box.
- 2. Select the versions of LabVIEW and NI Vision you want to use to create the VI.
- 3. Select a folder where you want to save the VI.
- 4. Click **OK** to migrate the inspection to LabVIEW.
- Note Template images, OCR character set files, and classification files are maintained independently from the rest of an inspection. If your inspection contains inspection steps that use additional files, such as the Match Pattern, Geometric Matching, or Detect Defects steps, you must copy the generated Template Files folder to each computer or remote target where you want to run the inspection. Otherwise, the template images necessary for the inspection will be missing.

#### **Step Requirements**

Some Vision Builder AI steps require that additional software be installed to successfully migrate an inspection to LabVIEW. The following table lists the requirements for steps that require additional software.



**Note** NI-IMAQ, NI-IMAQdx, and NI-IMAQ I/O are available on the NI Vision Acquisition Software CD include with Vision Builder AI.

Step Name	Requirement
Acquire Image	NI-IMAQ 4.1 or later
Acquire Image (IEEE 1394)	NI-IMAQ for IEEE 1394 Cameras 2.0 or later; or NI- IMAQdx 3.0 or later with Legacy NI-IMAQ IEEE 1394 support enabled
Acquire Image (IEEE 1394 or GigE)	NI-IMAQdx 3.2 or later
Acquire Image (Smart Camera)	NI-IMAQ 4.1 or later
Read/Write I/O	NI-IMAQ 4.1 or later
Read/Write I/O (NI-IMAQ I/O)	NI-IMAQ I/O 2.3 or later
Read/Write I/O (NI-DAQmx)	NI-DAQmx 8.0 or later
Generate Pulse	NI-IMAQ 4.1 or later
Generate Pulse (NI-IMAQ I/O)	NI-IMAQ I/O 2.3 or later
Data Logging	LabVIEW Internet Toolkit
Image Logging	LabVIEW Internet Toolkit

## **Vision Builder AI Configuration Options**

Use the Options dialog box to set preferences global to Vision Builder AI. Select **Tools**»**Options** to display the **Options** dialog box.
#### Configuration

The following controls are available for the Configuration category.

<b>Control Name</b>	Description
Inspection Display Mode	<ul> <li>Changes the representation of the inspection diagram, shown at the bottom left corner of the Configuration Interface. The following options are available:</li> <li>Table View—Displays the inspection steps in a tabular format.</li> <li>Diagram View—Displays the inspection steps in a graphical format. This view looks similar to LabVIEW code.</li> </ul>
Password- Protected Access to Configuration Interface	When enabled, Vision Builder AI requires that users enter a password to launch the Configuration Interface from the Welcome dialog box or switch from the Inspection Interface to the Configuration Interface. Use this feature when you deploy your inspection system and need to restrict the access to the Configuration Interface to specific users.

#### Image Display

The following controls are available for the Image Display category.

<b>Control Name</b>	Description
Image Display Palette	<ul> <li>Changes the display palette used to display the images.</li> <li>The following options are available: <ul> <li>Gray Levels—Gradual gradation from black to white.</li> </ul> </li> <li>Binary—16 cycles of 16 different colors. The binary palette is designed especially for binary images.</li> <li>Gradient—Gradation from red to white with a prominent range of light blue in the upper value range. 0 is black and 255 is white.</li> <li>Rainbow—Gradation from blue to red with a prominent range of greens in the middle value range. 0 is blue and 255 is red.</li> <li>Temperature—Gradation from light brown to dark brown. 0 is black and 255 is white.</li> <li>Extended Rainbow—Complete rainbow gradation from black to violet, blue, green, red, and white. 0 is black and 255 is white.</li> <li>Iron—Display palette traditionally used for thermal imaging. The color gradation matches the changing hues of iron when heated: black to purple, red, orange, yellow, and white. 0 is black and 255 is white.</li> </ul>
Mapping Method	<ul> <li>Enables the mapping technique used when displaying a 16-bit grayscale image. The following options are available:</li> <li>Full Dynamic—Full dynamic range of the 16-bit image is mapped to an 8-bit (256 grayscale values) scale. 16-bit images are displayed by scaling the data to 8 bits, calculated as a function of the dynamic range from the image source. The minimum value (min) and the</li> </ul>

	<ul> <li>maximum value (max) are calculated automatically. Then the following formula is applied to each pixel: Display(x, y) = (Src(x, y) - min) × 255/(max - min)</li> <li>Downshift—16-bit image pixels are shifted to the right the number of times specified by the # Shifts cluster member.</li> <li>Given Range—Pixel values in the range specified by Minimum Value and Maximum Value are mapped to an 8-bit scale.</li> <li>90% Dynamic—Dynamic range containing the middle 90% of the cumulated histogram of the image is mapped to an 8-bit (256 grayscale values) scale.</li> <li>Given Percent Range—Pixel values in the relative percentage range (0 to 100) of the cumulated histogram specified by Minimum Value and Maximum Value are mapped to an 8- bit scale.</li> </ul>
Minimum Value	Minimum value used for Given Range and Given Percent Range. When Mapping Method is set to Given Range, Minimum Value represents the value that is mapped to 0. When Mapping Method is set to Given Percent Range, Minimum Value represents the percentage of the range used to compute the pixel value mapped to 0.
Maximum Value	Maximum value used for <b>Given Range</b> and <b>Given</b> <b>Percent Range</b> . When <b>Mapping Method</b> is set to <b>Given</b> <b>Range</b> , <b>Maximum Value</b> represents the value that is mapped to 255. When <b>Mapping Method</b> is set to <b>Given</b> <b>Percent Range</b> , <b>Maximum Value</b> represents the percentage of the range used to compute the pixel value mapped to 255.
# Shifts	Number of bits to right-shift the pixel values for the <b>Downshift</b> conversion method.

#### Startup

The following controls are available for the Startup category.

<b>Control Name</b>	Description
Start Inspection when Launched	When enabled, the specified inspection begins running automatically when you open Vision Builder AI. Select an item from the <b>Inspection</b> list to specify which inspection on your system to run automatically.
Inspection	Inspection you want the run when Vision Builder Al launches. This option is available only when <b>Start Inspection When Launched</b> is enabled.
Run Setup and Cleanup States when	Specifies when you want Vision Builder AI to run the Inspection Setup and Inspection Cleanup states. The following options are available:
	<ul> <li>Open/Close Inspection (default)—Runs the Inspection Setup state only when an inspection opens and runs the Inspection Cleanup state when an inspection closes.</li> <li>Start/Stop Inspection—Runs the Inspection Setup state when an inspection starts running and runs the Inspection Cleanup state when an inspection stops running.</li> </ul>



#### Numbers/Symbols

- 1D One-dimensional.
- 2D Two-dimensional.
- 3D Three-dimensional.

#### Α

acceptance levelValue that indicates how closely an object must match a trained character to be recognized. A high acceptance level value indicates that the object and trained character must be closely matched for the object to be recognized. (OCR)alpha channelChannel used to code extra information, such as Gamma correction, about an image.area thresholdDetects objects based on their size.arithmetic operatorsThe image operations multiply, divide, add, subtract, and remainder.artifactsExtraneous pixels in the region of interest. (OCR)auto-median functionA function that uses dual combinations of opening and closing operations to smooth the boundaries of objects.AutoSplitWorks in conjunction with the maximum character bounding rectangle width, and uses an algorithm to analyze the right side of a character bounding rectangle. AutoSplit then determines the rightmost vertical line in the object that contains the fewest number of pixels and moves the rightmost edge of the character bounding box to that location. (OCR)		
alpha channelChannel used to code extra information, such as Gamma correction, about an image.area thresholdDetects objects based on their size.arithmetic operatorsThe image operations multiply, divide, add, subtract, and remainder.artifactsExtraneous pixels in the region of interest. (OCR)aspect ratio auto-median functionHeight/width ratio of a character. (OCR)AutoSplitWorks in conjunction with the maximum character bounding rectangle width, and uses an algorithm to analyze the right side of a character bounding rectangle. AutoSplit then determines the rightmost vertical line in the object that contains the fewest number of pixels and moves the rightmost edge of the character bounding box to that location. (OCR)	acceptance level	Value that indicates how closely an object must match a trained character to be recognized. A high acceptance level value indicates that the object and trained character must be closely matched for the object to be recognized. (OCR)
<ul> <li>area threshold</li> <li>Detects objects based on their size.</li> <li>The image operations multiply, divide, add, subtract, and remainder.</li> <li>artifacts</li> <li>Extraneous pixels in the region of interest. (OCR)</li> <li>Aspect ratio</li> <li>A function that uses dual combinations of opening and closing operations to smooth the boundaries of objects.</li> <li>AutoSplit</li> <li>Works in conjunction with the maximum character bounding rectangle width, and uses an algorithm to analyze the right side of a character bounding rectangle. AutoSplit then determines the rightmost vertical line in the object that contains the fewest number of pixels and moves the rightmost edge of the character bounding box to that location. (OCR)</li> </ul>	alpha channel	Channel used to code extra information, such as Gamma correction, about an image.
<ul> <li>arithmetic operators</li> <li>artifacts</li> <li>artifacts</li> <li>Extraneous pixels in the region of interest. (OCR)</li> <li>aspect ratio</li> <li>A function that uses dual combinations of opening and closing operations to smooth the boundaries of objects.</li> <li>AutoSplit</li> <li>Works in conjunction with the maximum character bounding rectangle width, and uses an algorithm to analyze the right side of a character bounding rectangle width then determines the rightmost vertical line in the object that contains the fewest number of pixels and moves the rightmost edge of the character bounding box to that location. (OCR)</li> </ul>	area threshold	Detects objects based on their size.
<ul> <li>artifacts</li> <li>aspect ratio</li> <li>auto-median function</li> <li>A function that uses dual combinations of opening and closing operations to smooth the boundaries of objects.</li> <li>AutoSplit</li> <li>Works in conjunction with the maximum character bounding rectangle width, and uses an algorithm to analyze the right side of a character bounding rectangle. AutoSplit then determines the rightmost vertical line in the object that contains the fewest number of pixels and moves the rightmost edge of the character bounding box to that location. (OCR)</li> </ul>	arithmetic operators	The image operations multiply, divide, add, subtract, and remainder.
<ul> <li>A function that uses dual combinations of opening and closing operations to smooth the boundaries of objects.</li> <li>AutoSplit</li> <li>Works in conjunction with the maximum character bounding rectangle width, and uses an algorithm to analyze the right side of a character bounding rectangle. AutoSplit then determines the rightmost vertical line in the object that contains the fewest number of pixels and moves the rightmost edge of the character bounding box to that location. (OCR)</li> </ul>	artifacts	Extraneous pixels in the region of interest. (OCR)
<ul> <li>A function that uses dual combinations of opening and closing operations to smooth the boundaries of objects.</li> <li>AutoSplit</li> <li>Works in conjunction with the maximum character bounding rectangle width, and uses an algorithm to analyze the right side of a character bounding rectangle. AutoSplit then determines the rightmost vertical line in the object that contains the fewest number of pixels and moves the rightmost edge of the character bounding box to that location. (OCR)</li> </ul>	aspect ratio	Height/width ratio of a character. (OCR)
AutoSplit Works in conjunction with the maximum character bounding rectangle width, and uses an algorithm to analyze the right side of a character bounding rectangle. AutoSplit then determines the rightmost vertical line in the object that contains the fewest number of pixels and moves the rightmost edge of the character bounding box to that location. (OCR)	auto-median function	A function that uses dual combinations of opening and closing operations to smooth the boundaries of objects.
	AutoSplit	Works in conjunction with the maximum character bounding rectangle width, and uses an algorithm to analyze the right side of a character bounding rectangle. AutoSplit then determines the rightmost vertical line in the object that contains the fewest number of pixels and moves the rightmost edge of the character bounding box to that location. (OCR)

#### В

barycenter	The value representing the centroid of the range of an image's grayscale values in the image histogram.
binary image	An image containing objects usually represented with a pixel intensity of 1 (or 255) and the background of 0.
binary morphology	Functions that perform morphological operations on a binary image.
BMP	Bitmap. Image file format commonly used for 8-bit and color images (extension .bmp).
border function	Removes objects (or particles) in a binary image that touch the image border.

С	
caliper	A function that calculates distances, angles, circular fits, and the center of mass based on positions given by edge detection, particle analysis, centroid, and search functions.
CCD	Charge-coupled device. A solid-state imaging device that stores an electrical charge representation of the optical image by means of photoconductivity. A readout mechanism converts the charge image into a video signal.
center of mass	The point on an object where all the mass of the object could be concentrated without changing the first moment of the object about any axis.
centroid	<ol> <li>The average of the x-coordinates and y- coordinates of a binary image or a particle in the image. The centroid of a particle may lie outside the particle.</li> <li>The weighted average of the x-coordinates and y-coordinates in a grayscale image, where the weights are determined by the pixel values in the image.</li> </ol>
character	Recognized group of foreground elements. (OCR)
character bounding rectangle	Smallest rectangle that completely encloses a character. (OCR)
character recognition	Ability of a machine to read human-readable text. (OCR)
character segmentation	Application of several parameters, such as thresholding, character size, and element spacing, that isolates a character in a region of interest. (OCR)
character set	Set of trained characters and/or patterns. (OCR)
character set file	File that contains a character set. (OCR)

character size	Number of pixels that make up a character. (OCR)
character spacing	Horizontal distance between the right edge of one character bounding rectangle and the left edge of the next character bounding rectangle. (OCR)
character value	String that describes a character. For example, you might assign the character value "A" to a group of elements that resembles the letter A. (OCR)
circle function	Detects circular objects in a binary image.
classification	An operation that assigns samples to classes based on predefined features.
closing	A dilation followed by an erosion. A closing fills small holes in objects and smooths the boundaries of objects.
clustering	Technique where the image is sorted within a discrete number of classes corresponding to the number of phases perceived in an image. The gray values are determined and a barycenter is determined for each class. This process is repeated until a value is obtained that represents the center of mass for each phase or class.
codeword	Numeric value of the printed bar/space pattern in a 1D or 2D barcode.
color images	Images containing color information, usually encoded in the RGB form.
color look-up table (CLUT)	Table for converting the value of a pixel in an image into a red, green, and blue (RGB) intensity.
connectivity	Defines which of the surrounding pixels of a given pixel constitute its neighborhood. <i>See also</i> connectivity-4 <i>and</i> connectivity-8.
connectivity-4	Connectivity where only pixels adjacent in the horizontal and vertical directions are considered neighbors. Two pixels are considered as part of a same object if they are horizontally or vertically adjacent. They are considered as part of two different objects if they are diagonally adjacent.

connectivity-8	Connectivity where all adjacent pixels are considered neighbors. Two pixels are considered as part of a same object if they are horizontally, vertically, or diagonally adjacent.
convex function	Computes the convex regions of objects in a binary image.
convolution	See linear filter.
convolution kernel	Simple $3 \times 3$ , $5 \times 5$ , or $7 \times 7$ matrices (or templates) used to represent the filter in the filtering process. The contents of these kernels are a discrete two- dimensional representation of the impulse response of the filter that they represent.
coordinate system	A reference location (origin) and angle in an image that regions of interest can relate to when positional and angular adjustments of the region of interest are necessary. A coordinate system is depicted by two lines representing the orientation and direction of its two axes.

#### D

Danielsson function	Similar to the distance functions, but with more accurate results.
definition	The number of values a pixel can take on, which is the number of colors or shades that you can see in the image.
dendrite	Branches of the skeleton of an object.
density function	For each gray level in a linear histogram, it gives the number of pixels in the image that have the same gray level.
device	Plug-in data acquisition board that can contain multiple channels and conversion devices.
differentiation filter	Extracts the contours (edge detection) in gray level.
digital camera	A camera that transforms light information into pixels and then translates each pixel's level of light into a digital number inside the camera.
digital image	An image $f(x, y)$ that has been converted into a discrete number of pixels. Both spatial coordinates and brightness are specified.
dilation	Increases the size of an object along its boundary and removes tiny holes in the object.
distance calibration	Determination of the physical dimensions of a pixel by defining the physical dimensions of a line in the image.
distance function	Assigns to each pixel in an object a gray-level value equal to its shortest Euclidean distance from the border of the object.
dot-matrix character	Character comprised of a series of small elements. <i>See</i> segmented character. (OCR)
driver	Software that controls a specific hardware device, such as a data acquisition board.

#### Ε

Defined by a sharp change (transition) in the pixel intensities in an image or along an array of pixels.
Connected group of foreground pixels. Adjacent elements form a character. See object. (OCR)
Amount of space, in pixels, between elements. <i>See</i> horizontal element spacing <i>and</i> vertical element spacing. (OCR)
Method based on a classical image analysis technique that is best suited for detecting objects present in minuscule proportions on the image. For example, this function would be suitable for default detection.
See histogram equalization.
Missing or undecodable codeword at a known position in a 2D barcode.
Reduces the size of an object along its boundary and eliminates isolated points in the image.
See substitution error.
Expand the high gray-level information in an image while suppressing low gray-level information.
Decreases the brightness and increases the contrast in bright regions of an image, and decreases contrast in dark regions.

#### F

falling edge	The digital signal transition from the high state to the low state.
FFT	Fast Fourier Transform. A method used to compute the Fourier transform of an image.
field of view	Area of inspection that the camera can acquire as an image.
finder pattern	A specific pattern or sequence used by 2D codes to identify the orientation of data in the 2D code.
focal point	The pixel location in a pattern matching template whose coordinates are returned as the location of a match in the inspection image.
Fourier spectrum	The magnitude information of the Fourier transform of an image.
Fourier transform	Transforms an image from the spatial domain to the frequency domain.
frequency filters	Counterparts of spatial filters in the frequency domain. For images, frequency information is in the form of spatial frequency.
function	Set of software instructions executed by a single line of code that may have input and/or output parameters and returns a value when executed.

#### G

Gaussian filter	A filter similar to the smoothing filter, but using a Gaussian kernel in the filter operation. The blurring in a Gaussian filter is more gentle than a smoothing filter.
Gigabit Ethernet	Technologies which transmit Ethernet packets at a rate of one gigabit per second.
GigE Vision	A camera interface standard developed using the Gigabit Ethernet communication protocol.
grab	Acquisition technique that acquires and displays a continuous sequence of images using an image acquisition. Use this acquisition technique when you need to focus your camera.
gradient convolution filter	See gradient filter.
gradient filter	Extracts the contours (edge detection) in gray-level values. Gradient filters include the Prewitt and Sobel filters.
gray level	The brightness of a pixel in an image.
gray-level dilation	Increases the brightness of pixels in an image that are surrounded by other pixels with a higher intensity.
gray-level erosion	Reduces the brightness of pixels in an image that are surrounded by other pixels with a lower intensity.
grayscale image	An image with monochrome information.
grayscale morphology	Functions that perform morphological operations on a grayscale image.

#### Н

highpass attenuation	Applies a linear attenuation to the frequencies in an image, with no attenuation at the highest frequency and full attenuation at the lowest frequency.
highpass FFT filter	Removes or attenuates low frequencies present in the FFT domain of an image.
highpass filter	Emphasizes the intensity variations in an image, detects edges (or object boundaries), and enhances fine details in an image.
highpass frequency filter	Attenuates or removes (truncates) low frequencies present in the frequency domain of the image. A highpass frequency filter suppresses information related to slow variations of light intensities in the spatial image.
highpass truncation	Removes all frequency information below a certain frequency.
histogram	Indicates the quantitative distribution of the pixels of an image per gray-level value.
histogram equalization	Transforms the gray-level values of the pixels of an image to occupy the entire range (0 to 255 in an 8-bit image) of the histogram, increasing the contrast of the image.
hole filling function	Fills all holes in objects that are present in a binary image.
horizontal element spacing	Space, in pixels, between horizontally adjacent elements. (OCR)
HSI	Color encoding scheme in Hue, Saturation, and Intensity.
HSL	Color encoding scheme in Hue, Saturation, and Luminance.
HSV	Color encoding scheme in Hue, Saturation, and Value.

#### L

IEEE Institute of Electrical and Electronics Engineers.

- IEEE 1394 IEEE 1394, also known as FireWire®, is a highperformance serial bus originally developed by Apple computer in the early 1990s. The baseline specification handles throughput rates of 100 Mbits/s, 200 Mbits/s, and 400 Mbits/s. IEEE 1394 also features hot pluggable technology that enables devices to be connected and disconnected while your system is powered.
- image Light intensity as a function of the spatial coordinates f (x, y) where x and y denote spatial coordinates and the value f at any point (x, y) is the light intensity at that point.

# image A user-defined region of pixels surrounding an image.border Functions that process pixels based on the value of pixel neighbors require image borders.

- image file A file containing pixel data and additional information about the image.
- image mask A binary image that isolates parts of a source image for further processing. A pixel in the source image is processed if its corresponding mask pixel has a non-zero value. A source pixel whose corresponding mask pixel has a value of 0 is left unchanged.
- image The gradation of colors used to display an image on screen, usually defined by a color look-up table.
- image Encompasses various processes and analysis functions which you can apply to an image.
- image Original input image. If you start processing an image and source Want to revert back to the original image, select Source Image from the list box. When you click on Source Image, the image reverts to the original image, and any processing done on the image prior to selecting Image Source is cancelled.

image The presentation (display) of an image (image data) to the visualization user.

inner gradient	Finds the inner boundary of objects.
inspection	A vision inspection application created in and ran from Vision Builder AI that can perform inline or offline visual inspections.
inspection functions	Detects specific features in an image. The features detected include edges, peaks, and rotational shifts.
intensity	The gray-level value of a pixel in a grayscale image.
intensity threshold	Characterizes an object based on the range of gray-level values in the object. If the intensity range of the object falls within the user specified range, it is considered an object; otherwise it is considered part of the background.
interclass variance	Classical statistic technique used in discriminating factorial analysis. This method is best suited for images in which classes are not too disproportionate. For satisfactory results, the smallest class must be at least five percent of the largest one. This method has the tendency to underestimate the class of the smallest standard deviation if the two classes have a significant variation.
interpolation	Is the technique used to find values in between known

interpolation Is the technique used to find values in between known values when resampling an image or array of pixels.

J

JPEG Joint Photographic Experts Group. Image file format for storing 8bit and color images with lossy compression (extension .jpg). Κ

kernel Structure that represents a pixel and its relationship to its neighbors. The relationship is specified by weighted coefficients of each neighbor.

#### L

labeling	The process by which each object in a binary image is assigned a unique value. This process is useful for identifying the number of objects in the image and giving each object a unique identity.
LabVIEW	Laboratory Virtual Instrument Engineering Workbench. Program development environment application based on the programming language G used commonly for test and measurement applications.
Laplacian filter	Extracts the contours of objects in the image by highlighting the variation of light intensity surrounding a pixel.
line profile	Represents the gray-level distribution along a line of pixels in an image.
linear filter	A special algorithm that calculates the value of a pixel based on its own pixel value as well as the pixel values of its neighbors. The sum of this calculation is divided by the sum of the elements in the matrix to obtain a new pixel value.
logarithmic and inverse gamma corrections	Expand low gray-level information in an image while compressing information from the high gray-level ranges.
logarithmic function	Increases the brightness and contrast in dark regions of an image, and decreases the contrast in bright regions of the image.
logic operators	The image operations AND, NAND, OR, XOR, NOR, difference, mask, mean, max, and min.
look-up table	Table containing values used to transform the gray-level values of an image. For each gray-level value in the image, the corresponding new value is obtained from the look-up table and applied to the image.
lossless	Compression in which the decompressed image is

compression identical to the original image.

lowpass attenuation	Applies a linear attenuation to the frequencies in an image, with no attenuation at the lowest frequency and full attenuation at the highest frequency.
lowpass FFT filter	Removes or attenuates high frequencies present in the FFT domain of an image.
lowpass filter	Attenuates intensity variations in an image. You can use these filters to smooth an image by eliminating fine details and blurring edges.
lowpass frequency filter	Attenuates high frequencies present in the frequency domain of the image. A lowpass frequency filter suppresses information related to fast variations of light intensities in the spatial image.
lowpass truncation	Removes all frequency information above a certain frequency.
L-skeleton function	Uses an L-shaped structuring element in the Skeleton function.

#### Μ

match score	A number ranging from 0 to 1000 that indicates how closely an area of an acquired image matches the template image. A match score of 1000 indicates a perfect match. A match score of 0 indicates no match.
median filter	A lowpass filter that assigns to each pixel the median value of its neighbors. This filter effectively removes isolated pixels without blurring the contours of objects.
metric	Technique used in situations similar to interclass variance. For each threshold, a value is calculated that is determined by the surfaces representing the initial grayscale. The optimal threshold corresponds to the smallest value.
module	<ol> <li>A single cell that encodes one bit of data in a Data Matrix barcode.</li> <li>The narrowest discernible element in a PDF417 barcode.</li> </ol>
moments	Technique best suited for images that have poor contrast (an overexposed image is better processed than an underexposed image). The moments method is based on the hypothesis that the observed image is a blurred version of the theoretically binary original. The blurring that is produced from the acquisition process (electronic noise or slight defocalization) is treated as if the statistical moments (average and variance) were the same for both the blurred image and the original image. This function recalculates a theoretical binary image.
morphological transformations	Extract and alter the structure of objects in an image. You can use these transformations for expanding (dilating) or reducing (eroding) objects, filling holes, closing inclusions, or smoothing borders. They mainly are used to delineate objects and prepare them for quantitative inspection analysis.
M-skeleton	Uses an M-shaped structuring element in the skeleton

function.

#### Ν

neighbor	A pixel whose value affects the value of a nearby pixel when an image is processed. The neighbors of a pixel are usually defined by a kernel or structuring element.
neighborhood operations	Operations on a point in an image that take into consideration the values of the pixels neighboring that point.
nonlinear filter	Replaces each pixel value with a nonlinear function of its surrounding pixels.
nonlinear gradient filter	A highpass edge-extraction filter that favors vertical edges.
nonlinear Prewitt filter	A highpass edge-extraction filter that favors horizontal and vertical edges in an image.
nonlinear Sobel filter	A highpass edge-extraction filter that favors horizontal and vertical edges in an image.
number of planes (in an image)	The number of arrays of pixels that compose the image. A gray-level or pseudo-color image is composed of one plane, while an RGB image is composed of three planes (one for the red component, one for the blue, and one for the green).
Nth order filter	Filters an image using a nonlinear filter. This filter orders (or classifies) the pixel values surrounding the pixel being processed. The pixel being processed is set to the <i>N</i> th pixel value, where <i>N</i> is the order of the filter.

0	
object	<ol> <li>A connected region or grouping of pixels in an image in which all pixels have intensity levels in the same range.</li> <li>A group of elements that satisfy element spacing requirements. An object is an unrecognized character. (OCR)</li> </ol>
OCR Session	Character set and parameter settings that define an instance of OCR.
offset	The coordinate position in an image where you want to place the origin of another image. Setting an offset is useful when performing mask operations.
opening	An erosion followed by a dilation. An opening removes small objects and smooths boundaries of objects in the image.
operators	Allow masking, combination, and comparison of images. You can use arithmetic and logic operators in NI Vision.
optical character recognition (OCR)	Process of analyzing an image to detect and recognize characters/text in the image.
outer gradient	Finds the outer boundary of objects.
overlay	Regions of interest, text, and bitmaps that you can place on top of a displayed image to annotate it without modifying it.

#### Ρ

- palette The gradation of colors used to display an image on screen, usually defined by a color look-up table.
- particle Connected region or grouping of pixels in an image in which all pixels have the same intensity level.
- pattern Character for which the character value requires more than one byte. (OCR)

## pattern The technique used to quickly locate a grayscale template within a grayscale image.

pixel Picture element. The smallest division that makes up a digital image. For measurement tasks, optimum pixel dimensions are square (aspect ratio of 1:1, or the width equal to the height).

### pixel Directly calibrating the physical dimensions of a pixel in an calibration image.

pixel depth The number of bits (n) used to code the intensity of a pixel. For a given n, a pixel can take 2n different values. For

example, if n equals 8-bits, a pixel can take 256 different values ranging from 0 to 255. If n equals 16 bits, a pixel can take 65,536 different values ranging from 0 to 65,535 or 32,768 to 32,767.

- pixel frame Describes the neighborhood. For a square pixel frame, each pixel is surrounded by eight neighbors. The vertical and horizontal neighbors have a distance d from the pixel. Diagonal pixels have a slightly greater distance because they are farther away from the central pixel. For a hexagonal pixel frame, each pixel is surrounded by six neighbors. Each neighbor is at an equal distance from the central pixel.
- PNG Portable Network Graphic. Image file format for storing 8-bit, 16-bit, and color images with lossless compression (extension .png).

# Power 1/Y Similar to a logarithmic function but with a weaker effect. function

Power Y function	See exponential function.
Prewitt filter	Extracts the contours (edge detection) in gray-level values using a $3 \times 3$ filter kernel.
probability function	Defines the probability that a pixel in an image has a certain gray-level value.
Processing window	Vision Assistant feature that updates the image as you change parameters. The Processing window is located on the right side of the Vision Assistant window.
proper- closing	A finite combination of successive closing and opening operations that you can use to fill small holes and smooth the boundaries of objects.
proper- opening	A finite combination of successive opening and closing operations that you can use to remove small particles and smooth the boundaries of objects.

#### Q

quiet zone The area containing no data that is required to surround a 2D barcode. This area is measured in <u>module</u> widths.

quantitative Obtaining various measurements of objects in an image. analysis

#### R

read resolution	Level of character criteria OCR uses to determine if an object matches a trained character.
read strategy	Method by which you determine how stringently OCR analyzes objects to determine if they match trained characters.
Reference window	Vision Assistant feature that displays the original version of the image (image source) as you manipulate it in the processing window. The Reference window appears in the upper left corner of the Vision Assistant window.
region of interest (ROI)	An area of the image that is graphically selected from a window displaying the image. This area can be used to focus further processing.
resolution	The number of rows and columns of pixels. An image composed of $m$ rows and $n$ columns has a resolution of $m'n$ . This image has $n$ pixels along its horizontal axis and $m$ pixels along its vertical axis.
Reverse function	Inverts the pixel values in an image, producing a photometric negative of the image.
rising edge	The digital signal transition from the low state to the high state.
RGB	Color image encoding using red, green, and blue colors.
RGB chunky	Color encoding scheme using red, green, and blue (RGB) color information where each pixel in the color image is encoded using 32 bits: 8 bits for red, 8 bits for green, 8 bits for blue, and 8 bits for the alpha value (unused).
Roberts filter	Extracts the contours (edge detection) in gray level, favoring diagonal edges.
ROI	Region of interest.
ROI tools	Collection of tools from the Tools palette that enable you to select a region of interest from an image. These tools let you select a point or line; polygon, rectangle, and oval regions; and freehand lines and areas.

C
5
-

List of image processing and analysis functions and the parameters for each of those functions. Vision Assistant records each function and relevant parameters as you prototype your image processing application.
The window in which Vision Assistant displays a script. From the scripting window, you can edit, remove, or add steps and run scripts. The Script window appears in the lower left corner of the Vision Assistant window.
Fully partitions a labeled binary image into non- overlapping segments, with each segment containing a unique object.
Character that OCR isolates according to specific parameters, such as thresholding, character size, and so on.
Separates objects that touch each other by narrow isthmuses.
Acquisition technique that acquires images according to settings that you specify in the acquisition property pages.
Finds objects in an image whose shape matches the shape of the object specified by a template. The matching process is invariant to rotation and can be set to be invariant to the scale of the objects.
A highpass filter that outlines edges.
Applies a succession of thinning operations to an object until its width becomes one pixel.
Obtains lines in an image that separate each object from the others and are equidistant from the objects that they separate.
Blurs an image by attenuating variations of light intensity in the neighborhood of a pixel.
Acquisition techniques that acquires and displays a single image.

Sobel filter	Extracts the contours (edge detection) in gray-level values using a $3 \times 3$ filter kernel.
spatial calibration	Assigning physical dimensions to the area of a pixel in an image.
spatial filters	Alter the intensity of a pixel with respect to variations in intensities of its neighboring pixels. You can use these filters for edge detection, image enhancement, noise reduction, smoothing, and so forth.
spatial resolution	The number of pixels in an image, in terms of the number of rows and columns in the image.
Square function	See exponential function.
Square Root function	See logarithmic function.
state	A particular set of steps that execute under certain conditions during an inspection.
step	A component of a Vision Builder AI inspection that performs a specific visual inspection task or supporting tasks, such as decision making and serial communication.
stroke character	Character that consists of continuous elements in which breaks are caused only by imperfections in the image. (OCR)
structuring element	A binary mask used in most morphological operations. A structuring element is used to determine which neighboring pixels contribute in the operation and to what degree.
sub-pixel analysis	Used to find the location of an edge or template in terms of fractions of a pixel.
substitution character	Character that represents unrecognized characters. Typically, the substitution character is a question mark (?). (OCR)
substitution error	Erroneously decoded codeword at an unknown position in a 2D barcode.

#### Т

template	Pattern that you are trying to match in an image using the <b>Match Pattern</b> step. A template can be a region selected from an image or it can be an entire image.
thickening	Alters the shape of objects by adding parts to the object that match the pattern specified in the structuring element.
thinning	Alters the shape of objects by eliminating parts of the object that match the pattern specified in the structuring element.
threshold	Separates objects from the background by assigning all pixels with intensities within a specified range to the object and the rest of the pixels to the background. In the resulting binary image, objects are represented with a pixel intensity of 255 and the background is set to 0.
threshold interval	Two parameters, the lower threshold gray-level value and the upper threshold gray-level value.
TIFF	Tagged Image File Format. Image format commonly used for encoding 8-bit and color images (extension .tif).
Tools palette	Collection of tools that enable you to select regions of interest, zoom in and out, and change the image palette.
transition	An event that causes the inspection to move from one state to another.
trigger	Any event that causes or starts some form of data capture.
trigger polarity	Determines whether triggered events occur on the rising or falling edge of the trigger signal.
TTL	Transistor-transistor logic.

vertical Space, in pixels, between vertically adjacent elements. element (OCR) spacing

spacing VI

Virtual Instrument.

- 1. A combination of hardware and/or software elements, typically used with a PC, that has the functionality of a classic stand-alone instrument.
- 2. A LabVIEW software module (VI), which consists of a front panel user interface and a block diagram program.

#### V

# web The process of detecting defects in a continuous sheet of inspection materials at production speeds. Example materials include plastic film, cloth, paper and pulp products, metal, and glass.

#### W

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# **Image Options**

The following tables list the file formats supported by Vision Builder AI and information about additional options supported for each file format.

#### Image Type

	Desktop PC	NI 17xx Smart Camera	NI CVS-1450 Compact Vision System
8-bit	BMP, TIFF, JPEG,	BMP, TIFF,	BMP, TIFF, JPEG,
Grayscale	JPEG2000, PNG	JPEG, PNG	JPEG2000, PNG
16-bit	TIFF, JPEG2000,	TIFF, PNG	TIFF, JPEG2000,
Grayscale	PNG		PNG
32-bit RGB Color	BMP, TIFF, JPEG, JPEG2000, PNG	BMP, TIFF, JPEG, PNG	BMP, TIFF, JPEG, JPEG2000, PNG

#### Image Compression

	Desktop PC	NI 17xx Smart Camera	NI CVS-1450 Compact Vision System
Lossy	JPEG, JPEG2000	JPEG	JPEG, JPEG2000
Lossless	BMP, TIFF, PNG, JPEG2000 <sup>†</sup>	BMP, TIFF, PNG	BMP, TIFF, PNG, JPEG2000 <sup>†</sup>
<sup>†</sup> JPEG200 image compression is lossless only when the Use Lossless Compression control is enabled.			

#### **Overlay Information**

	Desktop PC	NI 17xx Smart Camera	NI CVS-1450 Compact Vision System
Merge Overlay	BMP, TIFF, JPEG,	BMP, TIFF,	BMP, TIFF, JPEG,
with Image	JPEG2000, PNG	JPEG, PNG	JPEG2000, PNG

# **NI Smart Camera Light Configuration**

Use the **Configure Light** dialog box to control your light. You must choose between **Select Light** and **Enter Light Protection Data** when configuring a light source.

Select **Select Light** to choose a lighting data file. Lighting data files exist in four levels of certification:

- Digitally Signed by National Instruments—The information contained within this 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 this 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 this 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 this file is unusable because the digital signature is corrupt, the data describing the light is corrupt, the data describing the light is not in the proper syntax, or the data does not meet the requirements of Direct Drive lighting.

Select **Enter Lighting Protection Data** to manually enter control limits for your light. Before manually entering limits for your light, be aware of the manufacturer specified limitations. Exceeding the maximum current or timing limits specified by the manufacturer will damage the light. All lights support the following options:

- Maximum Continuous Current (mA) specifies the continuous current limit in milliamps and is the maximum current limit the light supports in continuous mode.
- Maximum Strobe Current (mA) specifies the strobe current limit

in milliamps and is the maximum current the light supports when in strobe mode.

- Maximum Strobe Duration (ms) specifies the strobe duration limit in milliseconds and is the maximum amount of time that the light remains on when being driven with the maximum strobe current.
- Maximum Strobe Duty Cycle (%) specifies the maximum duty cycle to allow for the strobe. The duty cycle is the ratio of the light strobe duration to the frame period.
  - Note If you violate either the strobe duration limit or the strobe duty cycle limit, then the settings will revert to the continuous current limit.

Refer to your light documentation for additional information about supported features and lighting limits.

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## **Find Edges Concepts (Legacy)**

Note This step is deprecated. The replacement step is Find Edges, which incorporates the functionality of the original Find Edges step and provides additional functionality.

The **Find Edges** step searches for edges along a one-dimensional region of interest, such as a line, broken line, or curve. Edges are typically characterized by sharp transitions in pixel intensities.

The step locates an edge based on its edge strength. You can study the **Edge Strength Profile** to determine the edge strengths along the region of interest. A peak in the profile indicates that an edge is present at that position along the region of interest. The strength of that edge is given by the amplitude of the peak.

The default region of interest tool is a line. You can examine different path profiles of the image using the broken line tool or the freehand tool. Also, you can locate edges along multiple regions of interest.

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# **Find Straight Edge Concepts (Legacy)**

Note This step is deprecated. The replacement step is Find Straight Edge, which incorporates the functionality of the original Find Straight Edge step and provides additional functionality.

The **Find Straight Edge** step searches for a straight edge in a twodimensional region of interest. The region of interest contains a number of search lines along which the step searches for sharp transitions in pixel intensities. A sharp transition typically characterizes the edge of an object in the image. The step fits a straight line through the individual edge points of each search line to determine a straight edge on the object under inspection.

The step locates an edge based on its edge strength. You can study the **Edge Strength Profile** to determine the edge strengths in the region of interest. A peak in the profile indicates that an edge is present at that position in the region of interest. The strength of that edge is given by the amplitude of the peak.

The default region of interest tool is a rectangle. If the edge you want to locate is at an angle in the image, use the rotated rectangle tool to draw the region of interest. If the edge extends radially from a center point, use the annulus tool to draw the region.

Draw the region of interest so that it encloses the entire edge that you want to find but excludes as many edges of no interest as possible. Make sure the edge fills up most of the region length. Also, make sure that the region is at least 20 pixels wide on either side of the edge to accurately detect the points along the edge.



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# Find Circular Edge Concepts (Legacy)

Note This step is deprecated. The replacement step is <u>Find</u> <u>Circular Edge</u>, which incorporates the functionality of the original **Find Circular Edge** step and provides additional functionality.

The **Find Circular Edge** step searches for a circular edge in a twodimensional, annulus-shaped region of interest. The region of interest contains a number of search lines along which the step searches for sharp transitions in pixel intensities. A sharp transition typically characterizes the edge of an object in the image. The step fits a circle through the individual edge points of each search line to determine a circular edge on the object under inspection.

Note The search lines extend radially in the region of interest.

For the best results, ensure that the region of interest encloses the entire edge that you want to find but excludes as many edges of no interest as possible. Make sure the edge fills up most of the region length. Also, make sure that the region is at least 20 pixels wide on either side of the edge to accurately detect the points along the edge. 龖

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## **Read Data Matrix Code Concepts (Legacy)**

Note This step is deprecated. The replacement step is <u>Read Data</u> <u>Matrix Code</u>, which incorporates the functionality of the original **Read Data Matrix Code** step and provides additional functionality.

The Read Data Matrix Code step consists of two phases:

- Phase during which you specify an region of interest in the image, which helps to locate the region occupied by the barcode. This phase is optional, but it can increase the performance of the second phase by reducing the size of the search region.
- 2. Phase during which the region you specify is analyzed to decode the barcode.

The following factors can cause errors in the search and decoding phase:

- Very low resolution of the image
- Very high horizontal or vertical light drift
- Contrast of the modules in the image
- High level of noise or blurring
- Inconsistent printing or stamping techniques—such as misaligned barcode elements—inconsistent element size, or elements with inconsistent borders.
- Quiet zone that is too small or contains too much noise
  - Note The minimum quiet zone for a Data Matrix barcode is equal to one module width on all four sides of the barcode.

# **Specifying a Text Pattern**

Use the Pattern Setup dialog box to specify the valid characters for a character string. The first character in the list corresponds to the first character in the string, the second character in the list corresponds to the second character in the string, and so on. For each character in a string, you can specify the **Type** of character you expect to find in that position in the string. Specifying the character **Type** restricts the step to only search for valid characters of the specified **Type**, which improves the speed and accuracy of the character recognition process. Refer to the following table for a description of each character **Type**.

Note The textbox next to the **Type** control is only valid when you select **User-defined Characters** for the **Type**. Enter the string of characters that are valid for the character position in the textbox. The specified string of characters must correspond to one of the character defined in the character set file.

Format Type	Valid Characters for Corresponding Position
Any Character	Any ASCII character
User-defined Characters	Uses characters you specify in the <b>User-defined</b> characters string.
Alphabets	A–Z a–z
Alphanumeric	A-Z a-z 0-9
Uppercase Letters	A–Z
Lowercase Letters	a–z
Decimal Digits	0–9
Hexadecimal Digits	0–9 A–F
Pattern	Any Pattern
Force Space	Ignores the read character and forces a space at the corresponding position

# Vision Builder AI System Signals

Vision Builder AI supports the following system signals.

System Signal	Behavior
System Online	Signal goes high when Vision Builder AI opens and goes low when Vision Builder AI closes. When Vision Builder AI is running on a remote target, <b>System Online</b> is always high.
Inspection Loaded	Signal goes high when an inspection opens and goes low when an inspection closes
Inspection in Progress	Signal goes high when an inspection starts and goes low when the inspection stops.
Camera Ready	Signal goes high when an inspection starts or when an inspection reaches the End state. The signal goes low when an acquisition starts.
Inspection Busy	Signal goes high when an acquisition starts and goes low when an inspection reaches the End state.
Image Acquisition in Progress	Signal goes high when the inspection reaches an acquisition step and goes low when the acquisition step completes.
Image Acquisition Done	Signal goes high when an acquisition step completes and goes low when the inspection reaches another acquisition step or the End state.
System Error	Signal is always low.

Note System signals do not update on the remote target in Configuration mode when you run only a single state. When running an inspection on a remote target in Configuration mode the inspection starts and stops for each iteration. This behavior differs from Inspection mode, where the inspection runs continuously until the inspection is stopped.

The following figure illustrates the behavior of the System Online,

Inspection Loaded and Inspection in Progress signals.



The following figure illustrates the behavior of the **System Online**, **Inspection Loaded** and **Inspection in Progress** signals when Inspection Selection is enabled.



The following figure illustrates the behavior of the **Camera Ready**, **Inspection Busy**, **Image Acquisition in Progress**, and **Image Acquisition Done** signals.



# String Display Types

The following options are available for displaying strings.

Display Option		Description	
Normal Display	Display s	style of the string.	
\ Codes Display	Displays non-printable characters with a backslash (\) before the character. This mode is helpful when debugging communications in which you expect to receive non-printable characters.		
	The following table shows the Vision Builder AI interpretation of non-printable characters:		
	Code	Interpretation	
	\00–\FF	hexadecimal value of an 8-bit character	
	\b	backspace (ASCII BS, equivalent to \08)	
	\f	form feed (ASCII FF, equivalent to \0C)	
	\n	line feed (ASCII LF, equivalent to \0A)	
	\r	carriage return (ASCII CR, equivalent to \0D)	
	\t	tab (ASCII HT, equivalent to \09)	
	\s	space (equivalent to \20)	
	W	backslash (ASCII  equivalent to \5C)	
	%%	percent	
Hex Display	Displays This moo instrume	each character of the string in its hexadecimal value. de is helpful when debugging communication with nts.	

# Registers

Modbus bases its data model on a series of tables that have distinguishing characteristics. The following are the four primary tables:

Table	Description
Discrete Inputs	Single bit; Read-Only. This type of data can be provided by an I/O system.
Coils	Single bit; Read/Write. This type of data can be alterable by an application program.
Input Registers	16-bit word; Read-Only. This type of data can be provided by an I/O system.
Holding Registers	16-bit word; Read/Write. This type of data can be alterable by an application program.

The protocol allows for the individual selection of 65,536 data items for each primary table.

In Vision Builder AI, all four register tables are distinct in memory, do not overlap, and start at address 0x00000.

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### How to Find Edges (Legacy)

Note This step is deprecated. The replacement step is Find Edges, which incorporates the functionality of the original Find Edges step and provides additional functionality.

#### Main Tab

- 1. In the **Step Name** control, enter a descriptive name for the step.
- 2. Choose one of the following methods to specify the region of interest for the step:
  - Create a new region of interest.
    - a. Select **Constant** from the **Region of Interest** listbox.
    - b. Select a tool from the menu toolbar that matches the type of region of interest you want to specify.
    - c. Draw a region of interest on the image.
      - Tip Hold down the <Ctrl> key to specify a region of interest containing several contours using the same or different tools. Hold down the <Shift> key to draw a horizontal or vertical line.
  - Select a previously defined region of interest from the **Region of Interest** listbox.

When you specify a region of interest, the step automatically tries to locate edge points along the region. The located edges are marked on the image with blue and red squares.

3. Verify that the **Reposition Region of Interest** option is enabled if you want to link the region of interest specified in this step to a previously defined coordinate system.

Link the region of interest to a coordinate system if the position of the object under inspection changes from image to image, and you need to adjust the position of the region of interest to match the new location of the object.

#### **Settings Tab**

- 4. If the automatically located edges correspond to the edges you expected to find, proceed to step 5. Otherwise, disable the **Auto Setup** control and manually adjust the edge location parameters.
  - a. Choose the type of edges you want to detect from the Look For control. You can choose from All Edges, First Edge Only, and First & Last Edge Only.
  - b. Select the polarity of the edges you want to locate.
  - c. If the Edge Strength Profile contains peaks that correspond to all the edges you want to find, adjust the yellow edge strength line so that it lies slightly below the top of the shortest edge peak.

If the Edge Strength Profile does not contain peaks that correspond to all the edges, adjust the **Smoothing** and **Steepness** controls until the peaks appear.

#### Limits Tab

5. Set the minimum and/or maximum number of edges you want locate.

# Saving a VI for Distribution

Complete the following steps to save a LabVIEW VI for distribution:

- 1. Launch LabVIEW.
- 2. Open the VI. If the VI is already open, save the VI.
- 3. Select File»New Project.
- 4. Add the VI and any dependencies to the project. If you want to run the VI on a remote target, you must first add the target to the project. Compete the following steps to add a remote target to the LabVIEW project:
  - a. In the Project Explorer window, right-click the project root and select **New»Targets and Devices**.
  - b. Select the target you want to add from the **Targets and Devices** section of the Add Targets and Devices dialog box.
  - c. Click **OK** to add the target to the project.
- 5. Save the project by selecting **File**»**Save Project**.
- 6. Right-click **Build Specifications** underneath the VI you added to the project and select **New»Source Distribution** from the shortcut menu to display the Source Distribution Properties dialog box.
- 7. Enter a Build Specification Name and Destination Directory.
- 8. Select the **Source Files** category.
- 9. In the Project Files list, select the top-level VI and any dependencies, and add the files to the **Always Included** list.
- 10. Select the **Destinations** category.
- 11. In the **Destination type** control, select **LLB**.
- 12. Select the **Source Files Settings** category.
- 13. In the Project Files list, click **Dependencies**.
- 14. Enable the **Apply prefix to all contained items** checkbox and enter a prefix.
- 15. Select the Additional Exclusions category.
- 16. Enable the **Disconnect type definitions**, **Remove unused polymorphic VI instances**, and **Remove unused members of project libraries** checkboxes. Do not enable the **Modify project**

library file after removing unused members checkbox.

- 17. Disable the Exclude files from VI.lib, Exclude files from instr.lib, and Exclude files from user.lib checkboxes.
- 18. Select the **Preview** category. Click **Generate Preview** to review the generated file hierarchy for the source distribution. To ensure the preview is accurate, save changes to VIs in memory before you create or edit a build specification.
- 19. Click **Build**. You can find the resulting source distribution in the directory specified in the **Destination directory** control in the **Information** category of the build specification.





## **Inspection Setup**

Use the Inspection Setup state to add and configure steps to perform tasks that you want to complete before the main inspection runs, such as hardware initialization.



**Note** Steps in the Inspection Setup state are executed when the associated inspection is opened in Vision Builder AI.
### How to Use

- 1. Select a step you want to add to the Inspection Setup state from the **Inspection Steps** palette.
- 2. Configure the controls on the property page for the step.
- 3. Click **OK** to add the step to the Inspection Setup state.
- 4. Repeat steps 1–3 to add additional steps to the Inspection Setup state.



**Vision Builder AI Inspection Process** 



# **Inspection Cleanup**

Use the Inspection Cleanup state to add and configure steps to perform tasks that you want to complete after the main inspection runs, such as resetting the hardware to default values or disposing of hardware resources.



**Note** Steps in the Inspection Cleanup state are executed when the associated inspection is closed in Vision Builder AI.

### How to Use

- 1. Select a step you want to add to the Inspection Cleanup state from the **Inspection Steps** palette.
- 2. Configure the controls on the property page for the step.
- 3. Click **OK** to add the step to the Inspection Cleanup state.
- 4. Repeat steps 1–3 to add additional steps to the Inspection Cleanup state.



**Vision Builder AI Inspection Process** 

# Syntax for Browser Address Lists

You can enter an IP address, such as 130.164.140.12, or a domain name, such as www.ni.com, in the **Browser Access List**.

Use the \* wildcard to specify a group of browser addresses. For example, you can specify all browsers within the domain domain.com with the entry \*.domain.com. You can specify all browsers in the subnet whose first two octets are 130.164 with the entry 130.164.\*. You can only use the \* wildcard at the beginning of a domain name or at the end of an IP address.

The permission for an entry later in the **Browser Access List** overrides previous permissions. You can click and drag an entry in the list to change the order.

For example, if you deny access to all browser addresses ending in \*.test.site.com, but after that entry you give a.test.site.com and b.test.site.com access, those two browsers still have access, because the entries later in the list override the first entry.

In general, you should use the \* wildcard to set up general allowances or denials, and follow those entries with more specific entries that reverse part of the previous permission. For best performance, place the most frequently matched entries toward the bottom of the list.

Access List Entry		Permission Status
$\mathbf{i}$	*	Allows access to all browser addresses.
4	*.site.com	Allows access to all browser addresses ending with .site.com.
Х	public.site.com	Denies access to this browser address even though previous entry allows access.
Х	*.test.site.com	Denies access to any browser address ending with .test.site.com.
4	a.test.site.com	Allows access to this browser address even though previous entry denies access.
Х	130.164.123.*	Denies access to all browser addresses whose IP addresses begin with 130.164.123.

The following example illustrates how to use the \* wildcard correctly.

~	130.164.123.123	Allows access to this browser address even though
		previous entry denies access.

# **New Communication Device**

Use this dialog box to configure a new communication device.

### How to Use

- 1. Enter a name for the new device.
- 2. Select the communication Protocol. Vision Builder AI currently supports the Modbus Serial, Modbus TCP, and Ethernet protocols.
- 3. Select whether the new device is the master or slave device. Currently, Vision Builder AI supports Modbus master devices only and both master and slave Ethernet devices.

### **Control Descriptions**

The following controls are available on the New Communication Device dialog box.

<b>Control Name</b>	e Description	
Device Name	Name that identifies the communication device.	
Device Type	Whether the device you are adding is a master or slave device. Currently, Vision Builder AI supports only Modbus master devices and both master and slave Ethernet devices.	
Protocol	Type of communication protocol to use. The following options are available: • Modbus Serial • Modbus TCP • TCP/IP	
	Note When you specify Modbus TCP as the physical layer for communication, Vision Builder Al listens to Modbus TCP commands on port 502.	

#### Parameters

Note The available parameters vary according to the selected **Device Type** and **Protocol**.

#### **Modbus Serial**

<b>Control Name</b>	Description	
COM Port	Serial communication port used for communication with the Modbus device.	
Mode	<ul> <li>Specifies the mode used to transmit Modbus serial commands. The following options are available:</li> <li><b>RTU</b>—Transmits data using the Modbus RTU compact binary format.</li> <li><b>ASCII</b>—Transmits data using a human-readable ASCII format</li> </ul>	
Timeout (ms)	Specifies the period of time Vision Builder AI waits to receive a Modbus command before timing out.	

#### Modbus TCP

<b>Control Name</b>	Description	
Timeout (ms)	Specifies the period of time Vision Builder AI waits to	
	receive a Modbus command before timing out.	

#### **TCP/IP Master**

<b>Control Name</b>	Description
Port Specifies the port number to listen for a connection	

#### **TCP/IP Slave**

<b>Control Name</b>	Description	
IP Address Specifies the IP address of the device with which want to establish a connection.		
Timeout (ms)	Specifies the period of time Vision Builder AI waits to receive an Ethernet command before timing out.	
<b>Port</b> Specifies the port number to listen for a connection.		

## **Branch Offices**

Office	Telephone Number
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	33 (0) 1 57 66 24 24
Germany	49 89 7413130
India	91 80 41190000
Israel	972 0 3 6393737
Italy	39 02 41309277
Japan	0120-527196 / 81 3 5472 2970
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 3390150
Portugal	351 210 311 210
Russia	7 495 783 6851
Singapore	1800 226 5886
Slovenia	386 3 425 42 00

South Africa	27 0 11 805 8197
Spain	34 91 640 0085
Sweden	46 (0) 8 587 895 00
Switzerland	41 56 2005151
Taiwan	886 02 2377 2222
Thailand	662 278 6777
Turkey	90 212 279 3031
United Kingdom	44 (0) 1635 523545
United States (Corporate)	512 683 0100