

# Inspector PI50



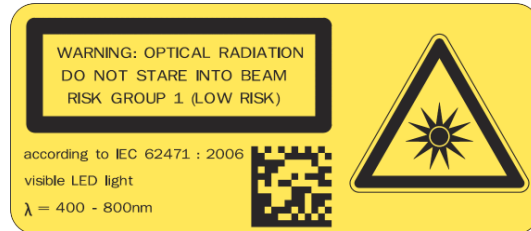
## Vision Sensor



## WARNING

### VSPP-5F2113 (Inspector PI50), VSPP-5F2134 (Inspector PI50 ECAT)

The Inspector is equipped with a LED illumination that must be considered as a lamp system of Risk Group 1 (low risk) according to IEC 62471:2006



WARNING: OPTICAL RADIATION DO NOT STARE INTO BEAM  
RISK GROUP 1 (LOW RISK) according to IEC 62471:2006  
Visible LED light  $\lambda = 400\text{-}800\text{ nm}$

### VSPP-5F2413 (Inspector PI50-IR)

The Inspector is equipped with an LED illumination that must be considered as a lamp system of Risk Group 0 / Free Group (exempt risk) according to IEC 62471:2006



NOTICE: IR EMITTED FROM THIS PRODUCT  
RISK GROUP 0 (EXEMPT RISK) according to IEC 62471:2006  
IR LED light  $\lambda = 850\text{ nm}$

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# Introduction

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# 1 Overview

Inspector PI50 is a 2D vision sensor for high-speed positioning and inspection applications.

Inspector PI50 is configured through the SOPAS engineering tool to analyze objects and to communicate inspection results over different interfaces.

After finished configuration, PI50 is running stand alone and continuously reporting the result over the configured interface.

The main features of Inspector PI50-Series are:

- High-speed positioning and inspection
- Toolbox for locating taught-in, free-form and line/polygon-shaped objects
- Multiple, simultaneous inspection of blobs, patterns, edges and pixel counting
- Export/import of configurations
- Image and result calibration
- Ethernet fieldbus communication through EtherNet/IP and Ethernet raw
- Ethernet fieldbus communication through EtherCAT
- HMI integration via Web API
- Out-of-the box Web Server
- Exchangeable lens
- Outputs by logical expressions
- Digital input and output extensions via I/O box
- Store inspected images to remote FTP server
- Live image/log/statistics view and reference object change via Inspector Viewer



Figure 1.1

*Inspector PI50 is a variant within the Inspector vision sensor family.*

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## Note

Feature support is dependent on device type within the PI50-Series, please see Section A.4, “*Technical Specification*” (page 108) for details.

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The tool concept allows for a high flexibility in combining all the tools within a configuration. The most common tool set-ups for performing Positioning and Inspection tasks with the Inspector PI50 are:

1. Find and report position of a known object shape and inspect details of it
2. Find and report position of a number of free-form objects and inspect details of them
3. Find and report the corner positions of polygon formed objects and inspect the edges of the polygon sides





*Object with known pretaught object shape*



*Object with free-form object shape*



*Object with polygon formed shape*

In all set-ups where the position or angle is needed, the Inspector PI50 needs to be configured to send the results over an Ethernet interface. If only evaluating inspection results either Ethernet or the digital interface can be used.

## 1.1 Safety

- Read the operating instructions before using the Inspector.
- Connection, assembly, and settings must be performed by competent technicians.
- Do not connect external I/O signals to the Inspector while it is powered. This may damage the device.
- Make sure that any loose cable ends are properly separated or isolated before powering the Inspector. Otherwise the device may be damaged.
- Protect the Inspector from moisture and dirt during operation.
- Do not use the Inspector in areas with risk for explosion.
- To keep IP 67 classification, open and close the front window only with the supplied tool. Make sure that the seal fits properly.
- To avoid damages, only Inspector accessory lenses offered by SICK are allowed to be used.
- Minimize the risk of getting dust into the device by changing the lenses in a dust-free environment. Do not keep the device without the front window and wipe off the front window before you open it.

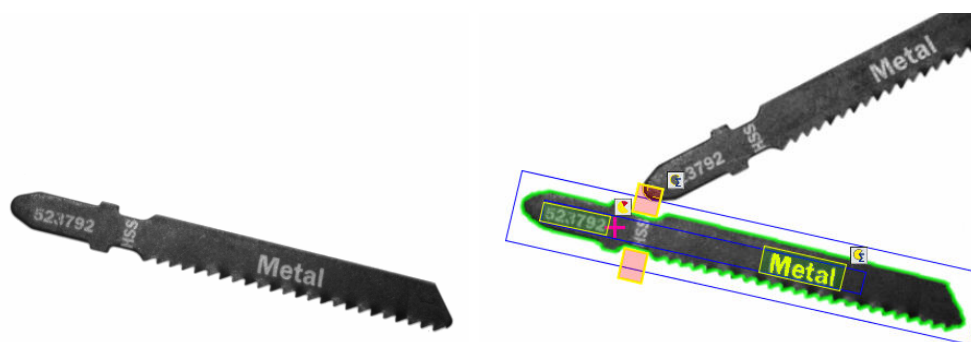
## 2 Applications

This section describes the three main set-ups for the positioning and inspection tasks. Other applications can use some details of each set-up, or a combination of them. The result is reported via Ethernet Raw, EtherNet/IP or EtherCAT protocol in all these application examples.

### 2.1 Find and report position of a known object shape and inspect details of it

Inspector PI50 uses the Object Locator to locate the position of a pre-taught, known shape. A number of inspection tools are used related to the Object locator to verify the quality and side orientation. The goal of the application is to locate and quality assure the part for robot picking.

- The Pattern tool is used to quality inspect the teeth of the blade
- The Pixel counter tool is used to verify that the text is present indicating that the object is facing correct side up
- The Edge pixel counter tool is used to verify that the grip areas around the part are free in order to not damage the grip tool



*The Object locator is the preferred tool to use Inspector PI50 has located the object and for positioning when the shape is known and verified quality and side orientation correct. always the same.*

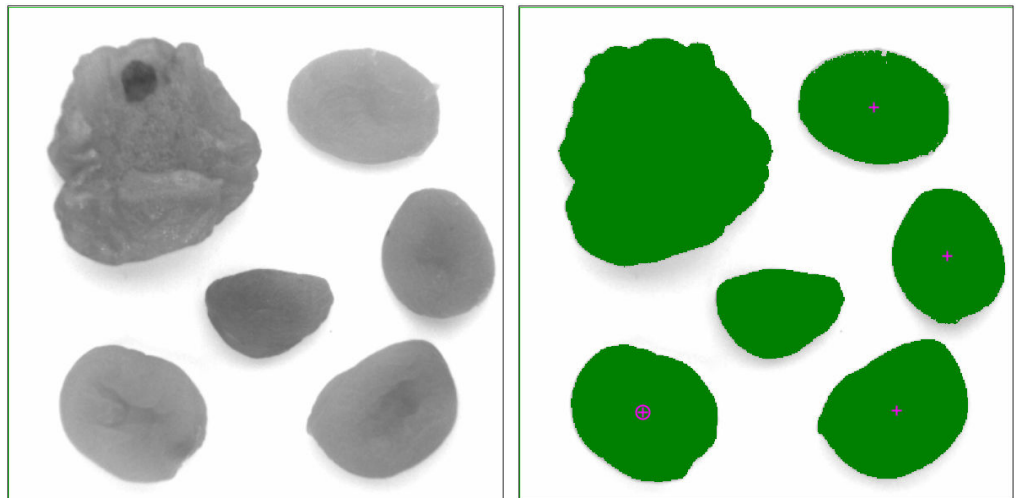
*It reports the position of the reference point (purple cross) and the object's angle of rotation, as well as the detailed inspection results of the tools.*

### 2.2 Find and report position of a number of free-form objects and inspect details of them

Inspector PI50 uses the Blob tool to locate the position of one or more free-form objects. Free-form means that the shape does not matter and that the size and gray scale are used as a search conditions. The goal of the application is to sort fruits by size and pick correctly sized pieces with a robot.

The Blob tool can locate up to 16 objects in one region. Because of the flexible shape, it is not possible to define a fixed reference point on the object. Instead, each object's center of gravity is reported (purple crosses).

The detail to inspect is the size. The size parameter of the blob tool is used to sort out the correct sized pieces.



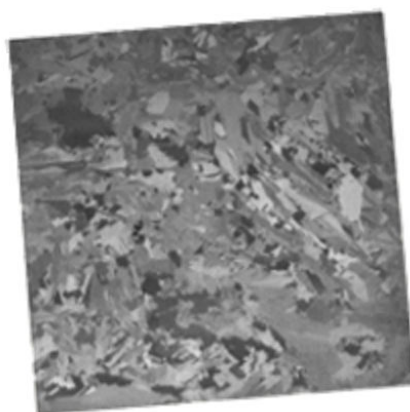
The Blob tool is the preferred tool to use for positioning when the exact shape is unknown, the objects are appearing as clusters of uniform gray scale range compare to the background.

Inspector PI50 has located the objects and sorted out the correct sized once by indicating a reference point (purple crosses) in the center of them. It reports the number of correct sized blob as well as the size of each of them.

### 2.3 Find and report the corner positions of a polygon formed object and inspect the edges of the polygon sides

Inspector PI50 uses the Polygon tool to locate the position of the corners of a polygon shaped object on which the number of sides are known. The goal of the application is to locate a solar wafer and assure that the edges are not damaged, before re-aligning it.

A polygon can be defined to be open or closed and have maximum 8 sides (16 corners). The reported coordinates are the found corners of the polygon. The polygon tool also has the ability to inspect the edges of the found sides very accurate which is used to verify that the sides are not damaged.



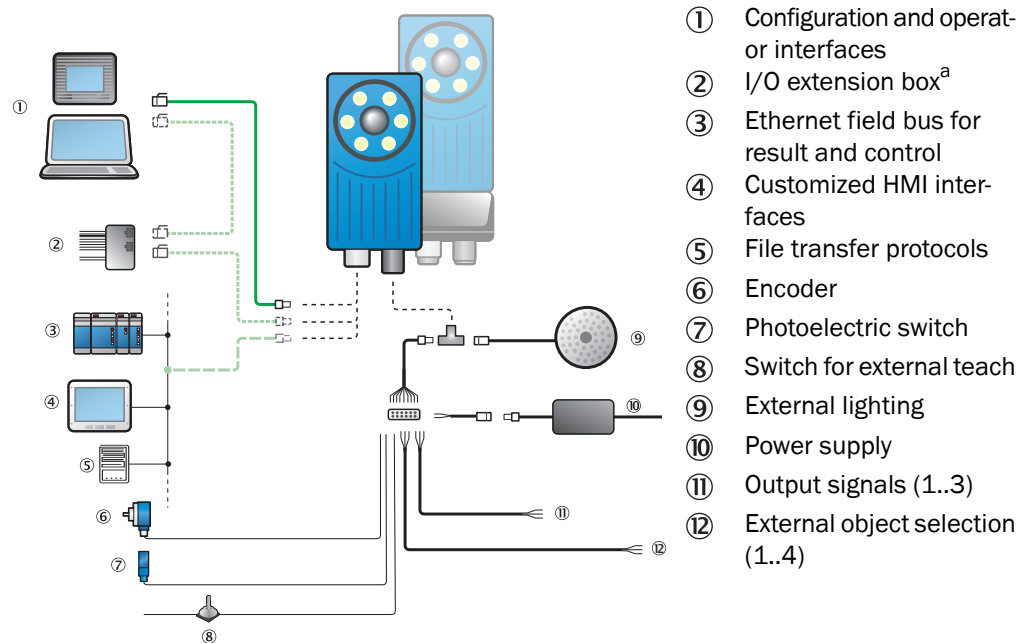
The Polygon tool is the preferred tool to use for positioning when the object is formed as a polygon but not always exactly defined in shape and size (then the Object locator tool could be preferred). Even if the polygon is exactly defined it can be an advantage to use

The object is lit from behind with a backlight to create high contrast. Inspector PI50 has located the object and detected an edge defect. It reports the position of the corners as well as the edge inspection result.

*Polygon tool instead of Object locator as the edges of the sides can be accurately inspected.*

### 3 Configuration and Machine Integration

The Inspector PI50 is designed for machine integration and offers a number of interfaces to interact with control equipment. The feature scope of machine integration is result, monitoring and control. Below image shows a summary of the available interfaces and a table overview of what features are implemented on the different interfaces.



<sup>a</sup>Not available for Inspector PI50 ECAT, VSPP-5F2134

Figure 3.1 Possible components in a positioning system.

#### 3.1 Initial Configuration

The initial tool configuration and interface set-up of Inspector PI50 is managed with **SOPAS Single Device**. This is a PC application delivered on the Inspector CD, which can be used for monitoring and advanced supervision apart for the initial configuration. When initial configuration is made, Inspector PI50 is ready to interact without connection to **SOPAS Single Device** according to its set-up.

#### 3.2 Result and image retrieval

Inspector PI50 generates the result after each image acquisition. This result can be read out as a binary value on the digital outputs or as detailed values over the field busses. The image can be retrieved for view or storage. Below table shows the possibilities of result and image retrieval on the different interfaces.

	Results					Image	
	Overall pass/fail/not located	Detailed pass/fail	Detailed values	Statistics	Trends	View	Storage
<b>Configuration interface</b>							
SOPAS Single Device <sup>a</sup>	X	X	X	X		X	X
<b>Digital interfaces</b>							

	Results					Image	
	Overall pass/fail/not located	Detailed pass/fail	De-tailed values	Statistics	Trends	View	Storage
Built-in digital outputs	X <sup>a</sup>	X					
Built-in digital inputs							
External I/O box	X	X					
<b>Operator interfaces</b>							
Inspector Viewer <sup>a</sup>	X	X	X	X	X	X	X
Web Server <sup>a</sup>						X	
<b>Field buses</b>							
Ethernet Raw	X	X	X				
EtherNet/IP	X	X	X				
EtherCAT <sup>b</sup>	X	X	X				
<b>Customized HMI interface</b>							
Web API <sup>a</sup>						X	
<b>File transfer protocols</b>							
Store images to FTP							X

<sup>a</sup>Factory default activated for VSPP-5F2113, VSPP-5F2413, VSPP-5F2134.

<sup>b</sup>Factory default activated for VSPP-5F2134.

### 3.3 Configuration and control

The Inspector PI50 supports external configuration handling and control. Once a configuration is created in **SOPAS Single Device** it can be stored directly on the device or exported to external memory for later handling such as device cloning or field exchange.

The Inspector PI50 can be controlled over the digital inputs as well as over the Ethernet interfaces. The digital inputs offers device control while the Ethernet interfaces also supports update of the configuration. The following table shows the possibilities of configuration and control via the various interfaces.

	Configurations		Control					
	Create	Handle	Image trig	External teach	Reference object selection	Encoder	Update configuration	Calibration
<b>Configuration interface</b>								
SOPAS Single Device <sup>a</sup>	X	X			X		full	X
<b>Digital interfaces</b>								
Built-in digital outputs								
Built-in digital inputs			X	X	X	X		
External I/O box					X			
<b>Operator interfaces</b>								
Inspector Viewer <sup>a</sup>		X		X	X		very limited	
Web Server <sup>a</sup>		X						
<b>Field buses</b>								

	Configurations		Control					
	Create	Handle	Image trig	External teach	Reference object selection	Encoder	Update configuration	Calibration
Ethernet Raw			X	X	X		limited	X
EtherNet/IP			X	X	X		limited	X
EtherCAT <sup>b</sup>		X	X	X	X		limited	X
<b>Customized HMI interface</b>								
Web API <sup>a</sup>		X		X	X		limited	X
<b>File transfer protocols</b>								
Store images to FTP								

<sup>a</sup>Factory default activated for VSPP-5F2113, VSPP-5F2413, VSPP-5F2134.  
<sup>b</sup>Factory default activated for VSPP-5F2134.

### 3.4 Connections

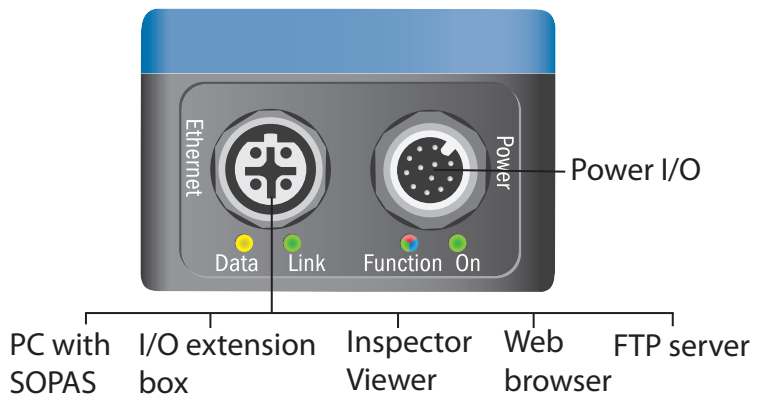


Figure 3.2 Connections Inspector PI50, VSPP-5F2113

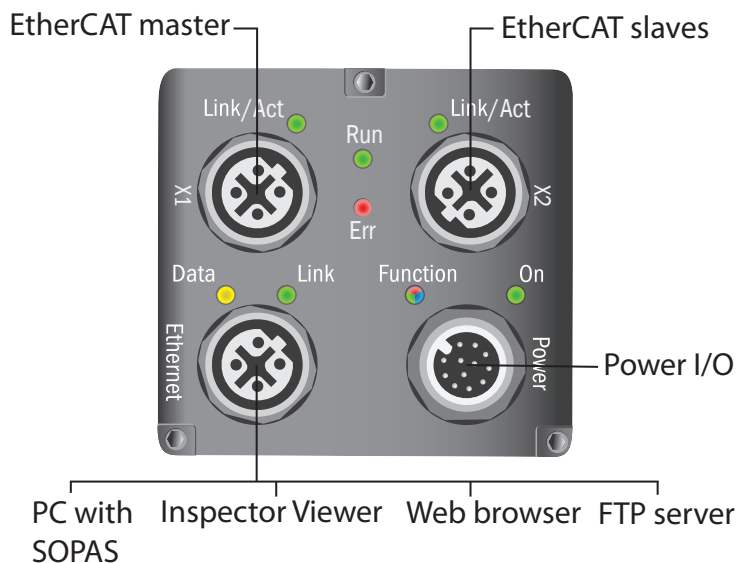













Figure 3.3 Connections Inspector PI50 ECAT, VSPP-5F2134

## 4 Toolbox


The toolbox for solving the vision task incorporates an “Object locator” and a number of “tools”. The Object locator is used to locate a pre-taught object independent of position, scale and rotation variations. The tools are used for detailed analysis and are per default related to the Object locator but can also be set to be independent of it.

All tools, including the Object locator, generate inspection result in form of a binary pass/fail as well as value based result/s that can be retrieved over Ethernet. The Object locator, Blob tool and Polygon tool can in addition generate positioning result (x, y).

Tool	Usage	Result data
<b>Object locator</b> 		
	Locate pre-taught object independent of position, scale and rotation variations, used when the shape of the object is always the same. One Object locator region can be applied per reference object.	Match score, position, angle and scale data.
<b>Blob</b> 		
	Find cluster of pixels within a defined grey range and size of cluster. Up to 8 Blob regions can be configured per reference object.	Number of found blobs and for each blob: Size in pixels, position, rotation, number of interior edge pixels, and border status.
<b>Pixel counter</b> 		
	Count pixels of a certain grey range within a region independent of pattern or clustering. Up to 32 Pixel counter regions can be configured per reference object.	Number of pixels.
<b>Edge pixel counter</b> 		
	Count edge pixels within a region independent of pattern or clustering. Up to 32 Edge pixel counter regions can be configured per reference object.	Number of edge pixels.
<b>Pattern</b> 		
	Compare a grey scale pattern pixel by pixel within a region. Up to 32 Pattern regions can be configured per reference object.	Match score.
<b>Polygon</b> 		



Inspector PI-series

Tool	Usage	Result data
	<p>Find edges of a pre-defined number of sided polygon (open or closed). Up to 8 Polygons can be configured per reference object.</p>	<p>Position of the end points and intersection of edges and defect detection of the edges.</p>

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# How To

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## 5 Getting Started

This chapter will guide you through the setup steps of locating and inspecting an object using some of the tools in the toolbox. The physical connection in this setup is using the simplest connection scenario for configuring needed for the Inspector PI50. Other connections are described in other chapters, see Chapter 3, “*Configuration and Machine Integration*” (page 13).

### 5.1 Preparations

#### 5.1.1 Task

The object in the example task used here is a saw blade, called the object in the text below, and the task is to locate it and verify that it is correct and possible to pick.



The object will be coming in front of the camera on a moving conveyor, and the position and angle are not fixed. All correct objects will be picked by a robot and all incorrect objects will be directed to a manual checking station.

It is important to make sure that the correct side of the object is facing up and that it is the correct type of saw blade. This will be done using tools to check the text on the blade and also to check the shape of the teeth. It is also important for the control system (PLC) to know that the object is possible to pick by the robot, and that no other objects are too close or on top of each other.

The needed result for the PLC is the position of a found object together with information if it is a correct or an incorrect object.

#### 5.1.2 Open the Box

The Inspector PI50 is delivered with the following parts:

- Inspector PI50 device
- Product installation CD
- A paper Quick Start
- A Hex key for adjusting focus
- Tool for removing the front window and changing the lens

In this application example, you will need the Inspector PI50, the CD and the Hex key for adjusting the focus.

### 5.1.3 Install SOPAS

**SOPAS** is the PC application for Windows used to control devices in the Inspector Vision Sensor Family. **SOPAS** is available in two versions:

- SOPAS Single Device
- SOPAS

**SOPAS Single Device** is only used for one Inspector at a time. **SOPAS** is used when simultaneously working with different SICK devices or multiple Inspectors. This manual only describes **SOPAS Single Device** (recommended).

#### Install from CD

To install the SOPAS application:

1. Start your computer and insert the SOPAS Inspector CD into your CD drive. The following window is displayed:

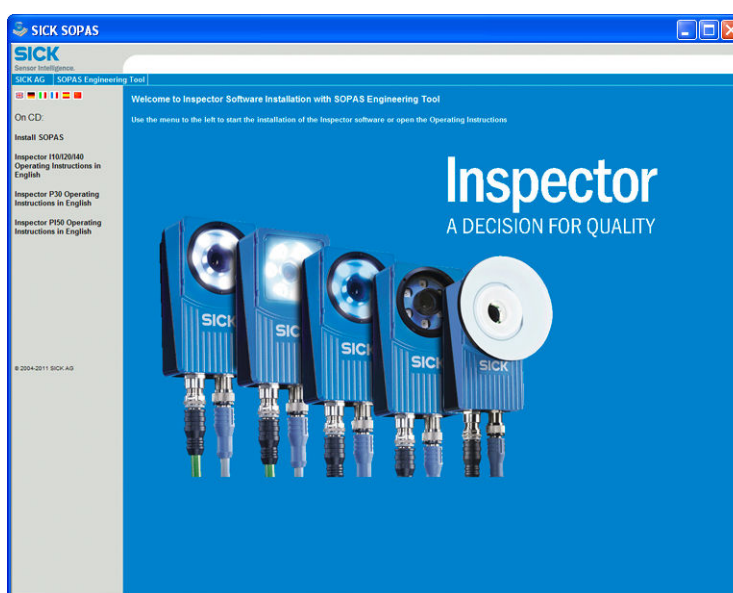


Figure 5.1 Inspector CD Welcome screen.

2. If your CD does not automatically show this window, open the CD and open the file `start.exe`
3. Click **Install SOPAS Single Device**. The installation program starts
4. Follow the on-screen instructions to complete the installation. A full installation is recommended.

## 5.2 Connect

### 5.2.1 Connect the Hardware

1. Mount the Inspector PI50 so that it is facing the object.

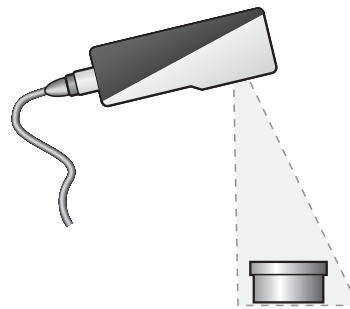


Figure 5.2 Mount the Inspector PI50 facing the object.

2. Connect the Ethernet cable from the Ethernet connector on the Inspector PI50 to the PC.

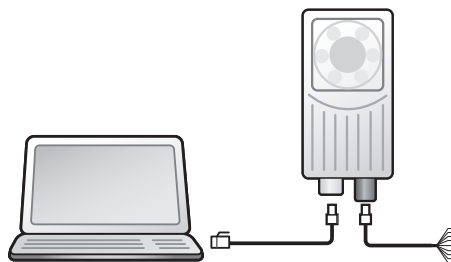


Figure 5.3 Connect the Ethernet cable.

3. Connect the Inspector PI50 power I/O cable to a 24 V DC power supply:  
Brown +24 V DC, pin 1  
Blue Ground (GND), pin 2

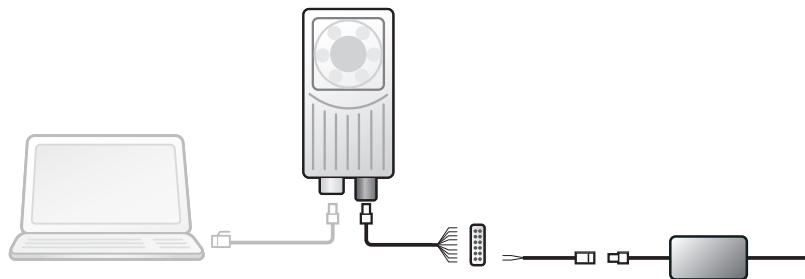


Figure 5.4 Connect to 24V DC power supply.

### 5.2.2 Connect SOPAS to the Inspector

Start **SOPAS Single Device** application on the PC and wait for the search for available devices to finish in the SOPAS welcome screen. Select the Inspector you want to connect to in the list of available devices.

#### Note

If the device is not in the list, click **Search connected devices** to open the **Connection Wizard** and perform a full search. For details see Section 6.1, "Use the Connection Wizard" (page 28).



Figure 5.5 SOPAS welcome screen

If the Inspector can be connected to, the connection is established and the **SOPAS Single Device** main window is opened. If the IP address of the Inspector must be changed before SOPAS can connect to the Inspector, the **Found devices** page in the **Connection Wizard** will be opened instead. See Section 6.4, “*Troubleshooting Connection Problems*” (page 29) for instructions how to change IP address.

### 5.3 Get a Good Image

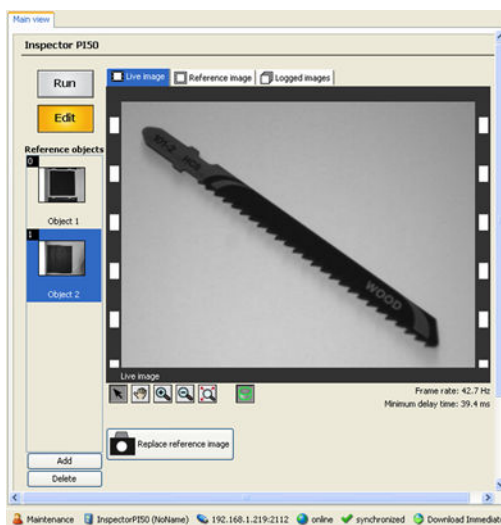


Figure 5.6 Main view

1. When the device is connected the live image is shown in the **Main view**. Switch from **Run** to **Edit** mode.
2. Place the object under the view of the Inspector PI50 so that it is visible in the **Live image** tab.
3. In the **Image settings** tab, click **Auto** to automatically adjust the image exposure and gain values.

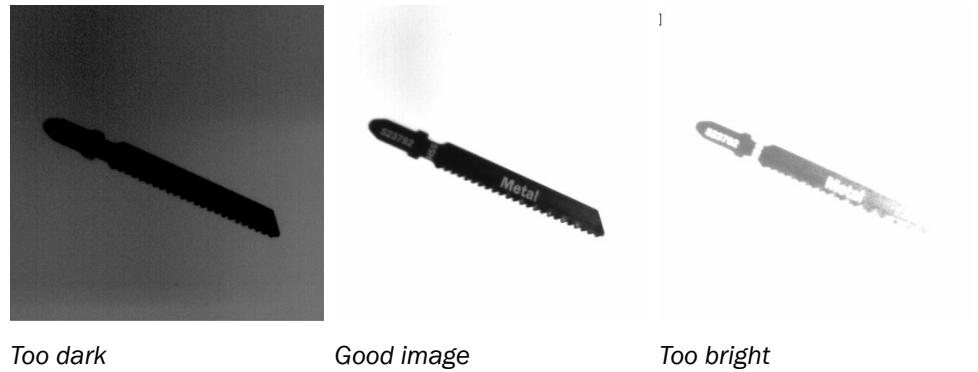


Figure 5.7 Image quality by tuning exposure time

- Adjust the focus by turning the adjustment screw on the top of the Inspector using the included 2 mm Hex key.

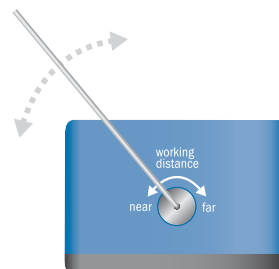


Figure 5.8 Adjusting focus.

The **Image settings** tab displays a focus feedback bar, which indicates when the focus is optimal.

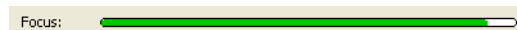


Figure 5.9 Focus feedback bar.

The image should now be sharp and neither too bright nor too dark.

At this stage one could calibrate the live image. Calibrate is an optional step that can be performed to get a good image in case of distorted image due to tilted mechanical set-up or use of a wide angled lens. It must also be performed if the result shall be presented as mm or inch values. See Chapter 9, "Calibrate" (page 41) how to perform a calibration. After calibration an image can be taken.

## 5.4 Configure the Application

To configure an application first thing is to teach a reference image of the object. The reference image is added to the reference object list and used as a reference when comparing and analyzing every acquired image in run time.

### 5.4.1 Teach the reference object

With the object in focus in the **Live image** tab, teach the reference object by pressing **Teach reference object**.

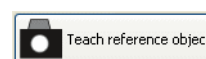


Figure 5.10 Teach reference locator button.

A reference image has now been created in the Reference objects list.

When the new reference object has been created then choose the tool you want to use in the Reference image tab.

### Note

It is possible to replace the image in the taught reference object. Click on the reference object in the Reference objects list and then choose Live image tab and adjust the settings of the image. Finally click Replace reference image.

### 5.4.2 Apply tools

Different tools within the toolbox are used to solve the application to position and inspect the saw blade:

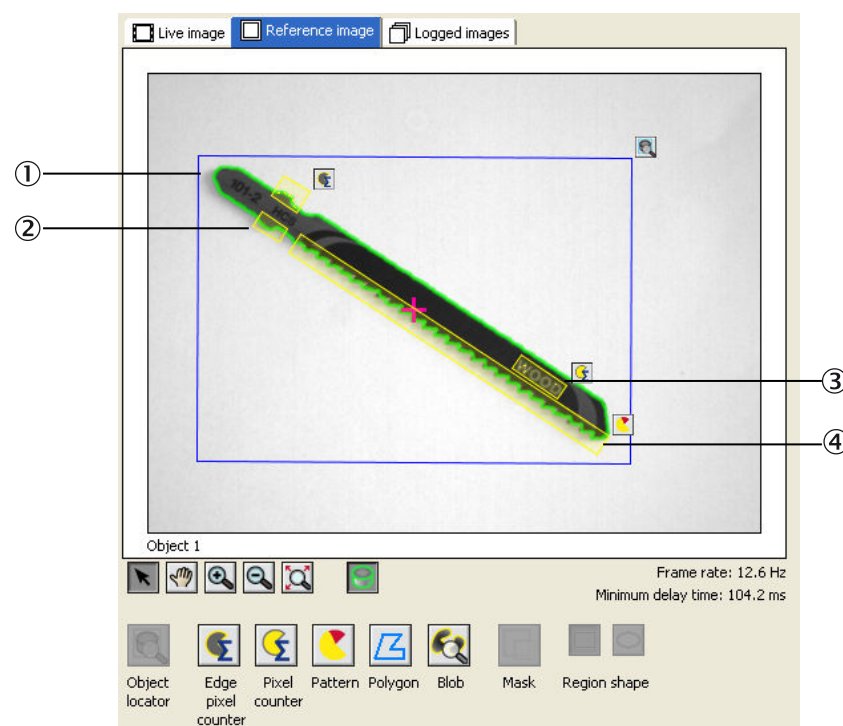


Figure 5.11 Applying tools in the reference image

#### Add Object locator ①

The Object locator is used to retrieve the location in terms of position and rotation of the saw blade. The location is used for two things: for positioning for the additional inspections and for report the result coordinates for precise picking.

To add an object locator press the button **Object locator**, then click in the image and draw a region which will be the object locator. A blue rectangular region appears that shows which part of the image that shall be taught (object locator region).

If necessary, move, resize and rotate the region. The green contours show what shape is recognized by the object locator.

For the object locator to work well, the amount of green contours needs to be enough (see the following images). The amount of contours is adjusted with the **Edge strength** slider in the **Object locator** tab.



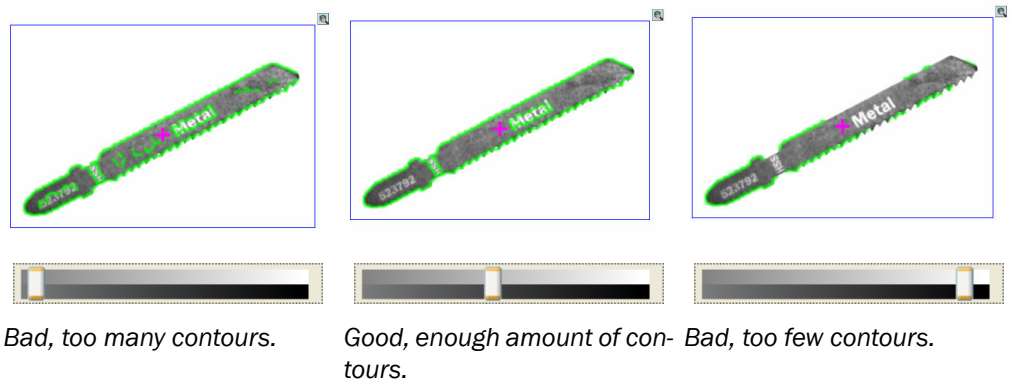


Figure 5.12 Adjusting the amount of contours.

In the center of the blue object locator teach region is the reference point, shown by the purple cross. If a particular point on the object shall be reported rather than the centre of region, for example as a pick point for a robot, move it manually to the desired position.

**Add Edge Pixel Counter ②**

An **Edge pixel counter** is used to make sure that the grip region is free from foreign objects. Add an Edge pixel counter by pressing the button Edge pixel counter , then click the image and draw a region.

If necessary, move, resize and rotate the region. The yellow edges show what edges are recognized by the tool.

Set the lower thresholds No. of edge pixels to zero and the upper to some pixels, this will result in a fail result as soon as a foreign object enters the region. Set the threshold Inspection edge strength by testing to insert a foreign object in the region. A good threshold is found when there are some yellow edges in the region when entering the object and no edges when no object is there.

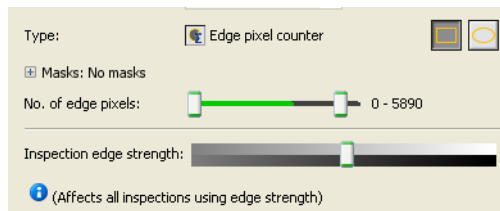


Figure 5.13 Parameters of Edge pixel counter tool

**Note**

For the tool to be able to see if the grip region is free we need a clean background.

**Add Pixel Counter ③**

A pixel counter is user to make sure that correct side of the saw blade is faced up by detecting the text on the top. Add an Pixel counter by pressing the button Pixel counter , then click the image and draw a region.

If necessary, move, resize and rotate the region. The yellow overlay show what pixels are recognized by the tool.

Set the upper and lower thresholds of the Intensity range so that the yellow graphical overlay only covers the text "Metal". Set the upper and lower threshold of No. of pixel in range just above and under the peak of the green bar.

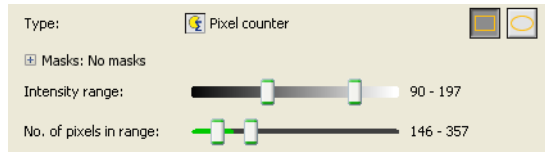


Figure 5.14 Parameters of Pixel counter tool

**Add Pattern** ④

Pattern is used to quality inspect the teeth of the saw blade. Add a pattern region by press the button Pattern button then click the image and draw a region.

If necessary, move, resize and rotate the region.

Set the threshold Position tolerance to 3 or 4 pixels for best stability. Set the Go to live image tab and test a good quality saw and bad quality saw to find a good threshold for the Match score.

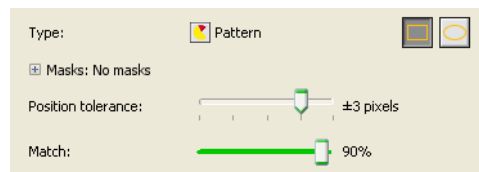


Figure 5.15 Parameters of Pattern tool

**Tool relation**

By default, all tools are automatically related to the object locator which makes the inspections follow the position and rotation of the moving saw blade on the belt.

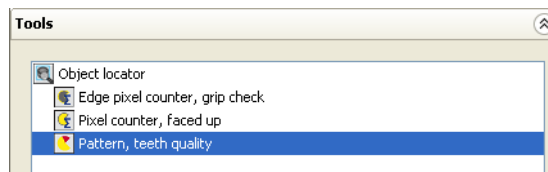


Figure 5.16 Tool relation

**5.4.3 Monitor the Result**

Switch from the Reference image tab to the Live image tab and see how the Inspector PI50 locates the object when it is moved around and also how it reports the results of the inspection in the Results tab.

The Results tab shows the over all result and behavior of the digital outputs. The details of the output definitions is found in Chapter 11, "View Result and Statistics" (page 57) .

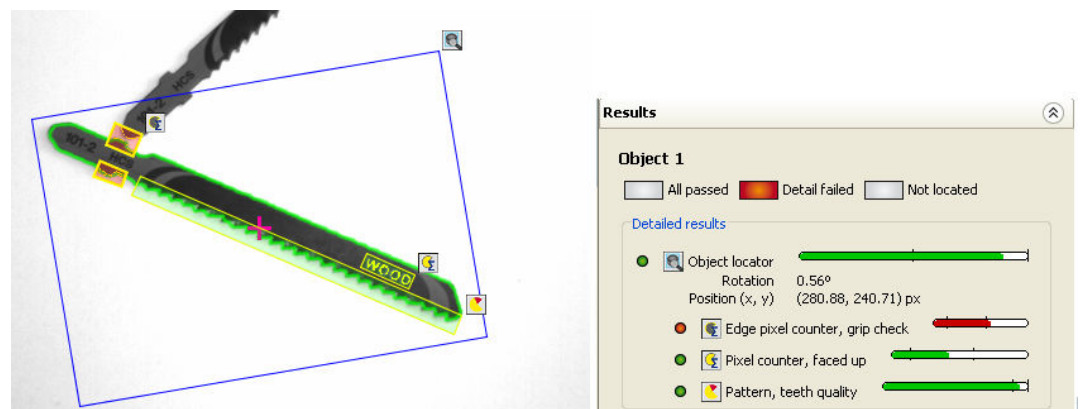


Figure 5.17 Live image and result of grip region fail

**Inspector PI-series**

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In addition, detailed results such as match score (the green bar) and the location of the reference point is displayed. For positioning applications, this is information that can be retrieved from the Inspector via ethernet. Note that the x and y coordinates are the number of pixels from the top left corner of the image.

---

**Note**

When configuring the Inspector PI50, the physical outputs are enabled by default. You can enable them in **Edit mode** by clicking **Enable built-in outputs in Edit mode** in the **Interface and I/O Settings** dialog in the **InspectorPI50** menu. To be able to use digital I/O at all they have to be enabled first.

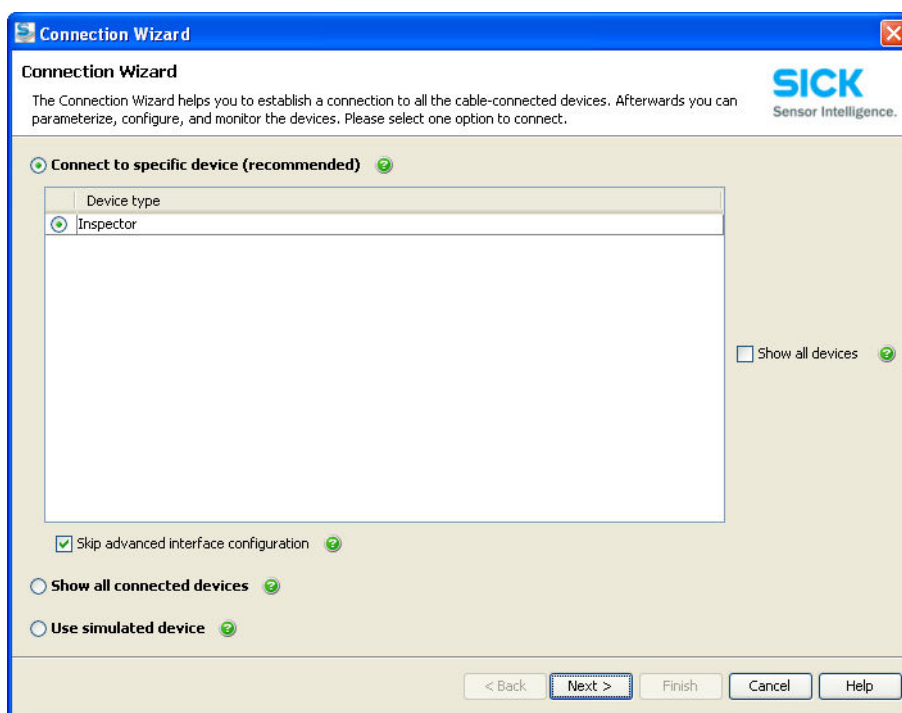
---

## 6 Connect

To connect to an Inspector that is plugged in to the PC or the network, either select the Inspector in the SOPAS welcome screen, see Section 5.2.2, “Connect SOPAS to the Inspector” (page 21), or choose **Connection Wizard** from the **Communication** menu in **SOPAS Single Device**.

### 6.1 Use the Connection Wizard

To connect to an Inspector using the **Connection Wizard**, open **Connection Wizard** in the **Communication** menu, choose **Connect to specific device** and select **Inspector** in the device type list. Then click **Next**.



**SOPAS Single Device** will now search for Inspectors that are connected to your computer through the network:

- If there is only one Inspector connected, SOPAS will automatically try to connect to that Inspector and open the main window.
- If there are more than one Inspector connected, or if there was a problem connecting to the only connected Inspector, the **Found devices** page will be displayed.
- If the **Interface selection** page is displayed, click **Next** to go forward and to start searching for Inspectors.

The icons and colors in the list of found devices have the following meanings:



The Inspector can be connected to.



The Inspector is used by another user.



The IP address of the Inspector must be changed before SOPAS can connect to the Inspector.

See Section 6.4, “*Troubleshooting Connection Problems*” (page 29) for instructions on how to change IP address.



No matching SDD available. The file **Inspector PI50.sdd** is missing. Copy the file from a working **SOPAS Single Device** application. **SOPAS Single Device** has to be shut down and restarted to be able to connect to a device.

## 6.2 Manage IP Address

### Change IP Address

To change the IP settings of an Inspector, for instance as a preparation before moving the Inspector to another network, do the following:

1. Open the **Connection Wizard** from the **Communication** menu in **SOPAS Single Device**.
2. Choose **Connect to specific device**, select **Inspector** in the device type list, and deselect **Skip advanced interface configuration**. Then click **Next**.
3. In the **Interface selection** page, click **Next**.
4. In the **Found devices** page, select the Inspector to configure and select to change the device IP settings **Manually**.
5. Change the IP configuration and click **OK**.

The wizard will now configure the Inspector with the new IP configuration and the **Found devices** page will after a while be shown again. If the task was only to change the IP address of the device, the connection flow can now be cancelled.

### View IP Address

To view IP address of the device:

1. Choose **Device info** from the **InspectorPI50** menu.
2. Select the **Network** tab. The IP address is displayed.

## 6.3 Use a Simulated Device

How to use a simulated Inspector device instead of connecting to an real Inspector is described in Chapter 24, “*Use the Simulated Device*” (page 99).

## 6.4 Troubleshooting Connection Problems

### No device was found

- Make sure the Inspector has started.  
You may have to wait up to 40 seconds after switching on the power or after restarting the Inspector before it's available for connection.

- Make sure the PC has a network connection.  
The icons in the Windows taskbar can indicate if the PC's network connection is not working properly:



The PC has no connection to the network



The PC is trying to connect to the network, but does not yet have a network connection.



The PC is connected to a network, but the connection is not properly set up.

This should be OK if the Inspector is connected directly to the PC without any local network.

- Click **Scan again** to make SOPAS search the network again.

### Ethernet connector icon is red. Notice: "Please configure the device interface"

You will need to change the IP address of the Inspector or the PC before connecting.

To change the Inspector's IP address, do the following:

1. Select the Inspector in the list of found devices.
2. Depending on the connection to the Inspector, do one of the following:
  - If the Inspector is connected with the Ethernet cable directly to the PC, choose to change the device IP settings **Automatically**. When the new settings are presented, click **Yes** to write the settings to the Inspector.
  - If the Inspector is connected via a local network, that has a DHCP server available that distributes IP addresses. In that case choose to change the device IP settings **Manually**, select **Obtain the IP settings automatically (DHCP)** and click OK.

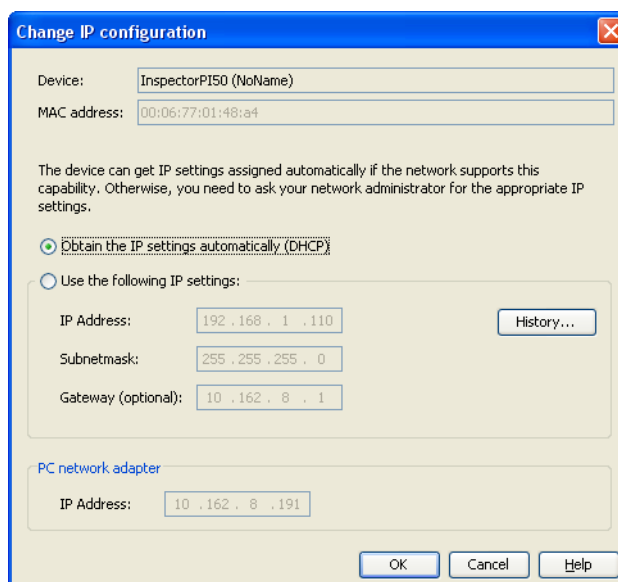


Figure 6.1 Change IP configuration

### Other Connection problems

See the **SOPAS Engineering Tool help** for more information on other connection related problems.

### 6.5 Connect to an Inspector Remotely

You can connect to an Inspector without scanning (UDP broadcast) for it if you know the IP address of the Inspector. This could be useful for example if you have a remote connection to the Inspector over VPN (virtual private network)

1. Choose **Connection Wizard** from the **Communication** menu.
2. Choose **Connect to specific device**, and select **Inspector** in the device type list.
3. Make sure that **Skip advanced interface configuration** is not selected, and click **Next**.
4. On the Interface selection page, click **Configure interface**.
5. Disable **Auto IP** by deselecting **Enable Auto IP**.
6. In the Internet Protocol (IP) dialog box, click **Add** to add a new item to the list of IP address configurations.
7. In the Add dialog box, choose **Single address** and enter the IP address of the Inspector.
8. Click **OK** twice to return to the connection wizard, and then click **Next** to locate the Inspector.

If SOPAS was able to locate the Inspector, it will be displayed on the Found devices page. In that case, click **Next** to connect to the Inspector.

If SOPAS was not able to locate the Inspector, the list of found devices will be empty. In that case, see Section 6.4, "*Troubleshooting Connection Problems*" (page 29) for troubleshooting tips.

## 7 Use SOPAS Single Device

The Inspector PI50 has a PC based configuration application for any of the Inspector variants. The application is graphical. The **SOPAS Single Device** is a slim version of **SOPAS** (Engineering Tool) for supervision of one Inspector at the time.

The main usage of the PC based configuration application is to configure the Inspector. It also features a powerful support for monitoring live or log images, results and statistics in runtime. It also has support for post analysis and fine tuning of configuration in a simulated device environment.

**SOPAS** can be used for configuration of several devices, Inspectors and other SICK devices compliant with SOPAS, in a single application. **SOPAS** has a slightly different user interface and functions and is not described in this chapter. For further information on how to use multiple device configurations, see the SOPAS help for Engineering Tool.

### 7.1 Framework

This section describes the framework when connected to a real device. For specific controls for the simulated device, see Chapter 24, “Use the Simulated Device” (page 99). The figure below describes the **SOPAS Single Device** application and **Live Image** tab in the **Main view** after connected to the device.

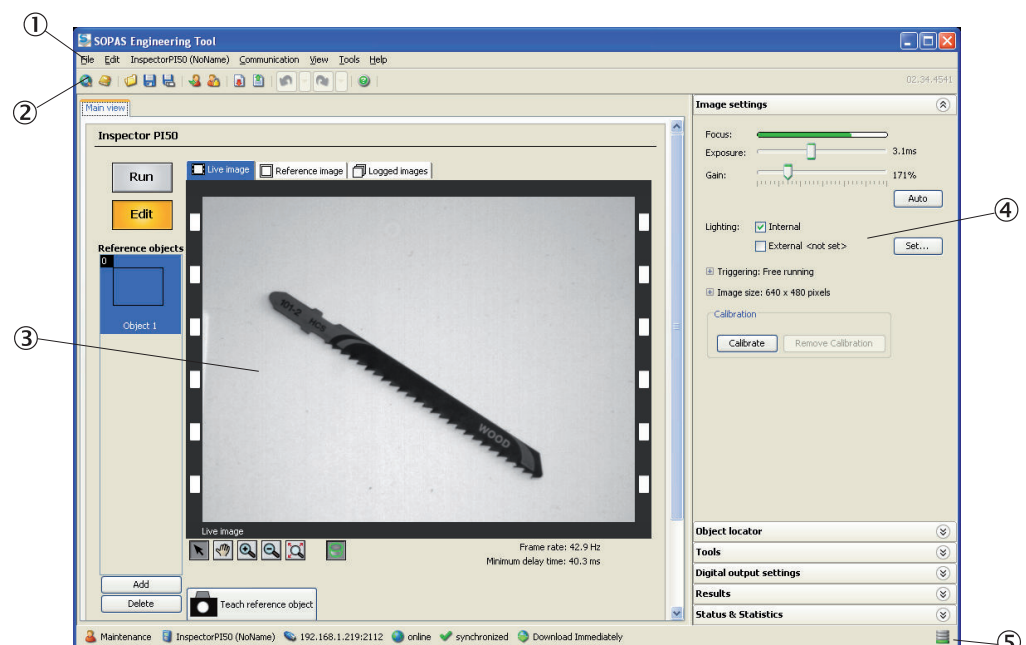


Figure 7.1 SOPAS Single Device main window

- ① Menu bar:
- **File** menu with for example alternatives for opening, and saving device configuration
  - **Edit** menu with for example the possibility to load data to device
  - **InspectorPI50** menu, see Section 7.3, “InspectorPI50 Menu” (page 34)
  - **Communication** menu for communication alternatives, for example run **Connection Wizard**
  - **View** menu. Select visible views in the GUI.
  - **Tools** menu. For example for switching language



- **Help** menu for starting **Help** and view version information **About Inspector** (application, FPGA, and monitor firmware versions)
- ② **Toolbar**
- ③ **Main view** with information and controls for (see Section 7.2, “*Main View*” (page 33) ):
  - **Image view** that can be either of **Live image**, **Reference image**, **Logged images**.
  - **Reference objects list**
  - **Teach reference object**.
- ④ **Tabs** for different detailed configuration tasks for Inspector PI50
- ⑤ **Status bar** reporting the user level, connected device, and synchronization status

## 7.2 Main View

### Run/Edit switch







Click **Edit** to teach reference images, set up inspections, and to test. Click **Run** mode for operating the device at full speed in production conditions. Settings can not be changed in **Run** mode.

### List of Reference Objects

The **Reference objects** list contains all taught reference objects. To select which reference object to work with, select **Edit** mode and click on the reference object in the list. Click **Add** to create a new reference object. Click **Delete** to remove the selected reference object. Reference objects can also be copied by right-clicking a reference object in the list and selecting **Copy to new reference object**.

### View Controls

The view control buttons consists of tools to work with regions and to set the view of the image. The buttons are:

-  Select regions. When moving the mouse pointer over the image the coordinates are visible in the frame of the image.
-  Move (pan), move a zoomed in image
-  Zoom in the reference image
-  Zoom out in the reference image
-  Zoom to fit - restores the image to full size after zooming in or out
-  Show or hide contours and feedback graphics of a ROI of a tool or locator in the reference image

### Frame Rate and Minimum Delay time

**Frame rate** shows the number of analyzed images per second (in Hertz, Hz). For triggered inspections, the max frame rate is the highest frequency with which the trig pulses can occur. Trigger pulses that occur at a higher rate are discarded, and can be viewed in the **Statistics** tab as **Number of ignored trigger pulses**. The **Minimum delay time** is the shortest delay time on any output signal (in milliseconds, ms). See also Chapter 22, “*Improve Speed*” (page 95).

### Add

Use **Add** button to make a new reference object. This button is enabled in **Live image** tab and **Reference** tab.

**Delete**

Use **Delete** button to delete a reference object. This button is enabled in **Live image** tab and **Reference** tab.

**7.2.1 Live Image tab****Live Image**

The **Live image** tab contains view control buttons, a teach button and output selection. When clicking on the teach buttons, an image is captured. An **Object locator** or desired tool can now be used in the new reference image.

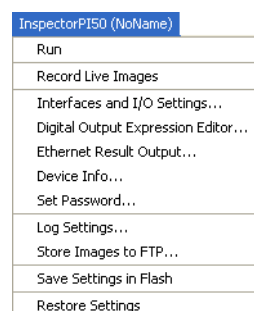
**7.2.2 Reference Image tab**

In the **Reference image** tab you can find the tools to use in the reference object. The inspections created with the tools Edge pixel counter, Pixel counter, Pattern, and Blob can be copied and pasted in the same reference object by right-clicking on the region. A polygon can not be copied and pasted. An object locator region can be copied from one reference object and pasted into another reference object.

**7.2.3 Logged Images tab**

The **Logged images** tab view the latest logged images. The images is shown in the images list in the lower part of the tab. Choose which images to log by choosing from **Log settings** from the **InspectorPI50** menu. When the Inspector PI50 is storing images to FTP, the image log cannot be displayed.

The list of logged images contains the 30 most recent logged images. To delete all images in the log, click on the **Clear log** button. To refresh the list, click on the **Update log** button. To save the images in the log to file, click on the **Save log** button. The images will be saved in two separate folders, one folder with the saved images with graphics and one folder without graphics in the saved images.

**7.3 InspectorPI50 Menu****Run**

The menuitem is shown when **SOPAS Single Device** is in Edit mode. To switch the Inspector to **Run** mode:

1. Choose **Run** from the **InspectorPI50** menu.  
A warning dialog box is displayed if any settings have been changed.
2. Click **Save to flash** to save the new settings in the Inspector's flash memory (permanent storage of configuration on device).

**Edit**

The menuitem is shown when **SOPAS Single Device** is in Run mode. To switch the Inspector to **Edit** mode, choose **Edit** from the **InspectorPI50** menu.

**Record Live Images**

Saves a stream of live images to file on the disk drive of the PC. For a detailed description see Section 23.3, “Record Live Images to PC” (page 97).

**Interfaces and I/O Settings**

To view or change interface settings, choose **Interfaces and I/O settings** from the **InspectorPI50** menu. Note that the settings made here are global for all reference objects. For more information about to configure the interfaces, see Chapter 14, “Use digital I/O” (page 64) to Chapter 18, “Use Web Server” (page 79).

**Digital Output Expression Editor**

In the dialog **Digital Output Expression Editor** you can define additional inspection results – for example if certain detailed inspections failed – which can then be mapped to digital outputs. For more information about digital output expression editor see Section 14.3, “Use Digital Outputs ” (page 68).

**Ethernet Result Output**

To configure the device to send Ethernet based result output, choose **Ethernet Result Output** from the **InspectorPI50** menu. For more information, see Section 16.2, “Output Results” (page 74).

**Device Info**

To see information about the current device, choose **Device Info** from the **InspectorPI50** menu. The **Device Info** dialog box is displayed, with two different tabs: **General** and **Network**.

**General**

Here you can see the following information about the device:

Name	The name of the current Inspector PI50 (device). The name can be changed. The name appears next to the <b>InspectorPI50</b> menu and also in the <b>Connection Wizard</b> .
Serial no	The serial number of the connected Inspector PI50 (device).
Save System Dump	To save the contents of the memory of the Inspector, click <b>Save system dump</b> . Select the directory where to save the dump. This is only used for support provided by SICK.

**Network**

Here you can see the following information about the network:

TCP/IP	The network configuration type; DHCP or Manually.
IP address	The IP address and port of the current Inspector PI50 (device).
Netmask	The netmask of the current Inspector PI50 (device).
Gateway	The gateway address for the network.
Network speed	The network speed for the current network connection.
MAC address	The MAC address or the Ethernet ID for the network card in the Inspector.

**Set Password**

To change the current password in the Inspector for user level **Maintenance** (used for **Edit mode**), choose **Set Password** from the **InspectorPI50** menu. The **Login** dialog box is displayed. Enter current password (default password is *Inspector*). Select user level **Maintenance**. Enter new password and re-enter new password. Click **OK**.

To remove password protection of **Edit mode** (user level **Maintenance**), set the password to the default password *Inspector*.

**Log Settings**

To select which types of images that should be logged, choose **Log Settings** from the **InspectorPI50** menu. For more on image log see Chapter 23, “*Log and Store Images*” (page 96).

The 30 most recent images of the specified type are saved in the log. The images can be viewed in the **Logged images** tab. The settings is also valid for storing images to FTP.

**Store images to FTP**

To store images to FTP. See Chapter 19, “*Store images to FTP*” (page 82) and Chapter 23, “*Log and Store Images*” (page 96).

**Save Settings in Flash Memory**


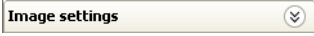

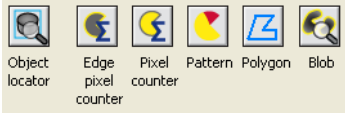
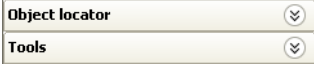
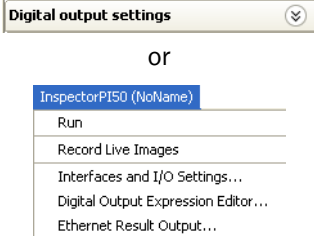



To save all device data (settings) in the Inspector's flash memory, choose **Save Settings in Flash** from the **InspectorPI50** menu. A progress bar is displayed during the process. When saving to flash memory the function LED will flash white. The Inspector will stop analyzing images until the flash memory is updated. For more information about device data, see Chapter 25, “*Handle Device Data*” (page 101).

**Restore Settings**

It is possible to restore settings and return to the factory settings. All device data will be deleted. To restore settings choose **Restore Settings** from the **InspectorPI50** menu. For more information about device data see Chapter 25, “*Handle Device Data*” (page 101).

## 7.4 Configuration Workflow

The basic flow when configuring an application is described in the table below. The flow assumes that the device is physically connected and that a connection to the Inspector PI50 has been established. For more information on how to connect, see Section 5.2, “*Connect*” (page 20) and Chapter 6, “*Connect*” (page 28):

SOPAS Single Device GUI reference	Description
	To be able to change the settings click <b>Edit</b> .
	Adjust the image settings to obtain a good image for the application and decide on how to capture the image, see Chapter 8, “ <i>Adjust Image</i> ” (page 38).
	Click <b>Teach reference object</b> to start configuring the application. See Section 5.4.1, “ <i>Teach the reference object</i> ” (page 23).
	Depending on the application type choose one or more of the tools in the <b>Reference image</b> tab
	Configure the settings for the tools, see Chapter 10, “ <i>Use the Toolbox</i> ” (page 44).
	Configure the settings for the digital outputs, for example active time and delay, see Section 14.3, “ <i>Use Digital Outputs</i> ” (page 68). Optionally choose to configure Ethernet based result output from the Inspector PI50, see Section 16.2, “ <i>Output Results</i> ” (page 74). If other interfaces than the default digital outputs are needed, configure this in the <b>Interface and I/O settings</b> dialog and <b>Ethernet result output</b> menus.
	Click <b>Run</b> to set the device in operating mode. If configuration should be permanently stored on the device choose <b>Save to flash</b> when asked if store to flash memory should be done
	Monitor the results for the analyzed images.
	Monitor the statistics for the analyzed images.

# 8 Adjust Image

## 8.1 Adjust Focus

To adjust focus, place an object to inspect in front of the Inspector, so that it is visible in the Live image tab.

Adjust the focus by turning the adjustment screw (hex key) on the top of the Inspector. Use the 2 mm Hex key that came with the Inspector. Look at the Live image tab and adjust until the image is focused.

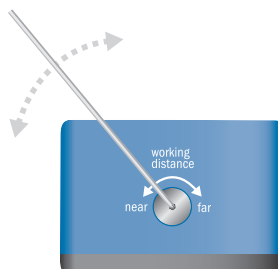


Figure 8.1 Adjust focus

## 8.2 Adjust Image Settings

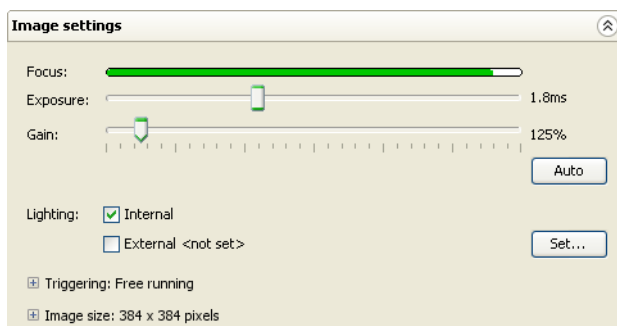
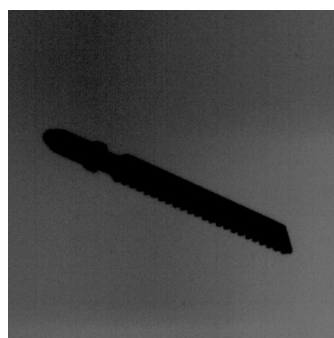


Figure 8.2 Image settings

Adjusting **Exposure** and **Gain** settings changes the image quality. To adjust exposure time and gain to good values, click **Auto**. The **Auto** adjustments will change exposure time and gain, only after clicking on **Auto**, the settings will not change continuously.



Under exposed (increase exposure time)



Good exposure



Over exposed (reduce exposure time)

## 8.2.1 Adjust Exposure

Exposure: amount of time imager is open to receive light. Measured in milliseconds (ms). Increasing the exposure time results in brighter images, but may also result in a lower frame rate.

If the object is moving and exposure time is too long, the image will be blurred, which may result in lower accuracy in the inspections. When a short exposure time is necessary because of object speed, there are two methods to make the image bright enough:

- Use external high-intensity lighting
- Increase the gain

To adjust exposure time, drag the **Exposure** slider on the **Image settings** tab.

## 8.2.2 Adjust Gain

The **Gain** setting is used for increasing the gain of an image after it has been captured. Increasing the gain may also increase the noise in the image and make it appear grainier. To adjust gain, drag the **Gain** slider on the **Image settings** tab. Setting **Gain** to 100% means that the image will be unaffected. A higher value means that the image will be brighter.

## 8.3 Use Lighting

The Inspector has a built-in lighting using LEDs (Light Emitting Diodes).

There are four different combinations of how to use lighting:

- None, only ambient light is used, such as normal indoor light or sunlight
- Internal (or built-in) lighting
- External lighting
- Internal and external lighting

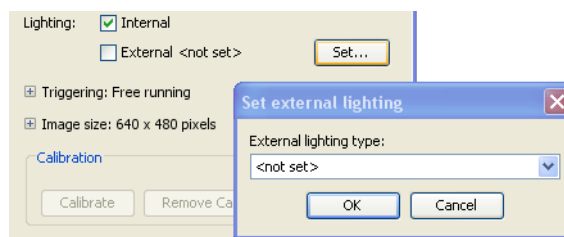


Figure 8.3 Use lighting options.

### Note

The internal and external light are active during the whole exposure time.

For a robust solution, always use internal or external lighting (or both). It is not recommended to only rely on ambient light.

### 8.3.1 Use Internal Lighting

To turn on (or turn off) the built-in lighting in the Inspector select (or deselect) the **Internal** check box on the **Image Settings** tab.

### 8.3.2 Use External Lighting

Before the Inspector can use an external lighting, the type must be specified.

To use external lighting with the Inspector:

1. Select **External** on the **Image Settings** tab.
2. Choose the correct external light source from the list in the **Set external lighting** pop-up dialog box.
3. Click **OK**

If a SICK ICL light source is used, the only configuration required is selecting the ICL-type in the list and all other settings will be configured automatically. Note that if the selected exposure time is longer than the maximum active time for the selected light source, then the exposure time is automatically adjusted to this limitation.

If a SICK light source used in combination with the VLR Trigger unit, the **Other – active low** choice shall be selected from the list.

#### Non-SICK External Light

If a non-SICK external light source is to be used, select **Other – active high** or **Other – active low** depending on the specifications of the external lighting. The option **Other – active high** is used for light sources that triggers on an active high signal (+5 V) and the option **Other – active low** is used for light sources that triggers on an active low signal (0 V). The signal is active during the whole exposure time, so adjust the **Exposure** setting to be lower than the maximum active time for the light source. If the external illumination has duty cycle restrictions, use an image trigger and adjust the trig rate so that the duty cycle of the light source is not exceeded.

#### Warnings

Do not use longer exposure time than what the external light is designed for. See the technical data for the light source.

Do not use shorter cycle time (frame rate) than what the external light is designed for. See the technical data for the light source.

To handle the variations of surrounding light an ambient light compensation can be used, see Section 21.2.1, “*Enable Ambient light compensation*” (page 91). To connect to an external light see Section 14.3.6, “*Connect an external light*” (page 71).

## 8.4 Adjust Image Size/Field of View

The image size is the size in pixels of the images captured by the Inspector.

The image size can be changed by changing field of view. Adjust the field of view so that the Inspector only captures images of the area in which the objects are expected to be found. The default field of view is the full area that the Inspector sees.

To change the field of view:

1. In the **Image Size** section of the **Image settings** tab, click **Change**.
2. In the **Live image** tab, resize the grey rectangle **Valid FOV** (field of view) region with the handles. The **Minimum FOV** (red rectangle) depends on all applied regions, that must be inside the field of view.



Full FOV



Reduced FOV

3. Click **Resize**. The Inspector will now use the new image size.



## 9 Calibrate

### 9.1 Overview

The calibration wizard can be started from the **Image settings** tab in **SOPAS Single Device**. The calibration model describes the geometrical relationship between the image sensor and the plane of the chessboard pattern.

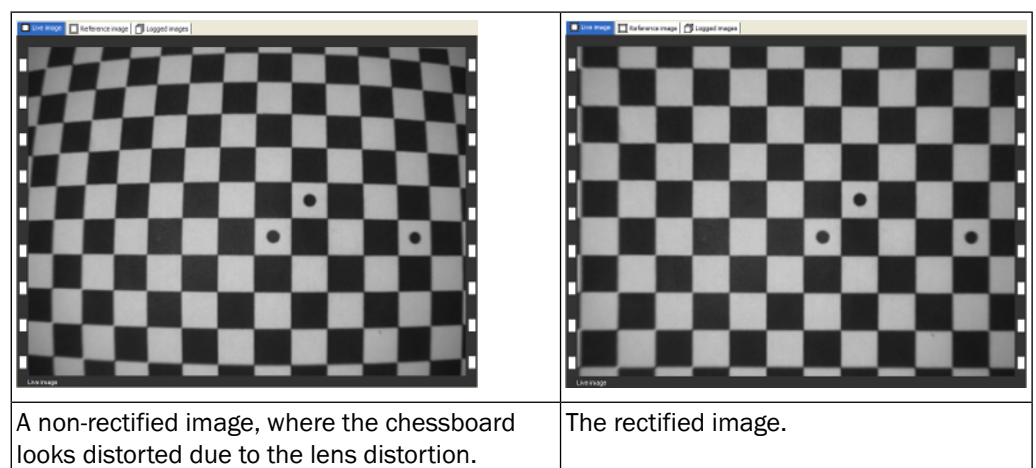
The model takes the following aspects into account:

- Scaling due to lens and standoff
- Lens distortion
- Perspective effects from cameras mounted with an angle to the chessboard

It is recommended to recalibrate in case of:

- unmounting and mounting of a lens, also remounting of the same lens
- adjusting focus
- replacing device

The calibration can be saved permanently on the device. Same calibration is being used for all reference objects. After the calibration the position results are presented in millimeters in the coordinates system of the chessboard pattern. All live images is also rectified, i.e. that the image is resampled according to the calculated calibration (see images below).



#### Note

It is possible to move a configuration from one device to another. If this is done the order to calibrate and configure is important; first calibrate and then configure the device. It is important that both devices are either calibrated or not calibrated. This is to reduce the differences in the result.

### 9.2 Preparation

Following preparations has to be done before calibrating:

- Measure the size of the chessboard square
- Place the calibration object (chessboard pattern in a pdf-file, found in the installation CD) in front of the device
- Connect to the device using **SOPAS Single Device** and switch to Edit mode
- Adjust focus, exposure and gain, see Chapter 8, “Adjust Image” (page 38).

**Note**

To be able to calibrate the following requirements must be fulfilled:

- The chessboard must have at least 4x4 but no more than 50x50 squares
- Minimum size of a square side is 15 pixels

**9.3 Instruction**

From the Image settings tab in **SOPAS Single Device** the calibration wizard can be started.

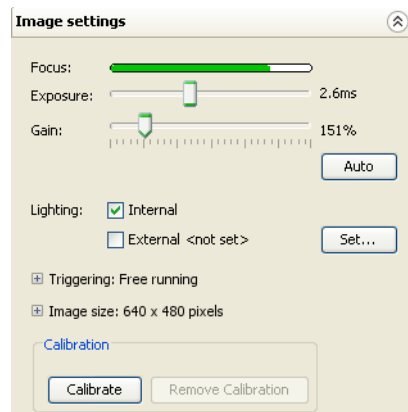


Figure 9.1 Calibrate in Image settings tab

1. Press **Calibrate** to open the **Calibration Wizard**. An un-rectified live image is shown.

**Note**

Note: If the camera has already been calibrated the **Calibrate** button is instead named **Re-Calibrate**.

2. Enter the side length of a chessboard's square in the calibration object in mm and then press **Calibrate**. The origin is shown as 2 thicker lines with the y-axis drawn on top of the x-axis. It is placed in a fixed position relative to the 3 circular dots on the chessboard. If no such dots are present, the origin is placed on the chessboards square corner nearest to the center of the image. The chessboard pattern should preferably cover the complete image.

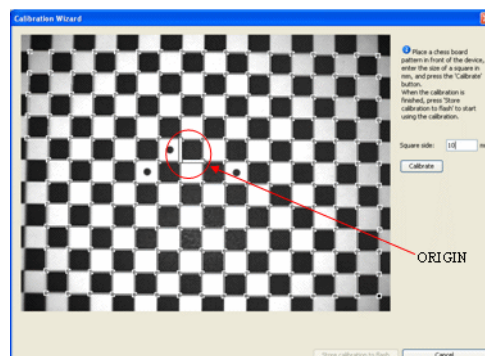


Figure 9.2 Start calibration

**Note**

The calibration is performed at full image size even if the image has been resized.

3. The calibration process is started and a progress bar is shown. This step can take about 1 minute.
4. When the Calibration has finished the window will show the results in terms of Mean and Max error in pixels, and pixel size. Now the rectified live image is shown.

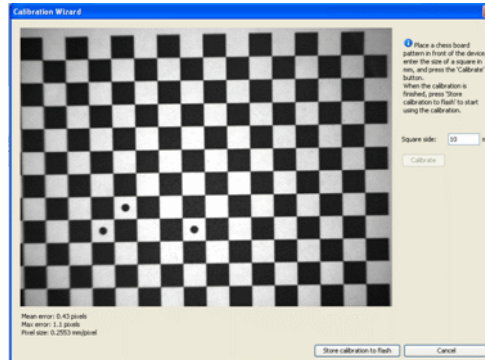


Figure 9.3 Calibration result with rectified image.

5. If the calibration shall be stored on the device press **Store calibration to flash**. This will permanently store the calibration and all acquired images will be rectified. If the calibration should not be stored, press **Cancel**.

# 10 Use the Toolbox

## 10.1 Tool concept

The toolbox for solving the vision task incorporates an “Object locator” and a number of “tools”. The Object locator is used to locate a pre-taught object independent of position, scale and rotation variations. The tools are used for detailed analysis and are per default related to the Object locator but can also be set to be independent of it.

All tools, including the Object locator, generate inspection result in form of a binary pass/fail as well as value based result/s that can be retrieved over Ethernet. The Object locator, Blob tool and Polygon tool can in addition generate positioning result (x, y).

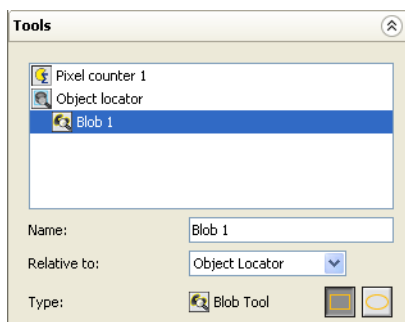


Figure 10.1 Tool tab

An Object locator or inspection is added with the buttons below the reference image. Click on the Object locator or one of the tool buttons and then click in the image to add the Object locator or inspection in the reference object.

A ROI is created representing the Object locator or tool. The ROI can be moved in the image. The inspections created with the tools Edge pixel counter, Pixel counter, Pattern, and Blob can be copied and pasted in the same reference object by right-clicking on the region.

An Object locator region can be copied from one reference object and pasted into another reference object. A reference object can only contain one object locator region.

An inspection can only be analysed if the entire region is within the field of view, regardless whether the inspections are related to the object locator or not. The Object locator is calculated even if it is partially outside the field of view.

It is possible to apply up to 32 inspections in a reference object.

Settings for all detailed inspections is made in the **Tools** tab.

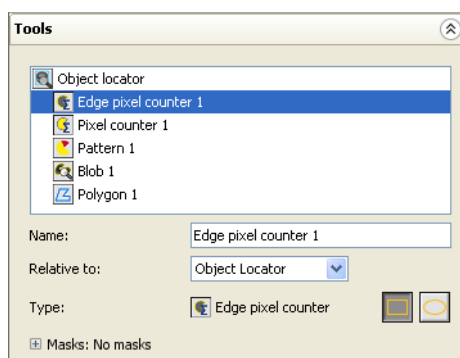


Figure 10.2 Settings in Tools tab

### Tools tab

The **Tools tab** lists all inspections for the selected reference object. The upper part of the tab is the same for all types of inspections, **Edge Pixel counter**, **Pixel counter**, **Pattern**, **Polygon** and **Blob**.

The lower part is different for all five inspection types in order to control the inspection's behavior.

Select **Edit** mode before any settings can be changed. The displayed settings are for the selected reference object.

### Tools List

The tools inspections list consists of all configured detailed inspections for the chosen reference object. To select a detailed inspection region in the reference image, click on the inspection name in the list.

### Name of detailed inspection in Tools list

The name of the detailed inspection is also displayed in the **Result tab**. Type in a new name in the field.

### Relative to

The ROI of a tool can be chosen to be relative to object locator (default setting) or fixed in a field of view.

### Inspection Type

The Type displays the name and the icon for the selected detailed inspection. The type can be **Edge Pixel counter**, **Pixel counter**, **Pattern**, **Polygon** and **Blob**. The type cannot be changed. In this case delete and draw a new detailed inspection to change detailed inspection type.

### Shape of Region

The basic shape of a detailed inspection region can be either a rectangle or an ellipse. Clicking on the other shape button can change the basic shape. See following figure. For the polygon tool this is not possible, since the polygon is specified by lines rather than regions.



Figure 10.3 Basic shape of detailed inspection region

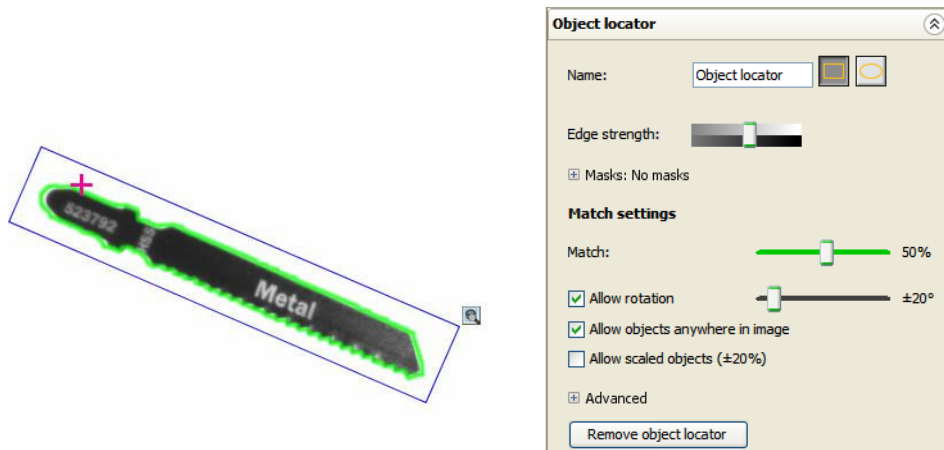
### Masks

The **Masks list** shows all mask regions (thin yellow lines) that are attached to the detailed inspection region. To display the mask list, click on the plus/expand button. To select a mask region in the reference image, click on the mask name (Mask 1 etc) in the list. The mask names cannot be changed. To remove a mask right-click on the mask name and choose **Delete**. Masks can not be used on the polygon tool.

## 10.2 Object locator

The Object locator is used to locate an object that has a known shape. The method uses a pattern matching function that recognizes and compares edges in the image.

The reference point (purple cross) has been moved manually from the center of the object locator region to the particular point on the object that shall be reported. The reference point for the object locator can be moved with either the mouse or the arrow keys on the keyboard.



Teach the shape to be located in **Reference image tab**      Configure the settings for the **Object locator**

The edges that will be searched and compared for are those inside the object locator region (blue rectangle), that are outlined with green contours. The following settings can be made for the object locator:

- Edge strength**

The amount of contours found is adjusted with the **Edge strength** slider. The Edge strength setting determines how much of the object's contours that are highlighted. In most cases, you should make sure that most of the characteristic contours in the object are highlighted but nothing is highlighted in the background or outside the object. Use the **Mask** tool to mask out areas of the region that lie outside the object if it is difficult to make pixels in the area around the object disappear with the **Edge strength** setting.
- Match**

The **Match** setting tells how well the located object must match. The match score can be set between 0% and 100%, but the most common value of match is between 30%-70%. Move to the left (lower values) if the Inspector fails to locate objects, move to the right (higher values) if the Inspector claims to locate objects that are not of the correct shape.
- Allow rotation**

The **Allow rotation** setting consists of a check box and a slider. If the check box is deselected, then the slider is inactivated. If the check box is selected, then the allowed rotation can be set between zero and  $\pm 180^\circ$ . Deselect the check box if the object always appears with the same rotation as in the reference image. This speeds up the inspections and makes it more robust.
- Allow objects anywhere in image**

The **Allow objects anywhere in image** setting is used for telling where in the image to search for objects. When selected, the Inspector will locate objects that are partially outside the image (although with a lower score). When deselected, you can specify the region (Search region in green color) in which the objects are allowed. Objects located outside or partially outside this search region will not be located.
- Allow Scaled Objects ( $\pm 20\%$ )**

The **Allow scaled objects** setting is used when objects appear at different distance from the Inspectors lens.

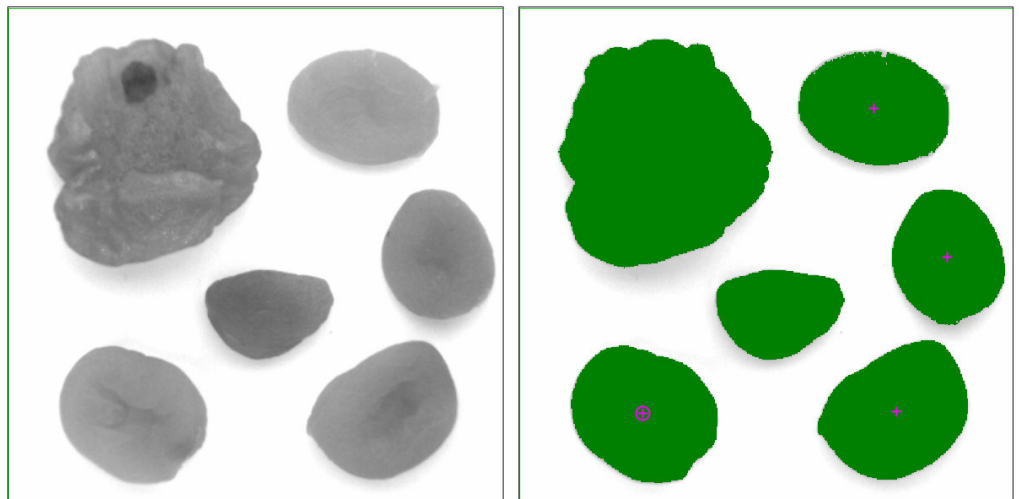
Deselect if the inspected objects always have the same size in the image as the reference object. Deselection will speed up and make the inspections more robust. When selected, the Inspector will locate objects that are scaled up to  $\pm 20\%$ .

Advanced – Search Method

See Section 21.1, “Object Locator” (page 89).

## 10.3 Blob Tool

The Blob tool is used to locate the position of one or more free-form shapes, also called blobs. The method uses a Blob tool function that recognizes objects of any shape in the image. A blob can either be dark object on a bright background, or bright object on a dark background. The located blob is found among pixels grouped together in a user configured intensity interval where the blob size matches a user configured area interval. It is possible to insert up to eight blob ROI on a reference object.



*Original image as seen in the SOPAS Single Device, Live Image tab*

*Reference object image with a blob tool search region. The green areas mark the blobs in correct intensity range. The two blobs without reference point are too big and too small compared to the configuration size settings*

The found blobs that meet the selection criterias are marked with purple crosses at the each blob's Center of Gravity (COG). The first blob in the configured **Sort by** setting is marked with a purple cross with a purple circle around it.

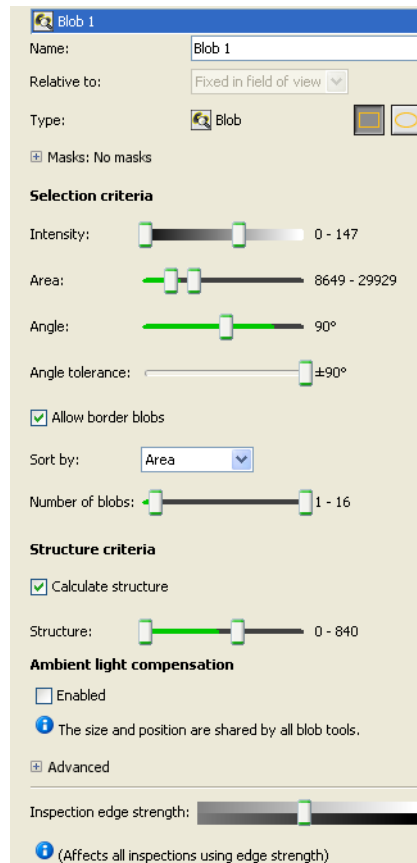


Figure 10.4 Blob tool configuration tab

The following settings can be done for the blob tool:

Intensity	Choose the <b>Intensity</b> interval with the sliders, for pixels to be selected to be inside a blob.
Area	Choose the blob <b>Area</b> interval for a shape to be selected as a blob. NOTE! For area calculations all holes in the found blobs are filled, and after that the area is calculated.
Angle	Choose the <b>Angle</b> of rotation for the blob. The calculated/reported angle is always a positive value between 0° and 180°. See Section 10.3.1, “Use Blob Angle” (page 49) for explanation on how the angle is calculated and reported.
Angle tolerance	Choose the Angle tolerance which is between 0° to ±90°. See Section 10.3.1, “Use Blob Angle” (page 49).
Allow border blobs	Enable to allow blobs that touches the border of the blob search region.
Sort by	Choose the sorting order for the found blobs. This will be the order in which the blobs are presented in the <b>Results</b> tab as well as in the Ethernet result output.
Number of blobs	Set a value for how many blobs to be found in a blob ROI. Up to 15 blobs can be found within an ROI. If this slider is set to 16, the result will be set to passed if 16 or more blobs are found.
Structure criteria	See Section 10.3.2, “Use Blob Structure Criteria” (page 50).
Calculate Structure	Enable or disable calculate structure

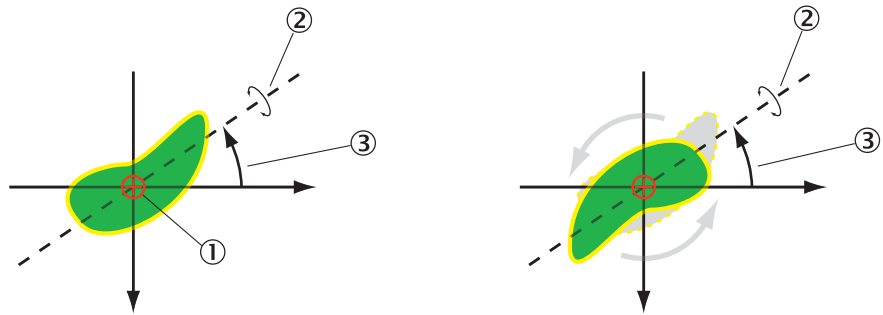


Ambient light compensation  
Enabled  
Advanced  
Inspection Edge Strength

See Section 21.2, "Blob tool" (page 90).  
See Section 21.2, "Blob tool" (page 90)  
See Section 21.2, "Blob tool" (page 90).  
See information about Inspection Edge Strength in Section 10.2, "Object locator" (page 45), and note in Section 10.6, "Edge Pixel Counter Tool" (page 56). The settings of Inspections Edge Strength affects all inspections in the same reference object.

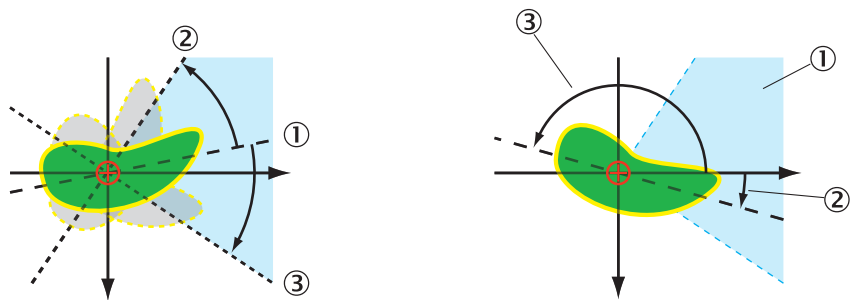
**10.3.1 Use Blob Angle**

The blob angle is the angle between the x-axis and an axis around which it would be easiest to rotate the blob. This angle will always be between 0° and 180°, since the Inspector does not distinguish between a blob and the same blob rotated 180°.



- ① Reference point
- ② Blob rotation axis in the xy-plane which is the axis around which it would be easiest to rotate the blob
- ③ The angle of rotation is calculated as the angle between the blob rotation axis and the horizontal, x axis in the image

When specifying the allowed rotation of blobs, two values are set; **Angle** and **Angle tolerance**. If for example **Angle** is set to 10° and **Angle tolerance** to ±45°, the range of allowed blob angles would be from -35° to 55°. But since the angle reported by the Inspector is always between 0° and 180°, the resulting blob rotations will be either in the range 0° to 55° or in the range (180°-35°) to 180°.



- ① Specified Angle
- ② Max allowed positive rotation of the blob
- ③ Max allowed negative rotation of the blob
- ① Allowed range of blob rotation
- ② Actual rotation of the blob
- ③ Reported angles of rotation, since the Inspector PI50 always reports an angle in the interval 0° to 180°.

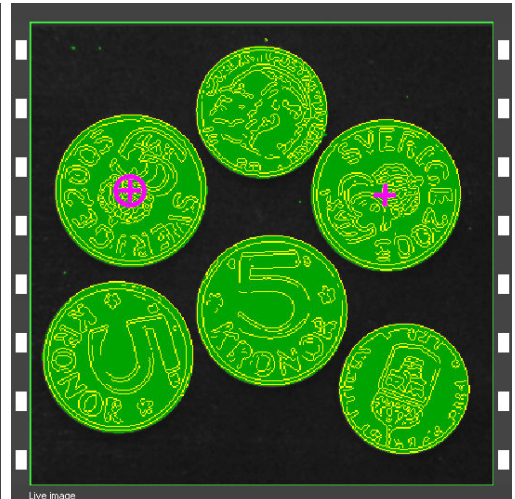
**10.3.2 Use Blob Structure Criteria**

The structure criteria can be used to inspect if a blob has a smooth or a rugged surface. The resulting structure is a measurement of the number of edges inside a blob. When locating objects that have two (or more) sides the structure measurement can be used to identify the side facing up.

In the example image below the **Structure** criteria, or more specifically the number of edges inside a located blob, is used to evaluate which side is facing up, heads or tails.

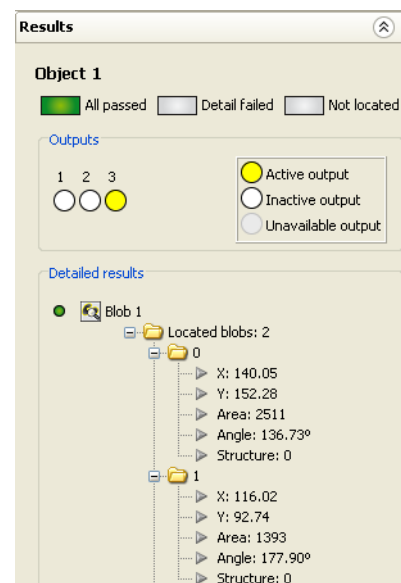
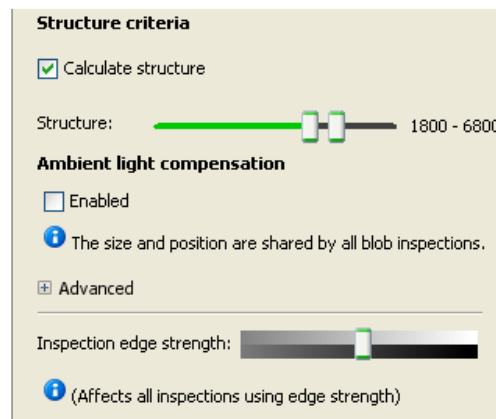


The original image of coins.



The resulting image after blob selection with use of structure criteria. The first blob in accordance with the **Sort by** sort order is marked with a cross with a circle around it.

If **Structure** and **Edge strength** settings are configured to be used and the resulting **Structure** is outside the boundaries, the blob(s) will be regarded as not located. Vice versa, if **Structure** is of no interest, set the structure boundaries to default, that is min to 0 and max to 100000.



The Blob tools **Structure** setting to select blobs. The Blob tools results. The larger coins with the most structure defining heads or tails (result in the image above).

### Note

The edge pixels on the edge of the blob are not counted as a part of the *Structure*

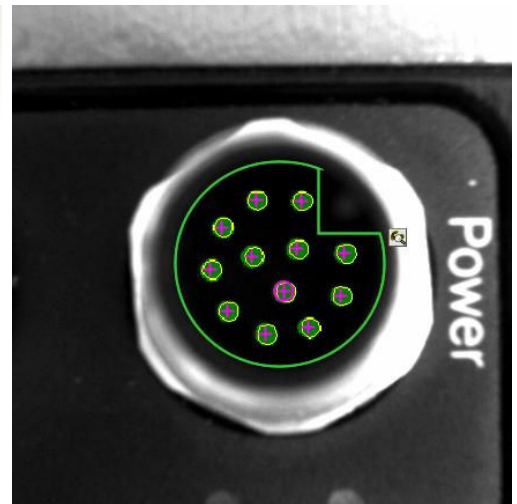
### 10.3.3 Number of blobs

The result output from the blob tool contains information about the number of located blobs and can be used for applications where there is a need to count and verify the presence of a certain number of blobs.

An example would be to count and verify that the correct number of pins are present on a power connector, see the following images.



Photo of the power connector (right).



Live image counting blobs.

## 10.4 Polygon tool

The polygon tool is used for localisation of corners on an object or localisation of an object's edge. The corner positions are estimated with high accuracy which enables for fine localisation of objects. The number of corners in a polygon can vary from 2 (single edge tool) to 16 and the polygons can either be closed or open. A closed polygon means that the starting point is the same as the end point. For closed polygons there is also an optional functionality to detect cracks or other defects along the polygon.

In general the polygon tool requires object edges with high contrast and a uniform image background for reaching the adequate robustness. This is especially important when using the crack/defect detection in order to get a robust tool.

A polygon will give a **Detailed failed** result if the match score is lower than the configured threshold or if the defect detection, if enabled, fails. More detailed information can be output by using **Ethernet Result Output**.

### 10.4.1 Adding a polygon

- Select the **Polygon** icon below the reference image to draw a polygon in the image. Click once for each corner point and lines will be drawn connecting them.
- The polygon may either be closed or open. A closed polygon has the same start and end point. When placing the mouse pointer near the start point, the cursor changes shape. Then click to close the polygon.

### Tip

An open polygon with two lines is well-suited for positioning a corner.

- If an open polygon is wanted, move the mouse pointer near the end point of the latest drawn line, make sure that the cursor changes shape, and click to finish the polygon.

The shape and position of this drawn polygon only need to be approximate since the algorithm will search and fit the drawn polygon to the edges found in the image. The fitted polygon is drawn in blue in the reference image.

The polygon corners can be edited after the polygon has been drawn. Select the polygon by clicking on it in the image or in the list in the **Tool** tab. Then click on one of the corner points and drag it to a new position with the mouse. The whole polygon can also be moved when selected by using the arrow keys on the keyboard.

### Note

It is not possible to add/remove corner points once the polygon is drawn. Also, it is not possible to close an open polygon or vice versa. To remove a polygon, select it in the image or in the list in the **Tools** tab and press Delete or select Delete polygon in the right-button menu.

### 10.4.2 Algorithm

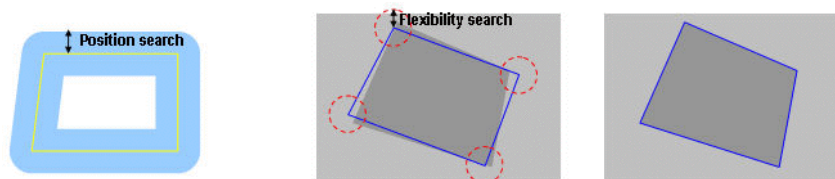
The polygon fitting is performed in two steps:

- |                      |  |
|----------------------|--|
| 1. Rigid positioning | <i>keeps the object shape and size</i> |
| 2. Flexible fitting  | <i>allows for shape deformation</i>    |

The *rigid positioning* step keeps the exact shape and size of the drawn polygon. It searches for the position and rotation that fits this shape to the edges in the image. The search is performed locally around the line segments.

The *flexible fitting* step allows the fitted polygon shape to deviate from the drawn shape. Each line segment of the polygon is fitted independently. This is useful when the drawn shape is imperfect, when objects have variations in shape, or when the calibration is imperfect.

The figure below shows an example. The user drawn polygon to the left is drawn yellow. Around this polygon is a search area for the rigid positioning. The gray polygon in the image does not perfectly match the drawn shape, but the coarse position and rotation is found in the rigid positioning step and drawn blue in the center image.



*Drawn polygon with search area    After rigid positioning    After flexible fitting*

After this step, the flexible fitting fits each line segment of the polygon to the edges of the image. This is drawn blue in the right image. The new corners are computed as the intersection of the fitted line segments. These corners are limited not to deviate too much from the rigidly fit corners. This limitation is drawn as red circles in the figure.

### 10.4.3 Algorithm - Single edge tool

The single edge is a special case of the polygon, i.e. a polygon with two corners. This requires for a slightly different algorithm where only the rigid positioning is required. The rigid positioning step searches for the edge with the highest contrast in the search region, which is specified by the position search parameter (see image below).

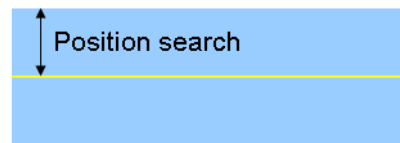


Figure 10.5 Illustration of the search region

There are some limitations if the algorithm shall be able to find the edge:

- The angle between the edge and the user drawn edge must be less than 45 degrees.
- The found edge must cross the left and right borders of the search region (see image below).

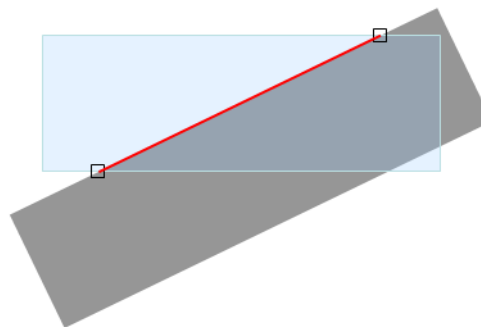


Figure 10.6 No edge will be found if the edge does not cross the left and right borders of the blue search region.

The estimated corner positions are the intersection between the found edge and the left and right borders of the search region. The corner positions are illustrated as black square in the figure below.

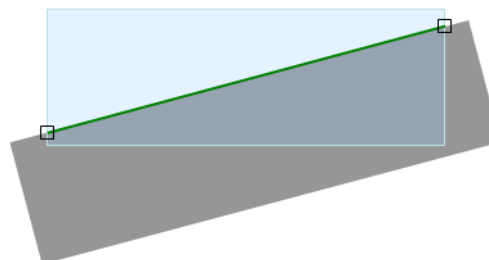


Figure 10.7 Illustration of the estimated corner positions (black squares).

#### 10.4.4 Parameters

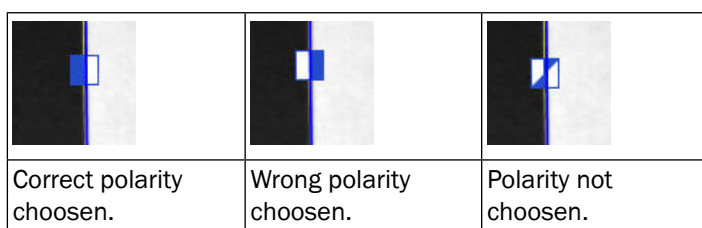
The following settings can be made for the polygon tool:

Position search	A search area can be defined by using the <b>Position search</b> parameter. Controls the extent of the rigid positioning. Avoid having values larger than approximately half of the object side since the Inspector PI50 may find other edges than the wanted.
Flexibility search	Control the amount of flexibility. This parameter limits the distance between the rigidly fitted corners and the flexibly fitted corners. If the object has a solid shape and it is only moved or rotated the value of Flexibility search should be low. A value of 0 means that no flexibility is allowed. It is not optimal to set a low value since it is difficult to draw the exact polygon for the object. Set a value of 3-4 for example to have a margin of error.

Observe that the flexibility search parameter is not valid when the single edge tool is used.

**Score**  
Reflects how well the flexibly fitted polygon matched the edges of the image. It is based on the line segment with worst fit. Adjust the score threshold so that the polygon tool gets the red failed status when no polygon is present in the image.

**Polarity**  
Use Polarity to get a robust analysis setup. With the polarity an edge can easier be found by the polygon tool. There are two different polarities; one where the object is bright and the background is dark and the other where the object is dark and the background is light. The polarity icon in the image should match the object. See the following pictures.  
One can see how well the results of the score is met if the correct polarity is selected. Default value is no polarity selected.



**10.4.5 Defect detection**

Click the **Defect detection** check box to inspect the polygon's sides for cracks or similar defects.

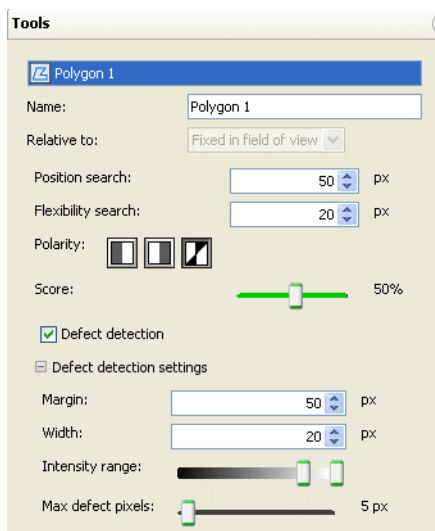


Figure 10.8 The polygon tool parameters

The inspection is a regular pixel counter. The pixels to be inspected are placed along a strip inside the polygon, see next figure. The width of the strip is controlled by the **Width** parameter. The **Margin** parameter positions the strip at a safety margin from the found polygon line segments.

**Note**

Defect detection can only be performed on closed polygons and not on open polygons.

Pixel counting works in an identical way to the **Pixel counter** tool. All pixels within the **Intensity range** are counted. If these are more than **Max defect pixels**, the tool will get the red failed status.

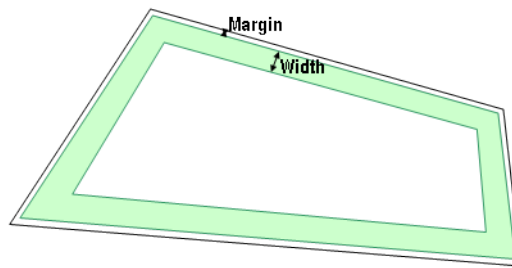


Figure 10.9 Pixels inside the green strip are inspected to find defects.

There is a trade-off between the minimal defect size to be found and the avoidance of false detections. Having a small margin allows for smaller defects at the risk of getting false detections. This trade-off is also controlled with the **Max defect pixels** parameter. The minimum value of **Margin** and **Max defect pixels** depends on many application specific issues such as:

- contrast and focus
- straightness of the sides of the objects
- size and shape of cracks
- illumination

The pixels inside the strip are inspected row by row starting from the top of the image. A red cross marks the first pixel within the **Intensity range**. If there are many defects only the first is marked.

### Note

The SOPAS User Interface colors all defect pixels within the complete polygon yellow, but only the pixels within the strip are counted

## 10.5 Pixel Counter Tool



Figure 10.10 Pixel Counter Inspection

The **Pixel counter** inspection tool makes an inspection by counting pixels within a certain grey scale range. The matching pixels are marked with yellow graphics and the value is compared with the No. of pixels in range interval setting.

### Intensity Range

The **Intensity range** specifies which pixels in the region that the Pixel counter should count. These pixels are highlighted (yellow) in the image. The interval is selected by the two sliders, that specify dark (left) upper limit and light (right) lower limit. The highlighted (yellow) area is those pixels that are in between the both slides.

### Number of Pixels in Range

The **No. of pixels in range** interval is specified as number of pixels within the inspection region. If the located object is scaled, the number of pixels is adjusted to be the number of matching pixels that should have been found if the located object had the same size as the reference object.

### Note

If the inspection region is changed the number of pixels in range will not automatically be changed

## 10.6 Edge Pixel Counter Tool

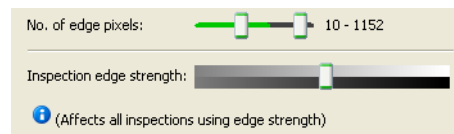


Figure 10.11 Edge Pixel Counter Inspection

The Edge pixel counter tool counts pixels that are edges and compares this number with the **No. of edge pixels** settings. Where the pixels are located does not matter.

### Inspection edge strength

The Inspection edge strength settings sets the minimal contrast required for a pixel to be marked as an edge. These pixels are highlighted (yellow) in the reference image.

#### Note

The **Inspection edge strength** setting affects all **Edge pixel counter** and **Blob** inspections in the reference object.

The **Inspection edge strength** setting for detailed inspections is different from **Edge strength** used in the **Object locator** tab.

### Number of Edge Pixels

The **No. of edge pixels** interval is specified as number of pixels within the inspection region. If the located object is scaled, the number of pixels is adjusted to be the number of matching pixels that should have been found if the located object had the same size as the reference object.

#### Note

If the inspection region is changed the number of pixels will not automatically be changed

## 10.7 Pattern Tool

The **Pattern** inspection tool compare a grey scale pattern pixel by pixel within a region. Up to 32 Pattern regions can be configured per reference object.



Figure 10.12 Pattern Inspection

### Position tolerance

The position tolerance specifies the maximum positional offset between the pattern in the region and the reference image. The tolerance can be set from +0 to +4 pixels.

### Match

The **Match** threshold sets the required similarity between the pixels of the region and the reference image. The setting is a value between 0 and 100%, where 100% means "perfect match".



# 11 View Result and Statistics

## 11.1 Results

The inspection result is displayed in the **Results** tab. The upper part of the **Results** tab shows the digital output signals and overall result information. The configuration of the outputs is being done in the **Digital output settings** tab.

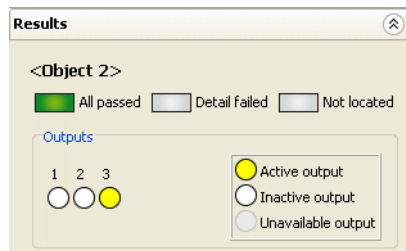


Figure 11.1 Example Output result

### Name of reference object

The name of the reference object is displayed above the results. Same name as in the **Reference objects** list.

### Overall results

Three different results are presented:

<b>All passed</b>	The object was located and all detailed inspections passed as well
<b>Detailed failed</b>	The object was located but at least one of the detailed inspections failed
<b>Not located</b>	The object was not located, or a detailed inspection was out of view

### Outputs

The status of the outputs is displayed in the **Results** tab. The color of the output indicates the status:

Color	Status
Yellow	Active output
White	Inactive output
Grey	Not available output

Active output can correspond either a high or a low signal. See Section 14.3.5, "*Invert Output Signals*" (page 71).

The detailed results for the different tools are presented in the lower part of the **Result** tab.

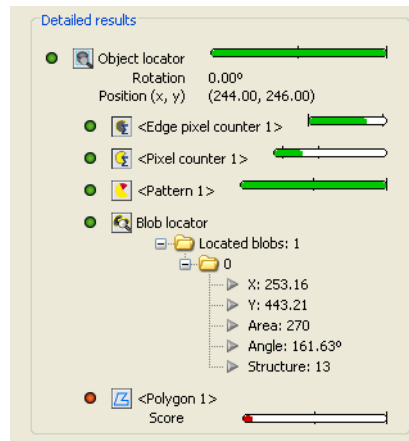


Figure 11.2 Detailed results of different tools

If the result has been passed the bullet in front of the tool is green otherwise red. When the match score in the live image is within the threshold value, the bar is green otherwise red.

- For **Object locator** the horizontal bar corresponds to the **Match** setting in the **Object locator** tab
- For **Edge pixel counter** the horizontal bar is corresponds to **No. of edge pixels** settings
- The horizontal bar for **Pixel counter** corresponds to **No. of pixels in range**
- The horizontal bar for **Pattern** corresponds to **Match**
- For the **Polygon**, the horizontal bar corresponds to **Score**

For the **Object locator** the **Rotation** and **Position** are presented for located objects. The x and y coordinates are presented in pixels from the top left corner of the image. (If calibrated it is presented in mm).

For the **Blob tool** coordinates are presented in the detailed results. X and Y is the position in pixels counted from the upper left corner of the field of view. (If calibrated it is presented in mm). For information about the angle of rotation for the blob see Section 10.3, “*Blob Tool*” (page 47). For more information on blob structure see Section 10.3.2, “*Use Blob Structure Criteria*” (page 50).

For the **Polygon tool** the score is presented in the detailed results. More detailed results can be obtained through the Ethernetbased interfaces.

## 11.2 Statistics

Statistics are collected for each reference object used by the Inspector. The statistics are updated in **Run** mode for the currently selected reference object, and all other reference objects are resting until selected.

The statistics is started to be updated as soon as the selected reference object is being used for inspections (**Run** mode). Switching between different reference objects will add to the statistics for each reference object until the statistics is reset.

### Note

If any reference object settings are changed, then the statistics will be reset for that particular reference object.

The statistics is displayed in the **Statistics** tab.

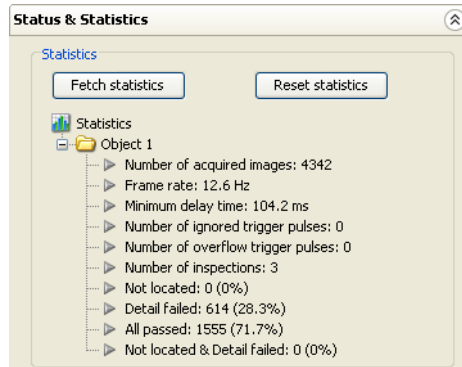


Figure 11.3 Statistics tab

To update the statistics, click **Fetch statistics**. The following statistics are collected for each reference object:

Number of acquired images	Total number of captured images.
Frame rate	The current maximum frame rate in Hertz (Hz). The same value as under the live image.
Minimum delay time	The latest minimum delay time in milliseconds (ms). The same value as under the live image.
Number of ignored trigger pulses	Loosing trig pulses can happen if you are using an external image trigger (in3) and the inspected objects are moving too fast (too high speed on conveyor belt).
Number of overflow trigger pulses	This can happen if there is a long distance between the image trigger and the Inspector (where the image is captured) and/or if there is a long distance between the Inspector and the rejecting device connected to the Inspectors output signals. The Inspector needs to remember all objects in the queue, the queue can be too long if the inspected objects are moving too fast (too high speed on conveyor belt).
Number of inspections	The number of inspections in the reference object. Object locator region and masks are not counted. This is a static value.
Not located	The total number of captured images where an <b>Object locator</b> or a <b>Blob tool</b> did not locate a shape/blob. The result is presented in percent of all captured images.
Detailed failed	The total number of captured images where one or more detailed inspections failed. When the Inspector is only locating without making detailed inspections, no images will be counted. The result is also presented in percent of all captured images.
All passed	The total number of captured images where the object was located and all detailed inspections passed (if any). When the Inspector inspects without locator, images with all detailed inspections passed will be counted.

Click **Reset statistics** to empty the statistic information.

## 12 Work with Multiple Objects

The Inspector PI50 can store up to 32 different reference objects, making it easy to switch between different inspection tasks with different reference objects.

### 12.1 Teach Additional Objects

To teach an additional object:

1. Under the **Reference objects** list, click **Add**. A new reference object is created. This new object is empty, without a reference image.
2. Place a new object in the Inspector's field of view and adjust image settings. Click on **Teach reference object** to create an additional object. A new reference image is placed in the image container.
3. To change the name of the reference image, double-click on the name, and type a new name.

### 12.2 Select Reference Object

The time it takes to switch reference object depends on the number of inspections, inspection type and sizes of the regions in the reference object. Typically it takes in the order of 0.5 s. The following table gives some guidelines:

Reference object configuration	Typical time for reference object selection
Only <b>Object locator</b>	65 ms
<b>Object locator</b> plus four <b>Blob</b> inspections	110 ms
<b>Object locator</b> plus four <b>Pixel Counter</b> inspections	70 ms
<b>Object locator</b> plus four <b>Edge Pixel Counter</b> inspections	68 ms
<b>Object locator</b> plus four <b>Pattern</b> inspections	75 ms
<b>Object locator</b> plus one <b>Polygon</b> inspections	120 ms (5 corners)
Four <b>Pixel Counter</b> inspections	35 ms
Only one <b>Blob</b> inspection	40 ms

#### 12.2.1 Select Object from PC

To select which reference object to be used for the inspections/when inspecting:

1. Select Edit mode, by clicking **Edit**.
2. In the **Reference objects** list, click on the desired reference object
3. Click **Run**, to start the inspection. Save the configuration to flash memory if the Inspector has to restart or in case of power failure.

#### 12.2.2 Select reference object with Interfaces and I/O

Apart from **SOPAS Single device** there are a number of alternative ways to select active reference objects:

- To use the digital inputs on the Inspector, see Section 14.2.4, “*Select Reference Objects with Inputs*” (page 67)
- To use the digital inputs on the I/O Extension box, see Section 14.4, “*Set up the Connection I/O Extension box*” (page 71)
- To use the interface EtherNet/IP, see Chapter 15, “*Use EtherNet/IP*” (page 72)
- To use the interface Ethernet Raw, see Chapter 16, “*Use Ethernet Raw*” (page 74)
- To use the interface Web API, see Section 18.3, “*Web API*” (page 81)

### 12.3 Duplicate Reference Objects

To duplicate a reference object:

1. Right-click on source reference object and select **Copy to new reference object** from the pop-up menu.
2. The new reference object is placed at the end of the **Reference objects** list.

To change the name of the reference image, double-click on the name, and type a new name.

### 12.4 Settings for Multiple Reference Objects

Some settings in **SOPAS Single Device** are unique for an individual reference object and some settings are common for all reference objects.

The settings made in the Configuration pane in the **Main view** and some other functions are unique for an individual reference object:

- Image settings
- Object Locator. Tools: Edge pixel counter, Pixel counter, Pattern, Polygon and Blob
- Digital Output Settings
- Ethernet Result Output

Other settings – made from the **InspectorPI50** menu – are global and applies to all reference objects, for example:

- Interfaces and I/O settings
- Log settings
- Calibration
- Store images to FTP

# 13 Interfaces

## 13.1 Overview interfaces

Inspector PI50 is designed to interact over a number of different interfaces in order to easily be integrated into centrally controlled machine designs. Apart from the digital interface there are several optional interfaces to cyclically tap the result, retrieve image and control the device by sending commands. Below image shows a summary of all interfaces. See Section A.4, "Technical Specification" (page 108) for explanation of which device is supported of which interfaces.

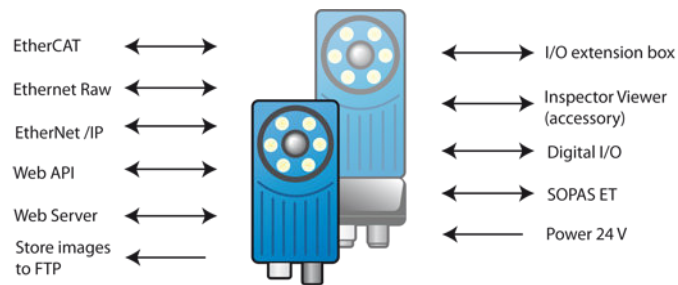


Figure 13.1 Overview interfaces to Inspector PI50

The enabling and configuration of the optional interfaces are made via the **Interface and I/O settings** and **Store Images to FTP** dialogues accessed via the **InspectorPI50** menu. See figure below. SOPAS ET and Inspector Viewer are enabled simply by a connection between them and a device.

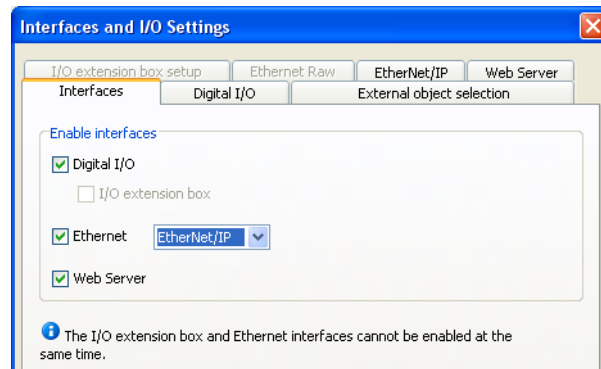


Figure 13.2 Interfaces and I/O settings dialog for Inspector PI50, VSPP-5F2113

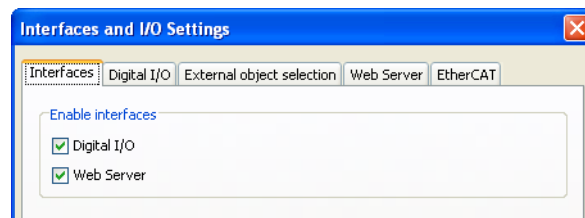


Figure 13.3 Interfaces and I/O settings dialog for Inspector PI50 ECAT, VSPP-5F2134

## 13.2 Simultaneous use and restrictions of the Interfaces

### Not possible combinations of interfaces

The interfaces can be used simultaneous except for below restrictions:

- Only one of Ethernet Raw, EtherNet/IP or EtherCAT can be used at a time

- Only one of **SOPAS Single Device** or Inspector Viewer can be connected a time

**Image sending restrictions**

Sending images to several interfaces will decrease performance on the least prioritized interface. The image interfaces are prioritized as follow with highest priority listed first:

1. Store Images to FTP
2. **SOPAS Single Device** or Inspector Viewer
3. Send images over Web Server/Wep API

**Configuration restriction**

It is not recommended to have **SOPAS Single Device** in online mode while sending configuration changes via other interfaces. This can cause problems with the connection between **SOPAS Single Device** and Inspector PI50. The problem may occur when a command with a long execution time, is executed.

Examples of such commands are calibration and save to flash memory. If the problem occur a message is shown that **SOPAS Single Device** has lost connection to Inspector PI50. An attempt to reconnect will be done. When the sent command has been executed, the **SOPAS Single Device** is able to connect to Inspector PI50 again. A synchronization dialog will also appear, select **Use Device Settings** to update **SOPAS Single Device** with the latest configuration.

It is also recommended to avoid changing settings in **SOPAS Single Device** while sending configuration changes via other interfaces.

# 14 Use digital I/O

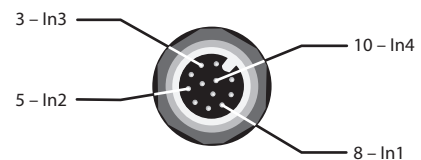
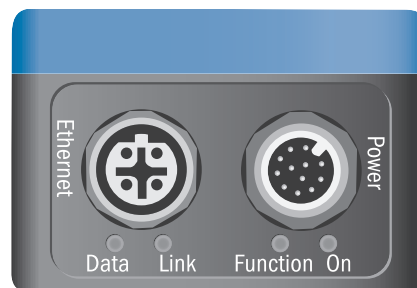
## 14.1 Overview Digital I/O

### Digital Inputs

The Inspector PI50 has four built-in digital inputs that can be used for different purposes:

- Teach reference object (in2)
- Trigger inspections (in3)
- Encoder (in4)
- Select which reference object to use when inspecting (in1...in4)

For the built-in digital inputs that have two purposes only one purpose can be chosen at the same time. The input signals are shown in the figure.



To use a digital input for triggering inspections, encoder input or teaching objects, connect the signal to its input on the Inspector PI50 and set the usage of the input in **SOPAS Single Device**. By default digital inputs are disabled.

Any input that is not used for trig, encoder or teach signals can be used for reference object selection. For example, if an encoder is used, in4 should be set as encoder input but the remaining three inputs can be used for object selection, making it possible to select between up to eight objects with the inputs.

### Digital Outputs

The Inspector PI50 has three built-in outputs and can be used for different purposes:

- Not located (Out 1)
- Detailed failed (Out 2)
- All passed (Out 3)

The above list is the default value of the digital outputs, the value can be changed.

### Overview I/O Extension Box

The Inspector PI50 can be connected to an I/O extension box that increases the number of digital inputs and outputs. The I/O Extension box is available as an accessory from SICK, see Section A.5, "Accessories Ordering Information" (page 111) details.

The number of inputs can be increased by using a I/O extension box. The increase of input is needed when input selection can not be achieved on the built-in digital inputs. Up to five additional inputs can be configured on the I/O box.

The number of outputs can be increased up to 19, when using I/O extension box, however it is not possible to set any output delay on the external output.

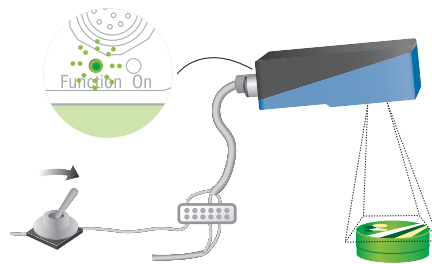


## 14.2 Use Digital Inputs

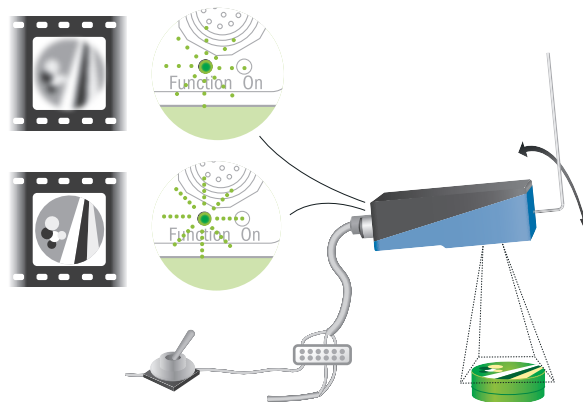
### 14.2.1 Use External Teach

To be able to re-teach reference objects without using a PC, do the following:

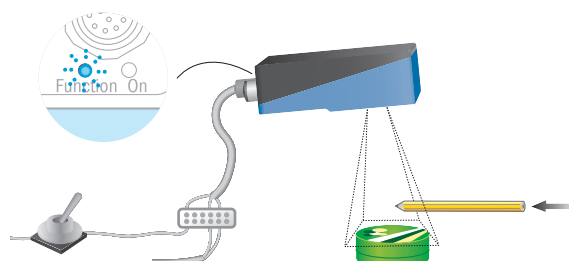
1. Choose **Interfaces and I/O Settings** from the **InspectorPI50** menu, and select **Use external teaching** in **Digital I/O** tab.
2. Make sure the Inspector is in **Run** mode. Place an object in front of the Inspector and connect **in2** (pin 5, cable color is pink on DOL-1212 cables) to **+24 V**. After about 3 seconds, the Inspector will start capturing images and flash with the lighting, if used. Also, the **Function LED** will start flashing.



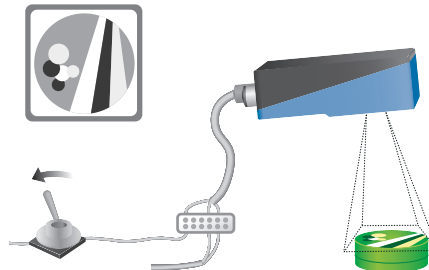
3. Adjust focus by turning the focus screw. The frequency with which the **Function LED** is flashing indicates how focused the images are – the faster it flashes, the better the focus. If re-focus is needed due to distance change between the object and Inspector turn the mechanical focus screw and adjust with help of the function LED.



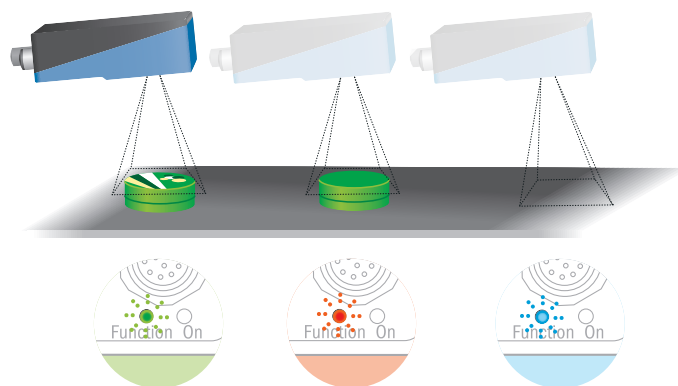
4. Find the field of view (that is, the area covered in the captured image) by using a finger, a pen or similar. When the finger/pen enters the field of view, the color of the **Function LED** changes from green to blue. The LED color reacts on motion in the image. Ensure that the finger/pen is moving and that the rest of the scene is stationary.



- When done, disconnect in2 from the power. The Inspector will now use the most recent image as the reference image, and learn the contours of the object in view. All device data is saved in flash memory. During the flash memory storage, the **Function** LED flashes white.



- The Inspector will then automatically switch to **Run** mode and start the application with the taught reference object. The procedure may take about 15 seconds.



#### Note

- The Inspector must contain a reference object, using external teach will only replace the reference image for the active reference object and change the exposure settings (exposure and gain). The exposure settings can also be kept by enabling **Use current exposure settings** in the **Interfaces and I/O Settings** dialog in **Digital I/O** tab. Any modifications made to the reference object will remain, for example if the object locator region has been resized.

#### 14.2.2 Connect an external Image Trigger

To use an external trigger for triggering the Inspector PI50 to capture the images, do the following:

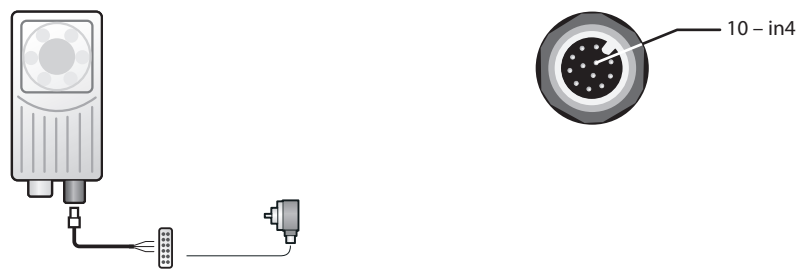
- Connect the image trigger to in3 (pin 3, cable color is white on DOL-1212 cables) on the Inspector.
- Choose **Interfaces and I/O Settings** from the **InspectorPI50** menu, and select **Enable image trigger (In3)** in the **Digital I/O** tab.
- Under **Triggering** in the **Image settings** tab, select **Triggered by In3** and choose whether the images should be triggered on the **Rising edge** (from 0.1 V to +24 V) or on the **Falling edge** (from +24 V to 0.1 V).

You can also set a delay between the trigger pulse and when the image is captured, by specifying a delay time in milliseconds or number of encoder pulses.

### Note

- If there are multiple reference objects, you must choose Triggered by in3 for each reference object for which images should be triggered. It is possible for the Inspector to have reference objects where image capturing should be free-running for some and triggered for others.
- The image trigger and the Inspector should be connected to a common ground, to avoid problems with signals not being registered properly by the Inspector.

### 14.2.3 Connect an Encoder



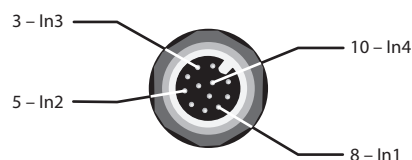
To use an encoder for controlling delay times for image triggering and/or output signals, do the following:

1. Connect the encoder to in4 (pin 10, cable color is violet on DOL-1212 cables) on the Inspector.
2. Choose **Interfaces and I/O Settings** from the **InspectorPI50** menu, and select **Use encoder (In4)** the **Digital I/O** tab.
3. Set the delays to be a number of encoder pulses:
  - Image capture delay are set on the **Image settings** tab for the reference object.
  - Output delays and active times are set on the **Digital output settings** tab by setting the delay and/or active times in the **Fixed fields**.

### Note

- The encoder and the Inspector should be connected to a common ground, to avoid problems with signals not being registered properly by the Inspector.
- The maximum encoder frequency is 40kHz.

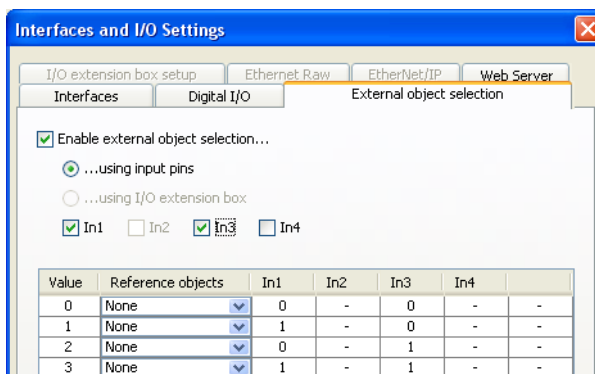
### 14.2.4 Select Reference Objects with Inputs



To be able to select objects with the inputs on the Inspector, you must first set up which combination of inputs that should select each object.

1. Select **Interfaces and I/O Settings** from the **InspectorPI50** menu, and select the **Enable external object selection** in **External object selection** tab.
2. Select which input signals to be used for object selection. If an input is already used for image triggering, encoder or external teach, that input cannot be used for object selection and the check box for that input is therefore disabled.
3. Select which **Reference objects** to activate for each combination of inputs. The object is selected from the drop down menu. The **Inputs** number is the binary value with the selected

input signals (in2 etc). The most significant binary digit is in2 (if used) or the one with the lowest number. The digit “0” means that the corresponding input is active low and the digit “1” means that the corresponding input active high.



4. Click **OK** when all settings are complete.

### Important

- When selecting a reference object with the digital inputs, the input signal levels must be kept during the time that the reference object should be used. As soon as the input signal changes, another reference object will be selected instead.
- The device providing the signals and the Inspector should be connected to a common ground, to avoid problems with signals not being registered properly by the Inspector.
- When the built-in inputs are not enough there is need to use an I/O extension box or one of the ethernet interfaces to achieve the input selection. For more details about I/O box see Section 14.4, “Set up the Connection I/O Extension box” (page 71).

## 14.3 Use Digital Outputs

The result from each inspection made by Inspector PI50 can be mapped to any of the built-in outputs, or to the outputs of a connected I/O extension box. The outputs in the table are the default outputs.

Output	Pin	LED color	Function	Activated when
Out1	4	Blue		<b>Not located</b> – The object was not located, or a detailed inspection was out of view
Out2	6	Red		<b>Detail failed</b> – The object was located but at least one of the detailed inspections failed
Out3	7	Green		<b>All passed</b> – The object was located and all detailed inspections passed as well

Normally the output signal level is low (0 V) when inactive and high (+24 V) when active, that is active high, but signals can be inverted.

The inspection result output settings are configured in the **Digital Output settings** tab.

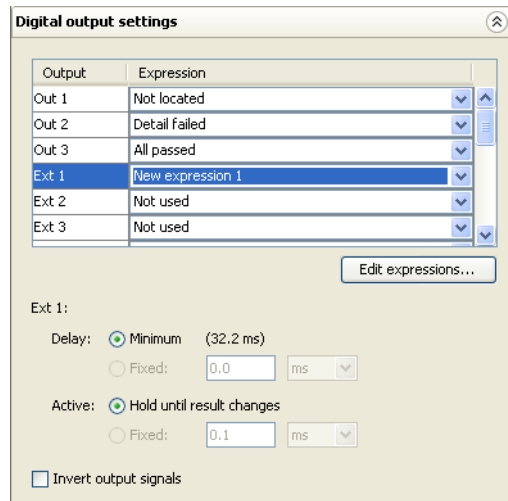


Figure 14.1 Digital output settings tab - I/O box enabled

### 14.3.1 Digital Output Settings tab

The **Digital Output settings** tab contains the detailed control of the output signals.

The displayed settings are for the selected reference object, except the **Invert output signals** setting.

#### List of Outputs

All available outputs are shown in the list. The digital outputs on the Inspector PI50 are called Out1, Out2 and Out3. If the I/O extension box is used, the outputs on the I/O extension box are added to the list. The outputs on the I/O extension box are called Ext1, Ext2 etc.

Each output can be mapped to **All passed**, **Detail failed**, **Not Located**, or any user defined expression. In Inspector PI50 a Store Images to FTP overflow warning signal can also be mapped to an output from the **Store Images to FTP** dialog box.

#### Assign Logical Expressions to Outputs

The user defined expressions are created in the **Digital Output Expression Editor**.

In the **Digital output settings** tab for the Inspector PI50, it is possible to define which expression that shall be used to control each output.

To select an expression for an output:

1. Click on the **Expression** column of the output to edit.
2. Choose the desired expression from the list.

### 14.3.2 Digital Output Expression Editor

The **Digital Output Expression Editor** is opened by clicking the button **Edit expressions...** in the **Digital output settings** tab. The editor is used to create and modify the expressions to use for the outputs. Each learned object can have up to 16 expressions.

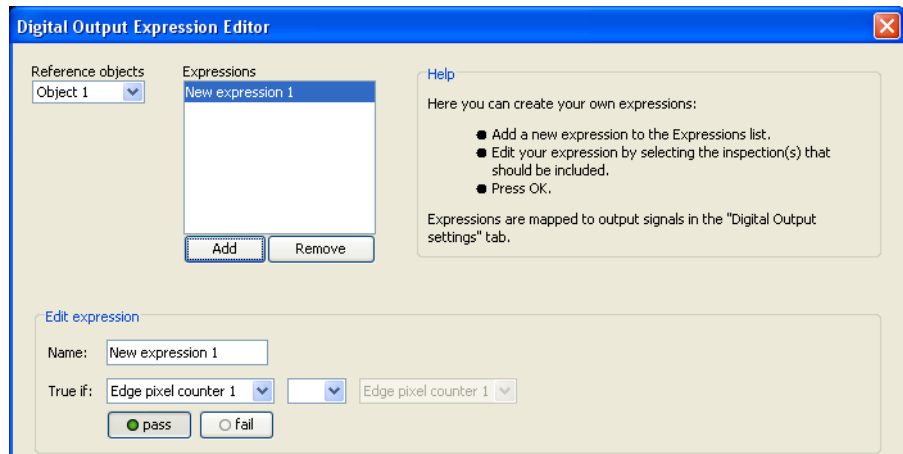


Figure 14.2 Digital Output Expression Editor

An expression is either the result of a single detailed inspection or a logical combination of two detailed inspections for a learned object. If an inspection is relative to a locator and the objector locator is not found, the inspection will be reported as fail. The inspections can be combined in two ways; logical AND, and logical OR. For each of the inspections, it is possible to specify if it shall pass or fail.

To create a new expression using the **Digital Output Expressions Editor**:

1. Choose the learned object from the list.
2. Click on the **Add** button.
3. Enter a name for the new expression.
4. Choose the detailed inspection(s) to use for the expression, and specify if each inspection shall pass or fail by clicking the appropriate button.
5. Choose the logical operation to perform on the result(s).
6. Save the new expression by clicking Apply.

The field for logical operation has three possible states and the expression will be true if:  
[empty] Only the first condition is fulfilled.

AND Both conditions are fulfilled.

OR At least one of the conditions is fulfilled.

The selected expression can be removed by clicking the button **Remove**.

#### Note

- If the removed expression is in use, the corresponding output will be set to Not used.
- If a detailed inspection that is used by an expression is removed, the corresponding expression will be modified. If the expression only contains the inspection that was removed, the expression will be removed, too.

### 14.3.3 Set Output Delay

The delay is always counted from when the exposure of the image started. To set a delay on a built-in output:

1. Select the output in the list on the **Digital output settings** tab.
2. Set the output delay by selecting either:
  - Minimum** The delay will be as short as possible – minimum delay time – which is the same as the time it takes the Inspector to make the inspection. The inspection time depends on many different settings for the current reference object. The time is displayed below the image in the **Live image** and **Reference image** tabs.
  - Fixed** Set the delay as a time (in milliseconds) or a number of encoder pulses.

When setting a delay in encoder pulses, the encoder should be connected to **in4**, and this input should be reserved as an encoder input. To do this, see Section 14.2.3, “*Connect an Encoder*” (page 67).

#### Notes

If you set the delay time to be shorter than the minimum delay time, a warning will be displayed and the minimum delay time will be used.

If the delay is set in encoder pulses, and the time these take when inspecting is shorter than the minimum delay time, the trig pulse is ignored. The number of ignored trig pulses is displayed in the Statistics tab, see Section 11.2, “*Statistics*” (page 58).

#### 14.3.4 Set Output Active Time

The active time is always counted from when the output signal is activated. To set the active time for a built-in output:

1. Select the output in the list on the **Digital output settings** tab.
2. Set the active time by selecting either:

##### Hold until result changes

The output will be active as long as the inspection result does not change.

Once the inspection result changes, the output will change. Note that the deactivation of the output will be after the output delay time.

##### Fixed

Set the active time as a time (in milliseconds) or a number of encoder pulses.

#### 14.3.5 Invert Output Signals

Normally the output signal level is low (0 V) when inactive and high (+24 V) when active, that is active high. You can change this by selecting **Invert output** signals on the **Digital output settings** tab. When inverted, all output signals will be +24 V when inactive, and 0 V when active.

#### 14.3.6 Connect an external light

To connect an external light, do the following:

1. Connect the external light to **Ext trigger** (pin 9, cable color is red on DOL-1212 cables) on the Inspector.
2. For settings in **SOPAS Single Device** see Section 8.3.2, “*Use External Lighting*” (page 39).

### 14.4 Set up the Connection I/O Extension box

The following basic steps are required to use the I/O extension box with the Inspector PI50. For details about the steps see the reference manual for the Inspector PI50.

1. Connect the I/O extension box to the network.
2. Configure the IP address of the I/O extension box to match the settings of the network, and the Inspector PI50. See Section 6.2, “*Manage IP Address*” (page 29) how to view the IP address for the Inspector PI50.
3. Open the **Interfaces and I/O Settings** dialog under the **Inspector PI50** menu. In the tab **Interfaces** check the **I/O extension box**. Enter the IP address of the I/O extension box in the **I/O extension box setup** tab in the same dialog.
4. In the **External object selection** tab activate the inputs and/or outputs on the I/O extension box depending on the application.

#### Note

The **SOPAS Single Device** application should be closed or set to offline when the power to the I/O box is disconnected. The I/O extension box needs to be restarted if the IP address is changed or if the connections to the inputs and output on the box are changed.

## 15 Use EtherNet/IP

The Inspector PI50 can be controlled and results can be read out using the EtherNet/IP standard. To be able to do this the connection has to be set up first.

### 15.1 Set Up the Connection EtherNet/IP

To set up the connection between the Inspector and a PLC and, do the following:

1. Enable EtherNet/IP on the Inspector PI50 by choosing **Interfaces and I/O Settings** from the **InspectorPI50** menu and selecting **Ethernet** and **EtherNet/IP** in **Interfaces** tab.
2. Choose input assembly in the **EtherNet/IP** tab.
3. Check **Allow changes via EtherNet/IP** if configurations changes via EtherNet/IP should be allowed.
4. Switch the Inspector to Run mode.
5. Set up the communication on the PLC. For information on how to do this, please refer to the documentation for your PLC.
6. Configure the Ethernet result string in the **Ethernet Result Output** dialog on the **InspectorPI50** menu.

---

#### Note

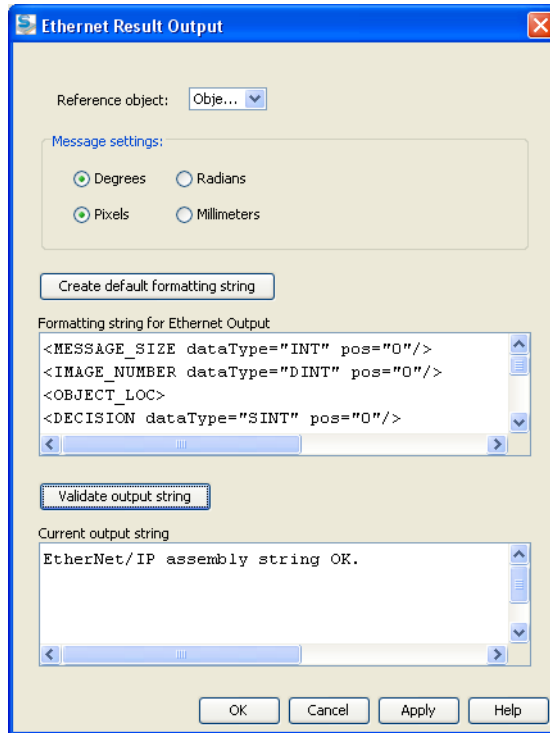
Activating EtherNet/IP will have impact on maximum frame rate.

---

### 15.2 Output Results

1. Open the dialog **Ethernet Result Output** on the **Inspector PI50** menu and select a **Reference object** from the list
2. Set other **Message settings**
3. Click the **Create default formatting string** button
4. Edit the formatting string to format the output as required
5. Click on **Validate output string** to validate the formatting string





## 15.3 Control the Sensor via EtherNet/IP

The Inspector PI50 has two Output assembly that can be used for controlling the Inspector. To do this the connection has to be set first, which is described in Section 15.1, “Set Up the Connection EtherNet/IP” (page 72).

The Output assembly is used for controlling the Inspector in the following ways:

- Reference object selection
- External teach
- Image trig
- Change device mode (run/edit)
- Read and change parameters for configured tools and inspections

For more information about using command channel and EtherNet/IP see the reference manual for Inspector PI50.

# 16 Use Ethernet Raw

Coordinate and angle results, as well as other detailed results and information, can be reported by the Inspector PI50 as binary values or as ASCII strings via ethernet communication. The format of the string can be arbitrarily user defined and can be different for each reference object.

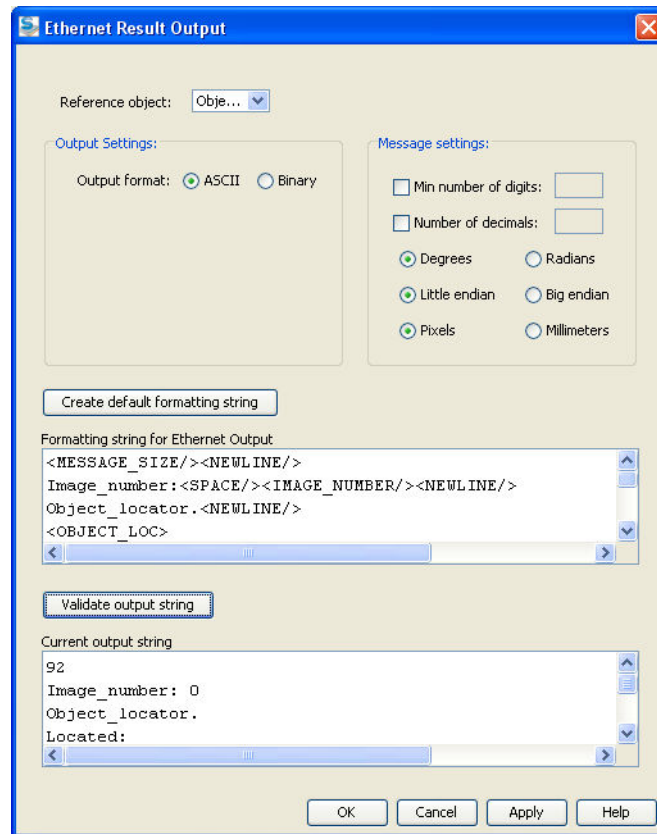
## 16.1 Set up the Connection Ethernet Raw

Do following to set up the result reporting via Ethernet Raw:

1. In the **Interfaces and I/O Settings** dialog in the **Inspector PI50** menu choose **Ethernet** and **Ethernet (Raw)** in the **Interfaces** tab.
2. In the **Ethernet Raw** tab choose which Ethernet protocol to be used for the communication, **TCP** or **UDP**.
3. For UDP enter the PC/PLC **Receiver IP address** and **Port** number. The TCP port number that the Inspector PI50 listens to is 2114.
4. Check **Allow changes via Ethernet Raw** if configurations changes via Ethernet Raw should be allowed.

## 16.2 Output Results

1. Open the dialog **Ethernet Result Output** on the **Inspector PI50** menu and select a **Reference object** from the list
2. Choose whether the results should be sent in ASCII (text) or binary format
3. Set other **Message settings**
4. Click the **Create default formatting string** button
5. Edit the formatting string to format the output as required
6. Click on **Validate output string** to validate the formatting string



## 16.3 Control the Sensor via Ethernet Raw

The command channel makes it possible to read and write a defined set of configuration parameters, and to trigger image acquisition, via UDP or TCP. This section describes how to setup image triggering and command channel settings in **SOPAS Single Device**, as well as the syntax of the command channel.

- External teach
- Image trig
- Reference object selection
- Change device mode (run/edit)
- Read and change parameters for configured tools and inspections

### 16.3.1 Set up the Connection Ethernet Raw Command Channel

The Inspector PI50 supports a set of commands in order to read and/or modify parts of the configuration without using the **SOPAS Single Device** PC application. Port 2115 is used for this communication. For image trigger port 2116 is used. As default the command channel is configured to use UDP. The channel can be switched to TCP or disabled in the **Ethernet Raw** tab in the **Interfaces and I/O settings** dialog (**InspectorPI50 menu**). To enable the Ethernet Raw tab, first choose **Ethernet Raw** in the **Interfaces** tab in the same dialog.

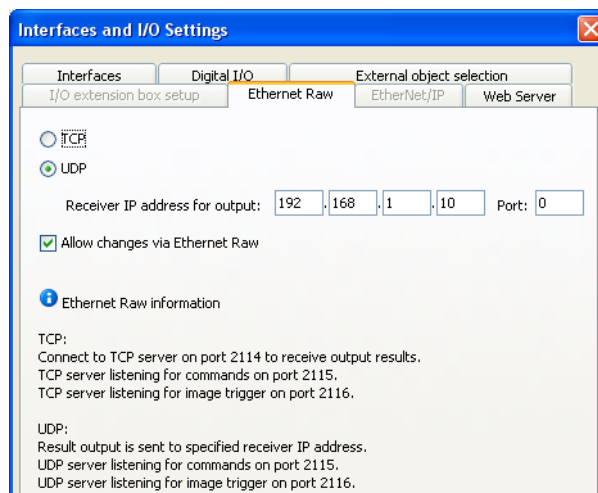


Figure 16.1 Ethernet Command Channel

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### Note

When using the command channel for changing the configuration it is recommended not to use **SOPAS Single Device** for configuration simultaneously.

For more information about using command channel and Ethernet Raw see the reference manual for Inspector PI50.

## 16.4 Communicate with Simatic S7 controls

The Inspector PI50 supports communication with Simatic S7-300 controls via so called Function Blocks. For more information about using communication with Simatic S7-300 controls see the reference manual for Inspector PI50.

# 17 Use EtherCAT

The Inspector PI50 ECAT can be controlled and results can be read out using the EtherCAT®<sup>1</sup> field bus standard. EtherCAT is always enabled on the Inspector PI50 ECAT. The communication and configuration of EtherCAT is managed in an EtherCAT master. For more information about how to configure and communicate using the EtherCAT interface see the reference manual for Inspector PI50.

## 17.1 Set Up the Connection EtherCAT

EtherCAT is always enabled for Inspector PI50 ECAT and cannot be disabled.

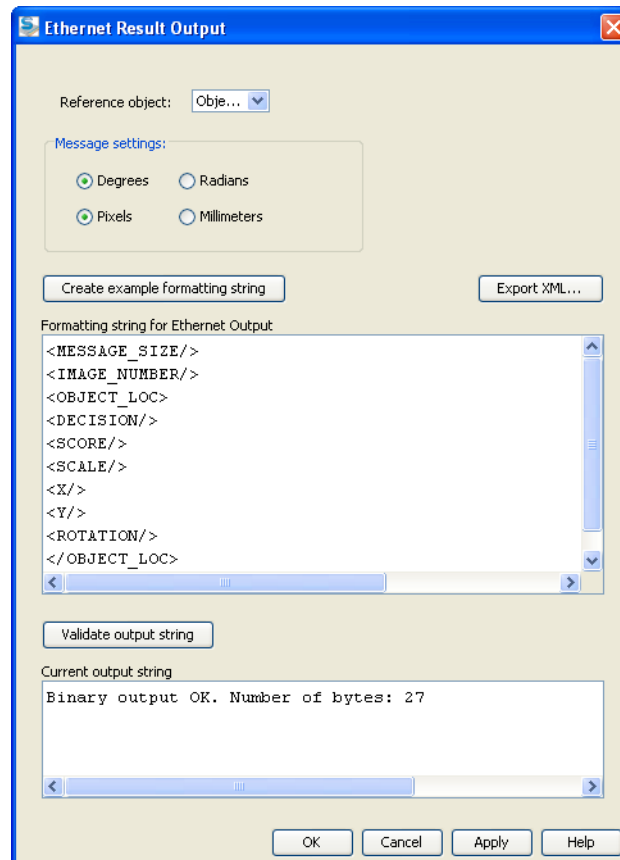
1. Make sure that the checkbox for **Allow changes via EtherCAT** in the dialog **Interfaces and I/O Settings** from the **InspectorPI50ECAT** menu checked if configurations changes via EtherCAT should be allowed.
2. Configure the Ethernet result string in the **Ethernet Result Output** dialog on the **Inspector-PI50ECAT** menu.
3. Set up the communication on the PLC. For information on how to do this, please refer to the documentation for your PLC.

## 17.2 Output Results

The Inspector PI50 ECAT uses EtherCAT Process Data to get output results.

1. Open the dialog **Ethernet Result Output** on the **Inspector PI50** menu and select a **Reference object** from the list.
2. Set **Message settings**.
3. Click the **Create example formatting string** button.
4. Edit the formatting string to format the output as required.
5. Click on **Validate output string** to validate the formatting string.
6. Fix any formatting errors. Also note how many bytes that are needed for the result.
7. Select suitable PD containers in the EtherCAT master, see reference manual.
8. Click on **Validate output string** again. No errors should be reported.

<sup>1</sup>EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.



### 17.3 Control the Sensor via EtherCAT

Via EtherCAT it is possible to control the Inspector PI50 ECAT in the following ways:

- Reference object selection
- External teach
- Image trig
- Change device mode (run/edit)
- Read and change parameters for configured tools and inspections

For more information about controlling the Inspector PI50 ECAT see the reference manual for Inspector PI50.

### 17.4 EtherCAT Functions

EtherCAT has following functions:

- **PDO - Process Data Object.** Inspection result and trigger
- **CoE - Command object.** Used for controlling the Inspector PI50 ECAT
- **EoE - Ethernet over EtherCAT.** Tunnel Web Server/Web API traffic (HMI) in the EtherCAT network
- **FoE - File Access over EtherCAT.** Download of Inspector PI 50 ECAT firmware and handling of configuration files
- **DC - Distributed Clock.** Time stamp and delayed trigger

Minimum EtherCAT cycle time is 1 ms.

# 18 Use Web Server

The Web Server has two functions, Web Server and Web API. The interface Web Server can view live images, logged images and reference objects in the Inspector PI50. Through the Web API you can control the Inspector PI50.

## 18.1 Set up the Connection to the webservice

To set up connection to the webservice do the following:

1. Open the **Interfaces and I/O Settings** dialog in the **Inspector PI50** menu. In the **Interface** tab check **Web Server** box. If this box is checked it will be possible to connect the Inspector PI50 via Web Server and Web API.
2. In the **Web Server** tab check **Allow changes via Web Server** to be able to use the Web API commands. By default, the web server listens to port 80. Some firewalls do not allow communication on port 80, if so, change this value to a port allowed by the firewall. If the used port is another than 80 write the following address in the browsers address field: `http://<ip-address>:<portnumber>`. The port given in the address field must be the same in **Sopas Single Device**.

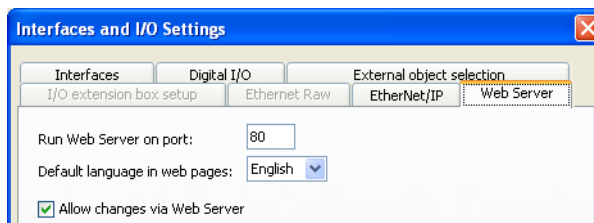


Figure 18.1 Set up connection to the Webservice

### Note

Activating the Web Server will have impact on maximum frame rate.

## 18.2 Web Server

Web Server is compatible with Internet Explorer 8 or higher or with Mozilla Firefox 4 or higher.



Figure 18.2 Main window in Web Server

Via the interface Web Server you can do following:

- View Live image
- View Logged images
- View the Reference objects
- Handle the configuration by creating a backup of the current device configuration or restore a backup of a previous device configuration

### 18.2.1 Connect to Web Server

Write the IP address for the Inspector PI50 in the browsers address field. The LAN settings in the browser may have to be adjusted to avoid using automatic configuration script.

### 18.2.2 Tabs in Web Server

The tabs in Web Server are described below.

#### Start tab

This tab is viewing the version number of current firmware being used by Inspector PI50. The serial number for the device is also viewed in the tab.

#### Live Image tab

In the tab **Live image** you can see the current live image. By default it will be updated one time per second and gets the latest available live image. It is possible to set the frequency for updating the live image. It is then necessary to pause the live image to set this frequency. By clicking on **Show overlay** the overlay graphic and result will be shown from the inspection. When you pause the display of the live image, you get a magnifying glass which you can carry around over the image. The magnifying glass works only in pause mode.

#### Logged Images tab

The logged images are viewed in the **Logged Images** tab. Below the image there is a scrollbar to scroll between the images. There are also arrows in the image to scroll forward and backward between images.

Maximum number of images that can be displayed is 10.



The button **Lock** locks the function of log in Inspector PI50 to get images to **Image Log**. The button **Unlock** unlocks the image log. It is always the most current logged images that are downloaded.

---

**Note**

The image log can not be locked if the function "Store images to FTP" is activated, see Chapter 23, "Log and Store Images" (page 96)

---

**Reference image tab**

In this tab the active Reference Objects is shown.

**Handle Configuration**

In this tab it is possible to choose to create a backup of the current device configuration on an external storage or to restore a backup of a device configuration.

- The **Save Backup** sub tab's function is similar to the Save functionality in **SOPAS Single Device**, but the file formats are not compatible. This is a protected function and therefore a login must be made. For information about password and user name, see Section 7.3, "InspectorPI50 Menu" (page 34)
- In the **Restore Backup** sub tab it is possible to restore a backup of a previous device configuration. The configuration will be stored on the device flash memory. Note that this operation will stop the device if it is in Run mode, and the device will be rebooted when the backup file has been processed. This is a protected function and therefore a login must be made. For information about password and user name, see Section 7.3, "InspectorPI50 Menu" (page 34)

---

**Note**

When restoring a configuration the current configuration will be replaced on the device

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### 18.3 Web API

With the Web API interface you can build your own API to communicate with Inspector PI50. The command set used is the same as used for Ethernet Raw. In addition Web API has a function for import and export device configuration. For more detailed information see the reference manual for Inspector PI50.

## 19 Store images to FTP

One of the interfaces to Inspector PI50 is to store logged images to a FTP server. This is useful to check the images and if necessary set of production parameters.

For details how to store images to FTP see Chapter 23, “*Log and Store Images*” (page 96). See also Chapter 13, “*Interfaces*” (page 62)

# 20 Improve Image Quality

## 20.1 Change Lens

It is possible to change the lens on Inspector PI50 in order to operate at different working distances and to be able to fit the field of view (FOV) for a better inspection. A special tool is required to open the front window of the Flex housing and to replace the standard lens. The tool is delivered in the Inspector PI50 package.

To replace the standard lens of the Flex housing:

1. Open the front window of the Flex housing using the large end of the supplied tool.
2. Remove the standard lens by using the small end of the tool.



3. Attach the new lens. Depending on the focal distance of the lens, and the working distance, one or more distance rings may be necessary.

---

### Note

- The default lens is 10 mm.
  - Refer to the table below for the correct number of distance rings to use.
-

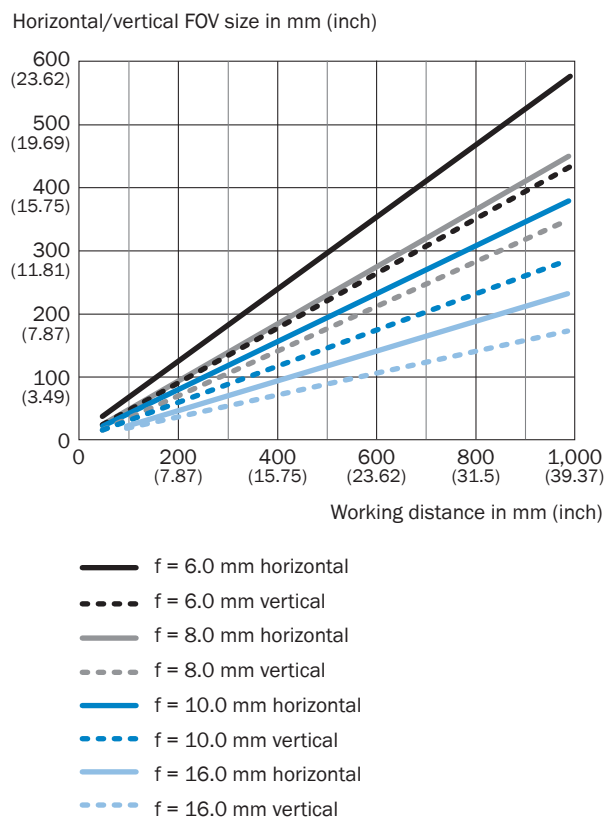


Figure 20.1 Theoretical FOV size (640x480 pixels)

Table 20.1 Lens and working distances

Lens	Distance ring	Working distance
Focal length 16 mm	Black (3 mm) + Silver (1.5 mm)	100 mm - 140 mm
	Black (3 mm)	140 mm - 600 mm
	Silver (1.5 mm)	600 mm - ∞
Focal length 10 mm	Silver (1.5 mm)	50 mm - 120 mm
	None	120 mm - ∞
Focal length 8 mm	Silver (1.5 mm)	50 mm - ∞
Focal length 6 mm	None	50 mm - ∞

4. Attach the front window again to the Flex housing.

After replacement, both the lens and the front window must be securely fastened to prevent them from falling off during operation.

**Important**

- To keep IP 67 classification, open and close the front window only with the supplied tool. Make sure that the seal fits properly.
- To avoid damages, only Inspector accessory lenses offered by SICK must be used.
- Minimize the risk of getting dust into the device by changing the lenses in a dust-free environment. Do not keep the device without the front window. Wipe off the front window before you remove it.

### 20.2 Improve Reflex Avoidance

When working with shiny objects there might be a need to minimize the effects of the reflexes produced by the surface. This can be done in two ways:

- Mount a Dome accessory to the device that diffuses the internal lighting
- Tilt the device with an angle towards the inspection area

#### 20.2.1 Dome

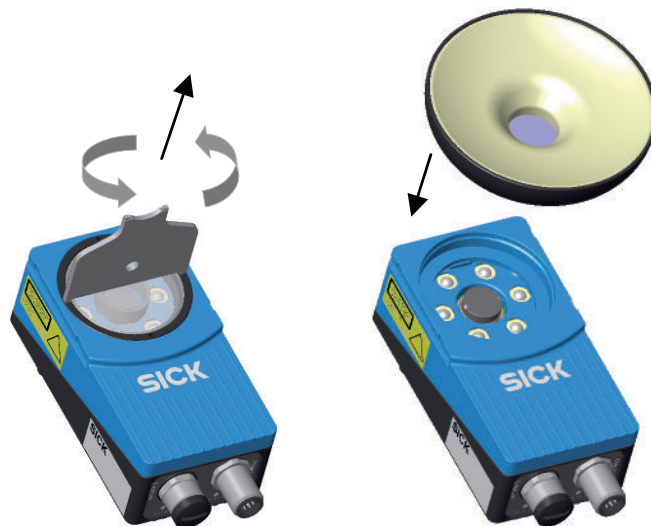
It is possible to replace the front window with a Dome lighting. The Dome lighting diffuses the internal lighting in order to improve performance when working with glossy objects.

When using a Dome lighting the optimal working distance is 50mm. Depending on the object being inspected other working distances may also work well. For example objects with flat and less glossy surfaces could possibly be inspected at a larger distance.

A special tool is required to open the front window of the Inspector. The tool is delivered in the Inspector Flex package.

To replace the front window with the Dome:

1. Open the front window of the Flex housing using the large end of the supplied tool. See the left image below.



2. Attach the Dome to the Flex housing by hand.

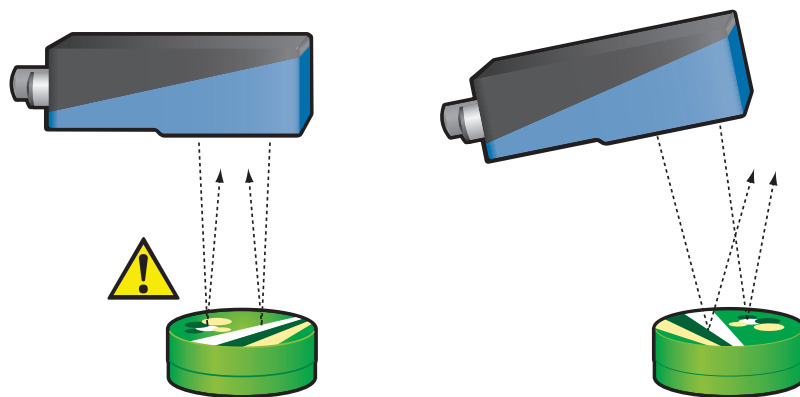
After replacement, the Dome must be securely fastened so that there is no risk of it falling off during operation.

#### Important

- To keep IP 67 classification, open and close the front window only with the supplied tool. Make sure that the seal fits properly.
- To avoid damages, only the Inspector Flex Dome accessory offered by SICK must be used.
- Minimize the risk of getting dust into the device by changing the lenses in a dust-free environment. Do not keep the device without the front window. Wipe off the front window before you remove it.

#### 20.2.2 Tilt Device

Depending on the physical installation limitations and the nature of the application it's possible to limit the reflections from the inspected material by tilting the device as compared to the object.



*Not recommended for glossy objects Slight tilt for glossy objects (recommended)*

---

**Note**

The tilt should be as little as possible but enough to be able to succeed with the configured application. If the device is tilted too much then the perspective will be distorted. Due to this, tilted device is not recommended when inspecting objects that has free rotation or small objects that move a lot within the field of view. Calibration can compensate for tilting.

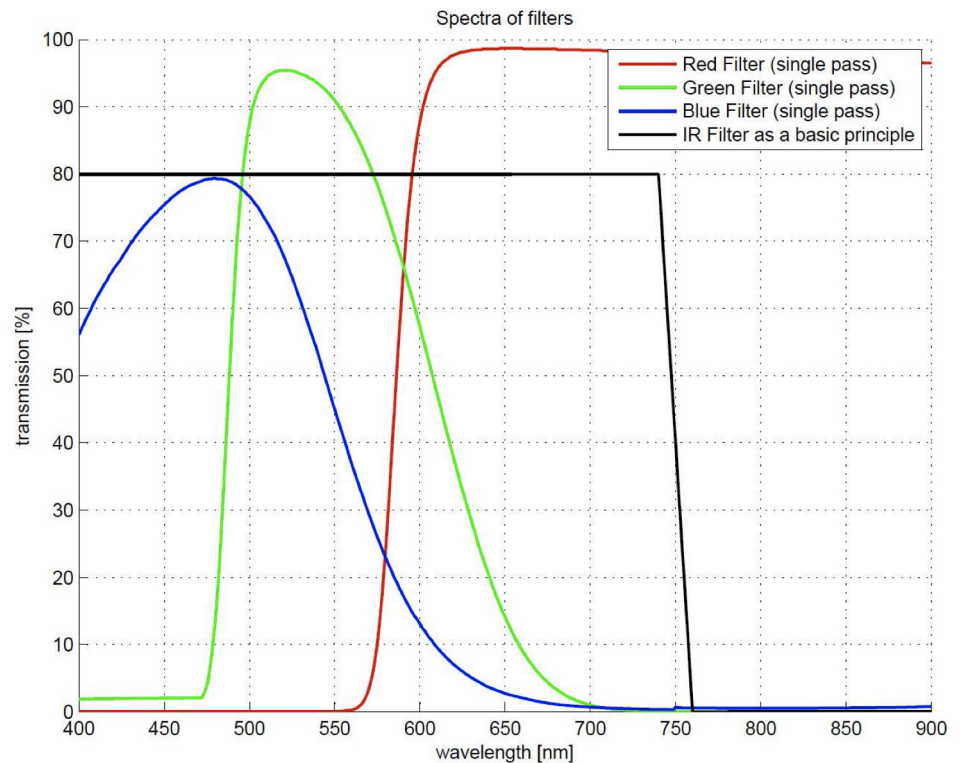
---

### 20.3 Calibrate image

The calibration function corrects perspective and lens distortion errors and provide an image with improved geometrical precision. The calibration improves the robustness and the fine positioning of the object locator, including the ability to find objects regardless of the position in field of view. The precision of the inspection tools are also improved by the calibration. For information on image calibration see Chapter 9, “Calibrate” (page 41)

### 20.4 Optimize Contrast on Multi Colored Targets

On the Inspector it is possible to replace the front window with a front glass filter accessory in order to handle multicolored objects. Available filters are red, green, and blue. Refer to the graph below for the transmission characteristics of the three different filters.



The right edge of the red filter is limited by the internal IR-filter of the Inspector.

The color filters can be used both with internal and external illumination. Please note that the transmission of the filters is only shown for single pass. For the internal lighting the overall transmission is lower because of the double passing.

A special tool is required to open the front window of the Flex housing and to mount the color filters. The tool is delivered in the Inspector Flex package.

The function of the color filters is to enhance that color and to suppress the opposing color, according to the principle of opposing colors, see figure below.

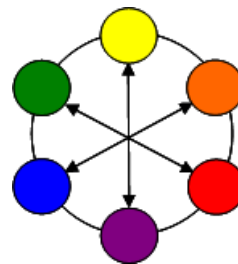
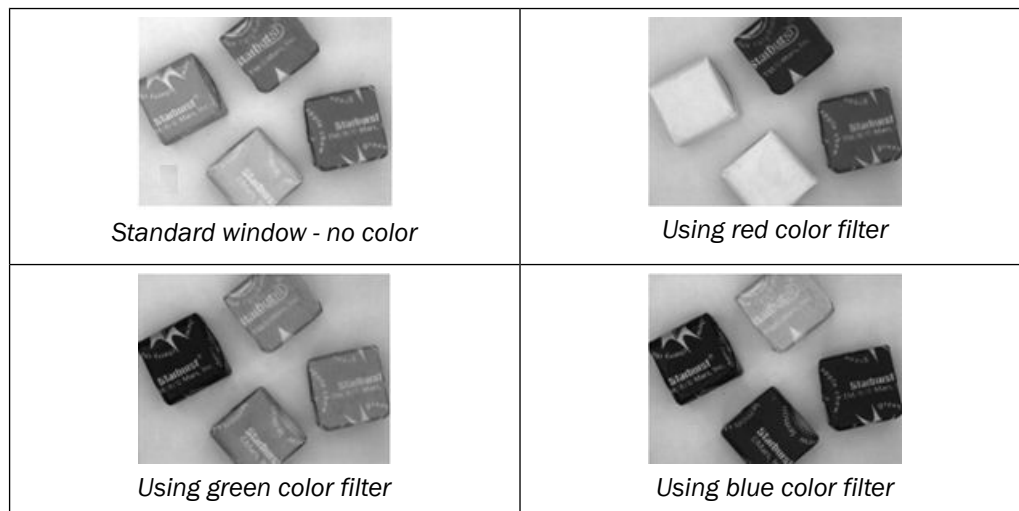


Figure 20.2 Opposing colors

Below is an example of an image and the result of using different color filters:





#### 20.4.1 Mounting filters

To replace the front window with a front glass color filter:

1. Open the front window of the Flex housing using the large end of the supplied tool.
2. Attach the front glass color filter to the Flex housing by using the supplied tool.



## 20.5 Environmental Conditions

Try to improve the quality and reduce the variations in the images captured by the Inspector when inspecting.

- Shield out ambient light or use external lighting to reduce the variation in exposure caused by the ambient light.
- If the objects will be moving at high speed, shorten the exposure time, to avoid motion blur in the images. If this is difficult to do while maintaining a good image quality, consider adding external lighting, see Section 8.3.2, “Use External Lighting” (page 39).



## 21 Improve Robustness

If the Inspector PI50 for example fails to locate correct objects or locates objects that are defect, there are a number of different ways to improve the accuracy/robustness of the locator functions. The most important is to verify that the image quality is good enough, see Chapter 20, “*Improve Image Quality*” (page 83). If this is fulfilled the next step is to adjust the tool settings.

### 21.1 Object Locator

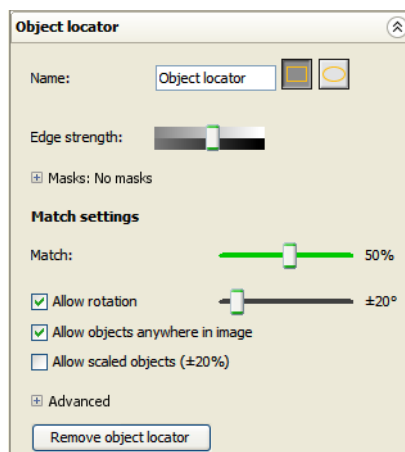


Figure 21.1 Object locator settings

If the Inspector has problems locating objects correctly, try the following:

#### Fine-tune the learned contours

Change the **Edge strength** setting on the **Object locator** tab to adjust which contours that the Inspector uses for locating. Also see Section 5.4.1, “*Teach the reference object*” (page 23) and Section 2.1, “*Find and report position of a known object shape and inspect details of it*” (page 10).

#### Modify the size and shape of the object locator region

Try to remove contours that are not distinguishing for the object, for example contours in the background. If there are no contours in the background, then it is good if the Object locator region (blue) covers the object with a margin. Use rectangular or elliptical shape on the locator region to adapt to the type of object.

In general, the object locator will be more robust if as much as possible of the object is included into object locator region. However, it is important that no disturbing edges from the background, shadows, reflexes, etc is included in the object locator region. This can be avoided by using the mask functionality. If the object is too small in the image, if possible try to change the lens or move the inspector closer to the object.

#### Deselect Allow rotation if possible

Objects that are rotated more than the **Allow rotation** setting will not be located at all.

#### Restrict Allow objects anywhere in image if possible.

If the objects will always be located in a certain part of the image, restricting the search region to this area will avoid having the Inspector mixing up contours outside or partially outside this region from the correct ones.

Restrict the allowed region by deselecting **Allow objects anywhere in image**, and adjusting the **Search region** (green rectangle) in the image.

**Deselect Allow scaled objects if possible**

If the objects always appear at the same size as the reference object, deselecting **Allow scaled objects** will avoid having the Inspector mixing up scaled contours from the correct ones.

**Adjust search method**

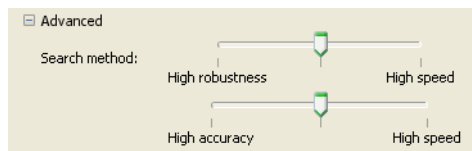


Figure 21.2 Advanced Object locator settings

Switch to a more robust search method for locating the objects, by changing the **Search method** setting (under **Advanced** on the **Object locator** tab). The Inspector's **Search method** can be changed using two sliders. One slider determines the trade-off between **High robustness** and **High speed**. The other slider determines the trade-off between **High accuracy** and **High speed**.

The term **High accuracy** relates to which sub-pixel precision the object is located. For simple applications it may not be necessary to find the optimal sub-pixel position of the object. A fast coarse localization may then suffice. But for applications where the positioning of the detailed inspections needs to be precise, this slider should be set to high accuracy.

The term **High robustness** means that the object is located better in difficult images. This includes images that for example contain much background clutter, heavy shadows, small objects, low contrast, or much occlusion. For simple and clean scenes with large and high contrast objects it is typically sufficient to run at the High speed mode.

**21.2 Blob tool**

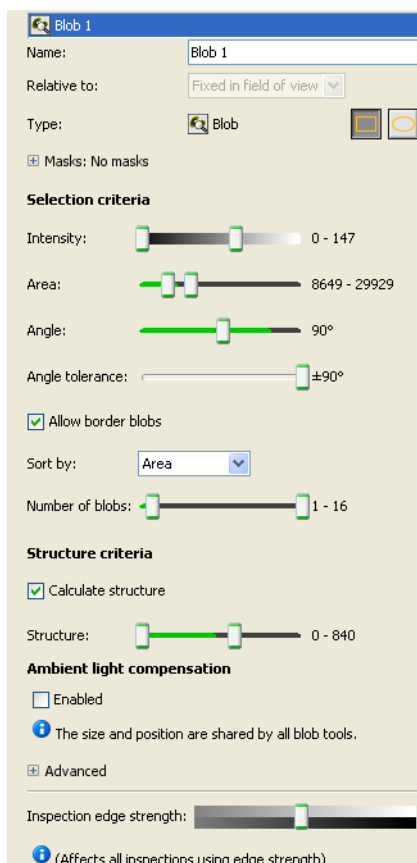


Figure 21.3 Blob tool settings

If the Inspector has problems locating blobs correctly, try the following:

### Modify the size and shape of the blob tool region

Try to remove areas which could include objects that are not to be defined as blobs. Use rectangular or elliptical shape on the locator region to adapt search region's shape.

### Mask out difficult areas

Areas that are known to vary between images, such as date codes or highly reflective areas, should be ignored in the blob tool region. This is achieved by masking the area.

### Adjust search method

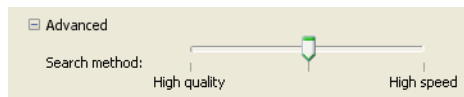
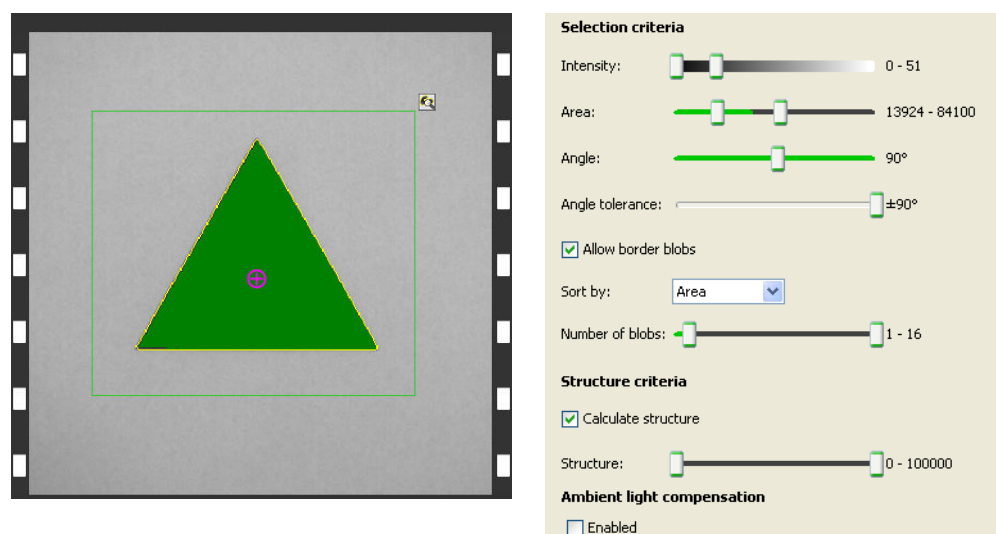


Figure 21.4 Advanced Blob tool settings

Switch to a faster search method for locating the objects, by changing the **Search method** setting (under **Advanced** on the **Tools** tab). The Inspector's **Search method** can be set with the slider that determines the trade-off between **High quality** and **High speed**. Normally the **High speed** option can be used on images where there is minor disturbance/noise in the image apart from the blobs themselves and **High quality** should be used on images with more disturbance/noise.

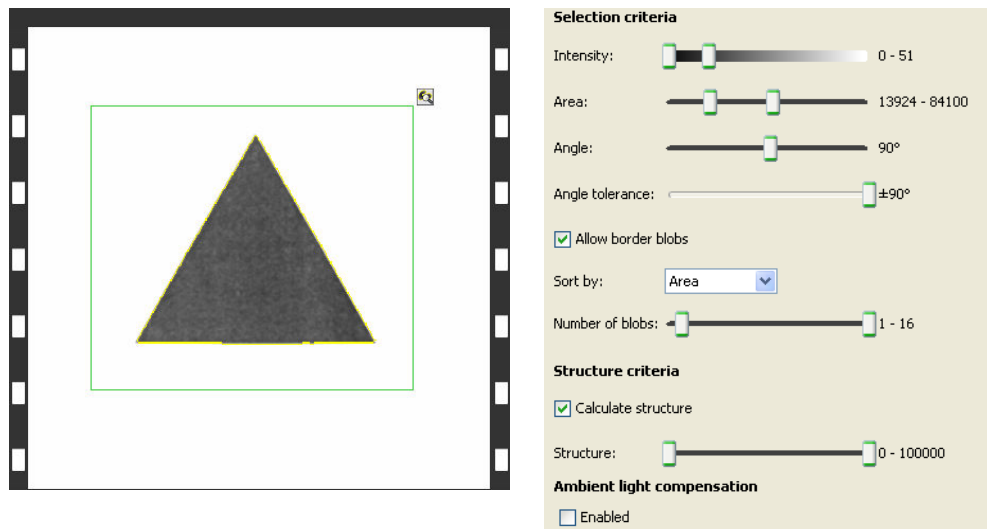
### 21.2.1 Enable Ambient light compensation

The ambient light compensation can be used to handle variations in the surrounding light conditional environment. To enable the function click on the Blob tool in the list in **Tool** tab, then click **Enabled** under **Ambient light compensation**. A yellow framed ROI is displayed and it is recommended to position the ROI somewhere within the field of view for the Inspector where there will not be any blobs passing by during the free-running/trigged inspection. Mask functionality can also be used to get a suitable shape of the ROI. The yellow ambient light compensation ROI of the live image is compared to the corresponding ROI of the reference image to get the adapted thresholds. It is recommended to place the ambient light compensation ROI at a place within FOV with similar grey level as the blobs that should be detected. The ambient light compensation ROI is the same for all blob ROI:s in the reference object. The following example illustrates the principle of ambient light compensation.



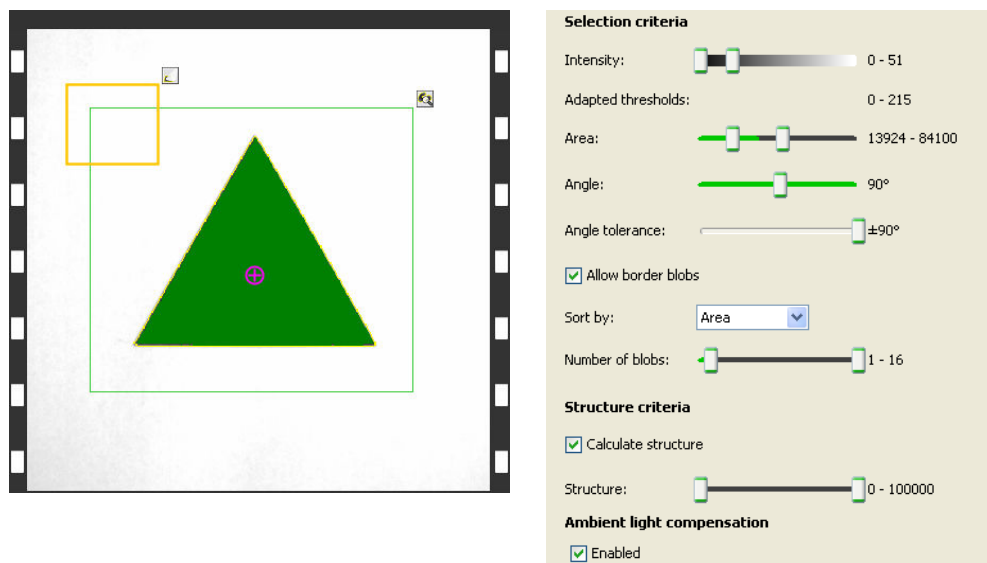
The triangular blob is detected (purple cross with circle) in normal light conditions without the ambient light compensation enabled. The blob has got grey values less than 50 and is therefore detected.

Now light conditions change and ambient light is added to the scene.



The triangular blob is not detected since the grey values of the triangle blob is now above 50. The thresholds for detecting a blob is still between 0-50.

To enable robust blob detection under varying ambient light conditions the ambient light compensation feature is enabled.



An ambient light compensation region has been added in the top left part of the image. The blob is now detected even though ambient light has been added to the scene. The thresholds for detecting a blob has adaptively changed to 0-93, and therefore the triangular blob is now detected.

### 21.3 Polygon tool

If there are problems to locate the polygon inspection, try the following:

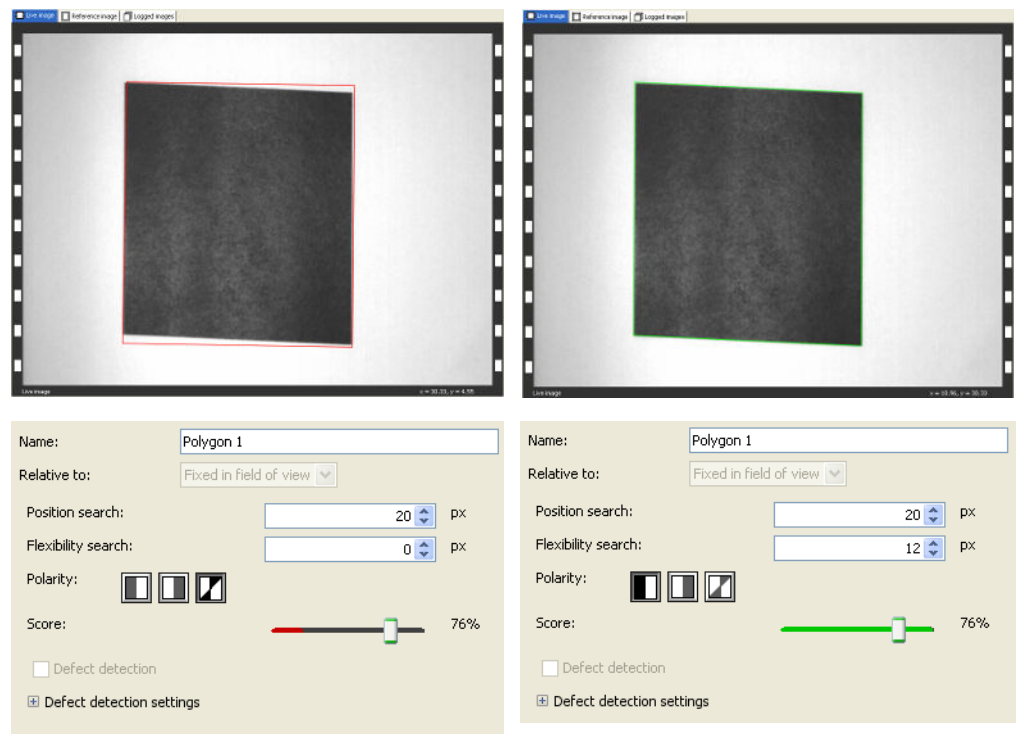
#### Position search

Controls the extent of the rigid positioning. Avoid having values larger than approximately half of the object side since the Inspector PI50 may find other edges than the wanted. How-

ever, the risk of finding other edges than wanted can be reduced if the polarity functionality is used (see below).

### Flexibility search

Control the amount of flexibility. This parameter limits the distance between the rigidly fitted corners and the flexibly fitted corners. If the object has a solid shape and it is only moved or rotated the value of Flexibility search should be low. A value of 0 means that no flexibility is allowed. It is not optimal to set a low value since it is difficult to draw the exact polygon for the object. Set a value of 3-4 for example to have a margin of error. Do not set the flexibility search too high, since this will increase the risk of finding other edges than wanted. See following figure. See also Section 10.4, “Polygon tool” (page 51).



Object not found, Flexibility search 0.

Object found, Flexibility search 12.

Figure 21.5 Flexibility search

### Note

High image quality is needed for the polygon tool to work. Edge with highest intensity is chosen rather than nearest edge.

### Polarity

If possible the polarity shall always be chosen since this will significantly decrease the risk of finding other edges than wanted. For the case when the object borders can both be darker or brighter than the background, the “no polarity” mode needs to be chosen. Try to avoid these situations by improving the lighting setup, e.g. a backlight setup.

## 21.4 Pattern, Pixel Counter, Edge Pixel Counter

If the Inspector has problems correctly inspecting details on objects after they have been located, try the following:

**Adjust inspection settings**

Try the following method to find proper settings for a detailed inspection:

1. Have the Inspector inspecting a number of acceptable objects, and note the result for the detailed inspection.
2. Do the same thing, using faulty objects instead, and note the result.
3. Set the **No. of pixels in range**, **No. of edge pixels** or **Match** setting so that the thresholds are halfway between the results for the acceptable and the faulty objects.

**Modify the inspection regions**

You can change the regions in the image on the Reference image tab:

- Move, resize and rotate an inspection region with the handles that appear on the region when selected.
- Change the shape of a region with the Shape buttons on the Detailed inspections tab.
- Mask out areas of the region with the **Mask** tool.

**Note**

After modifying a Pixel counter or an Edge pixel counter, you may have to adjust the setting for **No. of pixels in range** **No. of edge pixels**.

Stable intensity is needed for robust pixel counting

**Choose a different type of detailed inspection**

Sometimes it may help to try a different inspection type. For example, using an Edge pixel counter instead of a Pixel counter may make the inspection more tolerant of ambient light.

**Divide a detailed inspection into several smaller inspections**

Sometimes one defect may even out another defect in an inspected region, for example ink smudges may compensate for missing print in a printed date. Using several smaller detailed inspections that cover the same area on the object can reduce the risk for this to happen.

## 21.5 Replace Reference Image

Getting good images is often critical for correct inspections. To replace the reference image:

1. Place a good object in front of the Inspector.
2. Switch to Edit mode, and adjust the exposure and gain on the **Image settings** tab.
3. Click **Replace reference image** below the image on the **Live image** tab. The Inspector captures a new image of the object and displays it on the **Reference image** tab.
4. If necessary, adjust the regions in the reference image so that they are located at the correct positions on the object.

**Note**

To better handle variations in the orientation of the objects, choose a reference object that has a typical orientation.

## 22 Improve Speed

There are a number of ways to improve the inspection speed if it is not fast enough. The list below brings up the parameter settings that can improve the speed. When testing these improvements, observe the frame rate shown below the image. Speed optimization is a trade-off between speed and robustness or speed and available interfaces.

### Image settings

- Reduce exposure time
- Decrease image size
- Remove calibration

### Object locator

- Decrease size or remove the Object locator region, in reference image
- Reduce or unselect rotation
- Reduce search region by deselecting **Allow object anywhere in image**
- Unselect scale objects
- Adjust **Search method** to **high speed** under advance option

### Blob tool

- Reduce search region size
- Adjust **Search method** to **high speed** under advance option

### Polygon tool

- Decrease **Position search**
- Decrease **Flexibility search**

### Pattern tool

- Decrease **Position tolerance**
- Use **Pixel counter** tool if **Pattern** is not needed

### Edge pixel counter and Pixel counter tools

- Fastest tools, can not be optimized

### Interfaces and I/O settings

- Deselect **I/O extension box**
- Deselect **EtherNet/IP**
- Deselect **Web Server**
- Deselect **Store images to FTP**

## 23 Log and Store Images

### 23.1 Use Image Log

The Inspector PI50 saves up to 30 images in its memory. To view the logged images, click on the **Logged images** tab. To be able to log images at least one reference object has to be configured.

#### Note

The image log will not be displayed in **SOPAS Single Device** while the Inspector PI50 is storing images to FTP.

#### Log settings

To change which images the Inspector PI50 should log, choose **Log settings** from the **InspectorPI50** menu. You can choose the following alternatives:

All	Every captured image.
Passed	Images where the object was located and all detailed inspections passed.
Located	All images where an object was located, regardless of whether any detailed inspection passed or failed.
Detail failed	Only images where one or more detailed inspection failed.
Failed (Not located or Detail failed)	Images where either no object was located, or where one or more detailed inspections failed.

#### Save logged Images to PC

To save the log to the PC - all images and the results from the inspection - click **Save log**.

The log is saved as an HTML file (**LogReport.html**) that can be viewed in any web browser. The images are saved in two folders together with the HTML file, one folder that contains the images without graphical feedback, and one folder that contains the same images but with the graphical feedback.

The images without graphical feedback can be used in the simulated device.

#### Update the image log

Images that the Inspector PI50 adds to the log are not automatically added to the list on the Logged images tab. To update the displayed list of images with images added by the Inspector, click **Update log**.

When updating the log, the oldest images are removed from the list, keeping the maximum number of images at 30.

#### Clear the Image log

To remove all images from the image log, click on the Clear log button. The images are also removed from the Inspector PI50.

### 23.2 Store images to FTP

One of the interfaces to Inspector PI50 is to save logged images to a FTP server. This is useful to check the images and if necessary set of production parameters.

#### Setting up

To make the Inspector PI50 store logged images to an FTP server, do the following:

1. Choose **Store Images to FTP** from the **Inspector PI50** menu.



- In the dialog box, select the **Store images** tab and enter the following:
  - Check **Enable FTP storage of logged images**.
  - Choose whether to automatically start storing images to FTP when in **Run** mode.
- Select the **FTP settings** tab and enter the following information:
  - The IP address of the FTP server.
  - A user name and password for connecting to the FTP server.
  - The folder in which the images should be stored. This folder will be created on the FTP server if it does not already exist.
- Click **Test connection** to test the connection to the FTP server. The Inspector will try to log in to the FTP server.

---

**Note**

The selection criteria for store images to FTP is the same as image log.

---

**Warn for unsent images**

When the Inspector PI50 is storing images to FTP it can queue up to 30 images in case that it should not be able to store images as fast as it is inspecting.

To make the Inspector PI50 signal on a digital output if the queue is getting full, select **Warn for unsent images** and choose which digital output to use for the warning. When used, the warning will be mapped to the same output regardless of which reference object is currently used. The Inspector PI50 will warn if there are more than 20 unsent images. The warning will be reset when there are less than 10 images in queue.

If the queue of unsent images becomes full, for instance if the FTP server is down, the oldest image in the queue will be replaced with the new image.

**Using the stored images**

The images are stored on the FTP server as Windows bitmap files (BMP). The files are named in the following way:

```
<Reference object>_<inspection ID>_<result>.bmp
```

For example: Aloe\_00000147\_pass.bmp

Note that only the captured images will be saved, without any detailed result. To get the inspection result you can do the following:

- Let an external device (for example a PLC) read the inspection results via EtherNet/IP and store the results. Use the inspection ID to combine the stored image with the inspection result.
- Use **SOPAS Single Device** with a simulated device, and let the simulated device inspect the stored images. This way you can also get images with the inspections drawn in them, or use the images to adjust the configuration to make the inspections more robust.

---

**Note**

Activating the function **Store images to FTP** may have impact on the live image rate for other interfaces, for example the live image in **SOPAS Single Device**.

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### 23.3 Record Live Images to PC

To record images captured by the Inspector as files on the PC, choose **Record Live Images** from the **InspectorPI50** menu.

After selecting a folder in which to save the images, a dialog box is displayed in which the number of recorded images is displayed.

To stop recording images, click **Stop recording** in the dialog box.

The images will be saved as separate files in the folder you selected. The images are saved in 8-bit gray scale BMP format.

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**Note**

This saves only the images that are displayed in the **Live image** in the PC application, which is not necessarily every image that the Inspector PI50 captures.

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# 24 Use the Simulated Device

**SOPAS Single Device** has a built in simulated device which can be used to simulate and test device settings off-line without access to a real Inspector. The simulated device can be used for evaluating inspection settings by using previously saved images. Image capturing and external communication interfaces are not available in the simulated device.

### Note

The simulated device uses the same algorithms as the real Inspector, and for most configuration they will produce identical results. However, in some situations there may be minor differences, due to the different hardware in the Inspector and the PC. To minimize the impact of any such differences:

- Always make final verification of your configuration using a real Inspector.
- Make sure that there is a large enough difference between a pass and a fail result.

## 24.1 Start the Simulated Device

There are two ways to start the simulated device:

- Starting the simulated device when already connected to an Inspector
- Starting the simulated device when starting **SOPAS Single Device**

### 24.1.1 Start the Simulated Device when Connected to an Inspector

To start the simulated device when connected to an Inspector, select **Switch to Simulated Device** from the **Communication** menu.






### 24.1.2 Start the Simulated Device without PC Application Running

To start the simulated device without PC application running:

1. Start the **SOPAS Single Device** application.
2. In the SOPAS welcome screen, select the **Use simulated device** option.
3. In the **Connection Wizard** dialog box, select the **Inspector PI50** device. Click **Next** and the simulated device will start.

## 24.2 Control the Simulated Device

The buttons in the bottom of the **Live image** tab controls the simulated device. These controls are only visible when using the simulated device. The buttons are:

-  **Run**, loops over the images in the selected folder.
-  **Pause**, pauses on the current image.
-  **Next image**, steps to the next image and pauses.
-  **Previous image**, steps to the previous image and pauses.
-  **Repeat**, deselect to run through the images once.

## 24.3 Select Images to be Used

To use saved images with the simulated device, the images must be in bitmap (.BMP) file format (8 bit Grey scale). In order to retrieve images to PC, see Chapter 23, “*Log and Store Images*” (page 96). If the resolution does not match the selected FOV:

- Large images will be truncated and the centered part of the image will be used.

- Small images will be centered in the field of view and filled with black outside the image.

To select image source folder used by the simulated device:

1. Click **Select images**.
2. Select the image folder. Click **Open**. The folder path is displayed under the **Select images** button.

The selected images is shown in alphanumeric order with the numeric order first.

## 24.4 Copy Device Data from the Simulated Device to an Inspector

If you have used the menu option **Switch to Simulated Device**, then you can copy device data from the simulated device to an Inspector, by selecting **Switch to Physical Device** from the **Communication** menu.

If the connection to the simulated device were made with the connection wizard, then you can copy device data by:

1. In the simulated device, select **Save Device File** from the **File** menu.
2. Connect to an Inspector by using **Connection Wizard**, see Section 6.1, “*Use the Connection Wizard*” (page 28).
3. Load device data to device, see Section 25.4, “*Copying Device Data From one Inspector to Another*” (page 101) .

## 25 Handle Device Data

The device data are all settings used to configure and control an Inspector. The device data consists of:

- Reference images
- Image capturing settings
- Object locator and inspection tool settings
- Output settings
- Interface configuration settings

The image log and statistics are not included in the device data.

The device data can be stored permanently in the device flash memory to let the Inspector work independently from the configuration interfaces. The device data can also be extracted from the device for backup or transfer to other devices.

### 25.1 Save Device Data on the Inspector (in flash memory)

To save all device data (settings) in the Inspector's flash memory, select **Save Settings in Flash** from the **InspectorPI50** menu. A progress bar is displayed during the process. The Inspector will stop inspecting until the flash memory is updated. When saving to flash memory the function LED will flash white.

If the settings is changed in **SOPAS Single Device Edit** mode, a question to save to flash memory is raised when switching to **Run** mode.

Please note that it may take several minutes to save the settings in flash memory. The more reference objects present the longer time it takes.

Settings that are saved in the Inspector's flash memory will be used when the Inspector starts again after a power loss. If you do not save the settings in the flash memory, the changes made will be lost if the power is disconnected.

### 25.2 Save Device Data on PC

Choosing **Save Device File as** from the **File** menu will save the Inspector's current device data to a new file on the PC. This file will contain all device data including the reference images and a reference to the Inspector used. The device data saved with **SOPAS Single Device** is not compatible with the device data exported through the Web API interface.

### 25.3 Use Saved Device Data on the Inspector

To use saved device data, choose **Open Device File** from the **File** menu and select the file (.sdv). When opening a saved file, the PC application will try to connect to the Inspector for which the file was saved.

If you have unsaved changes in the Inspector, you will be asked if you want to save these before continuing.

If the Inspector, for which the file is saved, is found, then you can start using it.

If the Inspector is found but the device data differ between the Inspector and the file, then you are asked if you want to use the device data in the Inspector or from the file.

If the Inspector is not found, use the **Connection Wizard** to set up a connection with an Inspector and download the saved device data (see Section 25.4, "Copying Device Data From one Inspector to Another" (page 101)).

### 25.4 Copying Device Data From one Inspector to Another

To copy device data from one Inspector (source) to another Inspector (destination):

1. Connect to the source Inspector, by using **Connection Wizard**, see Section 6.1, “Use the Connection Wizard” (page 28).
2. Save the device file, choosing **Save Device File** as from the **File** menu.
3. Connect to the destination Inspector using the **Connection Wizard**.
4. Download the device data to the destination Inspector by using **Load Device Data to Device Wizard**.
  - a. Choose **Load Device Data to Device** from the **Edit** menu. Click **Browse** to browse for device files.
  - b. Select the device file and click **Open**.
  - c. The device data is transferred to the Inspector. Click **Finish**.

## 25.5 Export and import device data through Web Server or Web API

It is possible to export the device data through the Web API interface as well as the Web Server. For more information on how to do this through the Web API see commands section in the Reference manual for Inspector PI50. The device data exported through the Web API interface is not compatible with the device data saved with **SOPAS Single Device**.

## 25.6 Restore Settings to Factory default

It is possible to return to the factory settings from the Inspectors flash memory. All device data will be deleted. To restore settings:

1. Select **Restore Settings** from the **InspectorPI50** menu. A warning dialog box is displayed.
2. Click **Yes** to restore settings to factory settings. Or click **No** to cancel.

---

### Note

The IP address of the Inspector will not be reset when restoring the settings.

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# Appendix

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# A Technical Data

## A.1 Dimensional Drawings

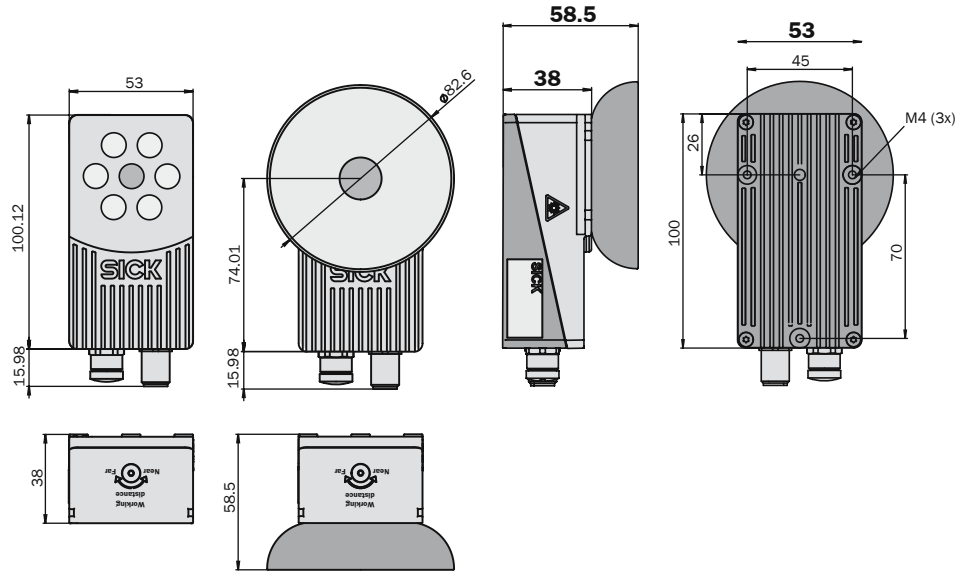


Figure A.1 Inspector PI50, VSPP-5F2113

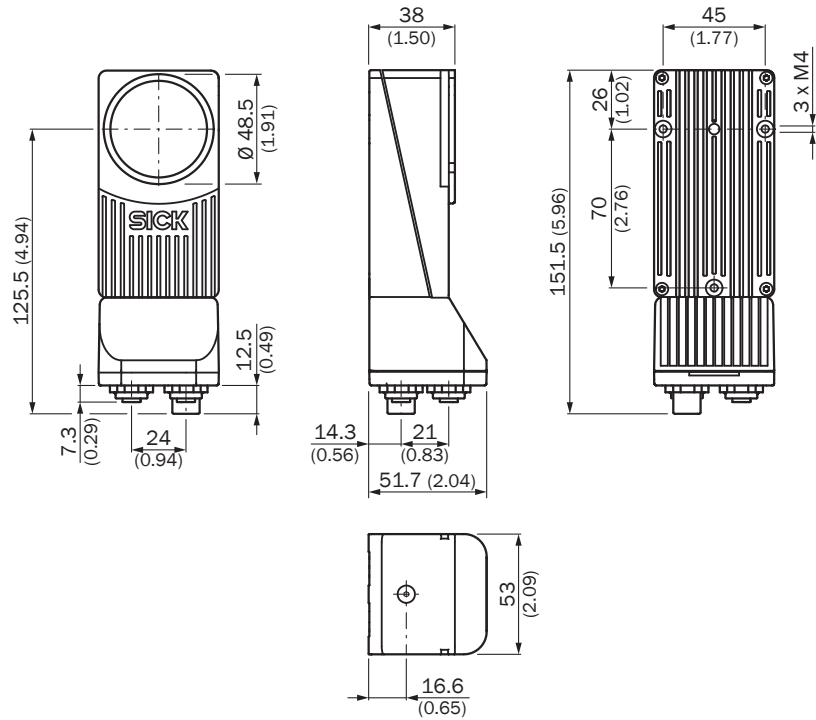
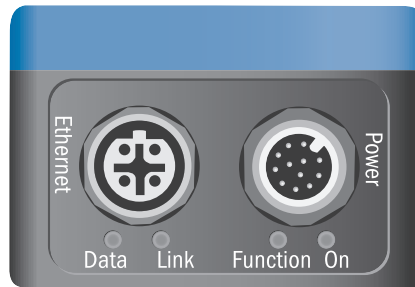


Figure A.2 Inspector PI50 ECAT, VSPP-5F2134

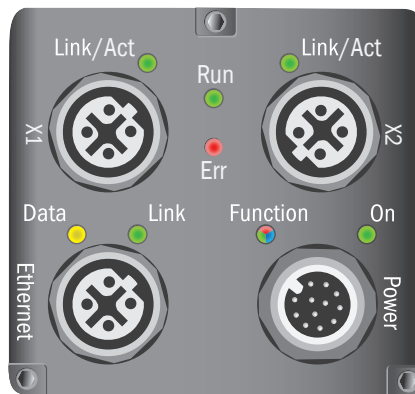




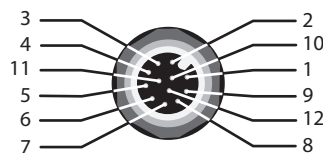
Inspector connector pinning – Ethernet/X1/X2, 4 pin, M12		
Pin	Signal	Signal description
1	Tx+	Transmit +
2	Rx+	Receive +
3	Tx-	Transmit -
4	Rx-	Receive -



**Inspector PI50, VSPP-5F2113**  
**Ethernet - 10/100 Mbit/s**



**Inspector PI50 ECAT, VSPP-5F2134**  
**Ethernet, X1, X2 - 100 Mbit/s**



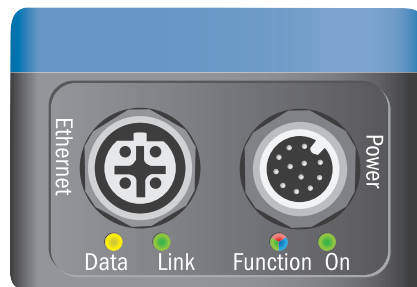
Inspector connector pinning – Power In/Out, 12 pin, M12 connector			
Pin	Color <sup>a</sup>	Signal	Signal description
1	Brown	Power	24 V power supply
2	Blue	GND	Ground 0 V
3	White	In3	Image trigger + External object selection (24 V)
4	Green	Out1	Output 1 – Object not located (B-type) <sup>b</sup>
5	Pink	In2	External teach + External object selection (24 V)
6	Yellow	Out2	Output 2 – Inspection failed (B-type) <sup>b</sup>
7	Black	Out3	Output 3 – All pass (B-type) <sup>b</sup>
8	Grey	In1	External object selection (24 V)
9	Red	Ext trigger	External trigger, external illumination, (5 C TTL)

Inspector connector pinning – Power In/Out, 12 pin, M12 connector			
Pin	Color <sup>a</sup>	Signal	Signal description
10	Violet	In4	Encoder + External object selection (24 V)
11	Grey/pink		Reserved
12	Red/blue		Reserved

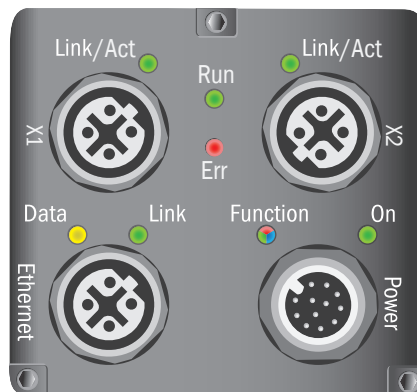
<sup>a</sup>Colors are valid for cable type DOL-1212.

<sup>b</sup>Push-pull output.

### A.3 LED Description



Inspector PI 50, VSPP-5F2113



Inspector PI50 ECAT, VSPP-5F2134

Inspector – LED description				
LED	Mode	Color	Description	
Data	All	Yellow	Ethernet Data	
Link	All	Green	Ethernet Link	
Function	Run/Edit	Blue	Not located	
		Red	Detailed failed	
		Green	All passed	
		Off	No inspection	
		White	Device data is stored in flash memory	
	External teach	Flashing		Image focus. Higher frequency means better focus.
		Green		No motion in field of view
		Blue		Motion in field of view
		White	Device data is stored in flash memory	

Inspector – LED description			
LED	Mode	Color	Description
	Anytime	Red, slow flashing	Fatal error
On	All	Green	Power On
Link/Act <sup>a</sup>	All	Green	EtherCAT® <sup>b</sup> Link/Activity
Run <sup>ac</sup>	All	Green	EtherCAT Run indicator
Err <sup>ac</sup>	All	Red	EtherCAT Error indicator

<sup>a</sup>Only VSPP-5F2134 \_ PI50

<sup>b</sup>EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

<sup>c</sup>EtherCAT standard ETG.1000.

## A.4 Technical Specification

		VSPP-5F2113 - PI50	VSPP-5F2413 - PI50-IR	VSPP-5F2134 - PI50 ECAT
<b>Working distance</b>	50 ... ∞ mm	X	X	X
<b>Working distance, internal illumination</b>	50 ... 200 mm	X	X	X
<b>Field of view, internal illumination</b>	22x15 ... 79x58 mm <sup>2</sup>	X	X	X
<b>Optics</b>	Exchangeable	X	X	X
<b>Performance</b>				
- Max	200 fps	X	X	
	160 fps			X
- Typical	40 fps	X	X	X
<b>Repeatability, position</b>				
- Object locator	± 0,2 pixels	X	X	X
- Blob	± 0,1 pixels	X	X	X
<b>Repeatability, angle</b>				
- Object locator	± 0,05°	X	X	X
- Blob	± 0,02°	X	X	X
<b>Toolset</b>	Object locator	X	X	X
	Blob, Pixel counter, Edge pixel counter, Polygon, Pattern	X	X	X
<b>Number of inspections</b>	32 regions	X	X	X
<b>Reference images</b>	32 objects	X	X	X
<b>Offline support</b>	Emulator	X	X	X
<b>Production control</b>				

		VSPP-SF2113 - PI50	VSPP-SF2413 - PI50-IR	VSPP-SF2134 - PI50 ECAT
<b>- Operator interface</b>	SOPAS, Inspector Viewer	X	X	X
	Web Server	X	X	X
<b>- Data store and retrieve</b>	30 images device log	X	X	X
	Record images on PC	X	X	X
	Store images to FTP	X	X	X
<b>- Ethernet communication</b>				
	EtherNet/IP	X	X	
	Ethernet Raw configurable	X	X	
	EtherCAT			X
	Web API	X	X	X
<b>I/O Extension box</b>	5 inputs for object selection	X	X	
	16 outputs	X	X	
<b>Resolution</b>	640x480 pixels	X	X	X
<b>Light source</b>	White ring light, 6x High-Power LEDs	X		X
	IR ring light, 850 nm		X	
<b>- LED class</b>	Risk group 1 (low risk, IEC62471:2006)	X		X
	Risk group 0 (low risk, IEC62471 : 2006)		X	
<b>Spectral response</b>	Approx. 400 ... 750 nm	X		X
	Approx. 370 nm ... 900 nm		X	
<b>Supply voltage</b>	24 VDC ±20%	X	X	X
<b>- Ripple</b>	< 5 Vpp	X	X	X
<b>- Current consumption</b>				
	< 450 mA, without load	X	X	
	< 500 mA, without load			X
<b>Digital outputs</b>	3 outputs 24 V (B-type) <sup>a</sup>	X	X	X
<b>- Output current</b>	100 mA	X	X	X
<b>- Default outputs</b>	Not located, detail failed, all passed	X	X	X
<b>-Configurable outputs</b>	Output by logical expressions	X	X	X
	Store images to FTP overflow	X	X	X
<b>Control of external light</b>	5 V TTL	X	X	X
<b>Digital inputs</b>	4 inputs 24 V	X	X	X
<b>- Configurable inputs</b>	External trigger, encoder, external teach, reference object selection	X	X	X
<b>- Max encoder frequency</b>	40 kHz	X	X	X
<b>Interface</b>	100 Mb Ethernet	X	X	X

		VSPP-SF2113 - PI50	VSPP-SF2413 - PI50-IR	VSPP-SF2134 - PI50 ECAT
<b>Ambient temperature<sup>b</sup></b>	Operation: 0 °C ... 45 °C	X	X	X
	Storage: -20 °C ... 70 °C	X	X	X
<b>Housing material</b>	Aluminum	X	X	X
<b>- Window material</b>	PMMA (plastic)	X	X	X
<b>Weight</b>				
	350 g	X	X	
	445 g			X
<b>Enclosure rating</b>	IP67	X	X	X
<b>Mechanical shock load</b>	EN 60068-2-27	X	X	X
<b>Vibration load</b>	EN 60068-2-6	X	X	X
<b>Device specific accessories<sup>c</sup></b>				
<b>- Lenses, focal length</b>	6 mm	X	X	X
	8 mm	X	X	X
	10 mm	X	X	X
	16 mm	X	X	X
<b>- Glass front filters<sup>d</sup></b>	Red (> 588 nm)	X	X	X
	Green (544 ± 53 nm)	X		X
	Blue (468 ± 62 nm)	X		X
	Visible block filter (> 730 nm)		X	
<b>- Dome</b>	Optimal for 50 mm working distance	X	X	X
<b>I/O extension box</b>	4 inputs, 8 outputs	X	X	X
<b>I/O module</b>	2 extra digital inputs	X	X	X
	8 extra digital outputs	X	X	X
<b>Viewer</b>	Live image/log/statistics view and reference object change	X	X	X

<sup>a</sup>Push-pull output.

<sup>b</sup>Rel. Humidity: 35 ... 85%, 95% at storage.

<sup>c</sup>Full accessory list at [www.sick.com](http://www.sick.com).

<sup>d</sup>> 60% transmission.



## A.5 Accessories Ordering Information

Type	Order no.
Inspector angle bracket	2045167
Inspector light/filter adapter	2045397
Inspector Universal arm + adapter bracket	1048400
Lens focal length 6 mm	2049668
Lens focal length 8 mm	2056692
Lens focal length 10 mm	2049415
Lens focal length 16 mm	2049418
Inspector Flex Color filter, red	2050675
Inspector Flex Color filter, green	2050677
Inspector Flex Color filter, blue	2050676
Inspector Flex Dome	2050678
I/O extension box (4 inputs, 8 outputs)	6037654
I/O module, 2 extra digital inputs	6039038
I/O module, 8 extra digital outputs	6037750
Front window, Inspector flex (glass)	2052266
Front window, Inspector flex (PMMA)	2050690
Tool, front window Inspector flex	2050703
Inspector Viewer	2057556

For a complete list of accessories for the Inspector, including cabling and external lightings, please visit [www.sick.com](http://www.sick.com).

## A.6 What's Included – Inspector PI50

The boxed version of the Inspector PI50 includes:

- Inspector PI50
- Product installation CD including operating instruction, reference manual and calibration target in pdf format
- Printed Quickstart
- 2 mm hex key
- Tool for exchange of lens
- Two focused stickers

Languages: English, French, Italian, German, Spanish, and Chinese (simplified).

## A.7 System Requirements

- Windows XP Professional (Service Pack 2) or Windows Vista Business Edition service pack 1 (32/64 bit) or Windows 7 Professional (32/64 bit)
- Pentium III 550MHz or higher
- For simulated device mode a Pentium 4 2.5GHz or higher should be used
- 512 MB of RAM (recommended 1024 MB)
- 1024 x 768 or higher screen resolution, minimum 256 colors (recommended 65536 colors)
- CD-ROM drive (570 MB free hard disk space)
- Ethernet: 100MBit/s recommended

## B Support

### B.1 Technical Support

#### B.1.1 Preparing for Technical Support

To increase effectiveness and speed up technical support issues it is good to find out the following before contacting support;

- Find out the *SOPAS Version* and *Build number* (SOPAS GUI: **Help**→**Info**)
- Find out the *Product model*, *Application*-, *FPGA*- and *Monitor version* (SOPAS GUI: **Help**→**About Inspector**)
- Save a device file that can be sent to support;
  - If using **SOPAS Single Device**, **File**→**Save Device File**
  - If using **SOPAS ET**, **Project**→**Export Device**
- Save a system dump file that can be sent to support (SOPAS GUI: **InspectorPI50**→**Device Info**→**Save system dump**)
- If possible, please also provide PASS/FAIL images (**InspectorPI50**→**Record Live Images**, or logged images with/without graphics)

#### B.1.2 Web Support

Technical support is available on-line at;

[www.sick.com](http://www.sick.com) →**Service&Support**→**Support**→**Support for Vision**

There is also a continuously updated FAQ document available at;

<http://sickivp.twinspace.net/download/FAQ%20Summary%20-%20Inspector.pdf>

#### B.1.3 First Line Support

Technical support is available to all users of the SICK Vision Technology. All 1st line technical support should always go to your *local SICK subsidiary* first hand. Below are contact information to dedicated 1st line support in USA, Canada and Germany. For the rest of the world, please contact your local SICK Subsidiary and ask for their vision specialist.

USA, Canada	Germany
vision@sick.com	machine.vision@sick.de

### B.2 Further Information

More product and order information is also available on: [www.sick.com](http://www.sick.com).

Please see the online help in SOPAS for Inspector.



# Glossary

Ambient light compensation	Function using the light intensity measurement in a specific area of the image to compensate for increase or decrease in overall light intensity compared to the reference image. This can be used to compensate threshold settings for tools sensitive to variations in the overall light intensity.
Angle	The term angle is used together with the blob tool. For each located blob its corresponding angle is calculated and is available in the Results tab and as Ethernet output. The term rotation is used together with the object locator.
Background	Everything in the image that is not the object(s) that the Inspector is configured to locate.
Blob	An object with a free-form shape. A blob is found in the image if it lies within specified intensity and size ranges.
Blob tool	The tool used to locate free-form shapes in the image.
Calibration	Procedure to measure lens and perspective distortion to calculate a transformation used to correct for these errors.
Capture image	To take an image. A captured image can either be used for object positioning or inspection in the live image or be used as a reference object in the reference image.
Center of gravity (COG)	The center of gravity for all found blobs are visualized in the <b>SOPAS Single Device</b> GUI and can be reported via Ethernet.
Chessboard pattern	Black and white square pattern used by the Inspector to measure lens and perspective distortion.
Color filter	An accessory that replaces the front window with a color filter front window to enhance contrast of certain color combinations. Red, green, and blue filters are available.
Contour	Another word for edge. The contours that the object locator finds on an object are marked green. The amount of contours is adjusted by the edge strength parameter.
Contrast	The difference in grey levels between dark and bright areas in the image.
Deployment	Activities performed to install a device. Includes fitting the correct lens, mounting, focus adjustment and loading of device data.
Device data	The device data are all settings used to configure and control an Inspector, for example reference images, tool settings and interface settings.
Device file	A file that contains device data of a specific Inspector. File extension is .dsv.
Dome accessory	An Inspector Flex accessory that replaces the front window of the Inspector Flex. The Dome diffuses the internal lighting in order to be able to work with glossy (shiny) objects.
Edge	The line that is formed between a dark and a bright area in the image.
Edge strength	The minimum difference in intensity (grey scale values) between neighboring bright and dark areas that is required for the object locator to consider it an edge (contour).
EtherCAT®	Field bus standard. EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.
Field of view (FOV)	The area which is currently seen by the Inspector, for example defined by its width and height in mm. The size depends on the working distance and the lens' focal length.

Flexible fitting	Flexible fitting is used by the polygon tool to get the best fit of the if each polygon segment without keeping the original polygon shape as drawn in the reference image.
Focal length	The aspect of a lens that determines how large the field of view becomes at a given working distance. If the focal length is short, for example 6 mm, then the lens has a wide angle and sees a large scene. If the focal length is long, for instance 16 mm, then the lens has a narrow view angle (tele lens) and sees a small scene far away.
FOV (field of view)	See field of view
Free-form object/shape	An object whose shape is not defined, also referred to as blob. The object is distinguished from the background depending on its grey values and size (pixel area).
Free-running	The image capture mode where images are captured and analyzed as fast as is possible, all done at a constant rate.
FTP	File Transfer Protocol. Standardized communication protocol.
Grey level	Another word for intensity. In Inspector, intensity values range from 0 (black) to 255 (white). Any value in between 0 and 255 is a grey level.
Image log	See Logged image.
Image settings	The parameters that control: <ul style="list-style-type: none"><li>• The quality of the captured images (exposure, brightness, use of lighting).</li><li>• When to capture images (free-running or triggered).</li></ul>
Image size	The size of the image captured by the Inspector, measured in pixels (width x height).
Intensity	See grey level.
Live image	A captured image that is inspected by the Inspector.
Locate	This is what the Inspector does to identify and find the position of the object in a captured image. Either of the methods object locator or blob tool can be used.
Log settings	The criteria for saving images in the image log.
Logged image	A captured image that is saved in the image log in the Inspector. The image log can contain up to 30 images.
Mask	A part of a region that shall be excluded from the image analysis. The mask can be used to exclude areas in the object locator search region or to avoid finding blobs in chosen areas of the blob tool search region.
Match	The required similarity between the object in the image and the reference object.
Match settings	Settings that affect when an object is considered located, for example similarity and rotation tolerance.
Object	What the Inspector shall locate and inspect.
Object locator	The tool used to locate an object of known shape in the image.
Pick point	A predefined point on the object, for example to be used as pick point in a robot picking application. Pick point terminology is used in robot applications, and it has the same meaning as reference point.
Polarity	Polarity is used by the polygon tool to increase the robustness of the edge fitting by not only searching for the strongest edge, but to also separate between dark-to-bright and bright-to-dark edges. This will reduce the risk of finding the wrong edge.

Polygon	A geometrical shape formed by a set of line segments connected to each other at the end of each line segment. A polygon can be open or closed.
Positioning	Finding the location of an object and reporting the object's reference point.
Rectification	The process to use the calibration information to transform an image captured by the image sensor, into an image greatly reducing lens and perspective distortion.
Reference image	Image of an object that is used as reference object.
Reference object	An object that the Inspector has learned to locate.
Reference point	A particular point on the object, for example to be used as pick point in a robot picking application. The default for the object locator is the center of the object locator region. The default for the blob tool is the center of gravity of the blob.
Region	An area of the image that is used for the locator or a tool.
Rigid positioning	Rigid positioning is used by the polygon tool to get the best fit of the whole polygon keeping the original polygon shape as drawn in the reference image.
ROI	Region of interest.
Rotation	The term rotation is used together with the object locator. The rotation of a located object relative the taught object is calculated and is available in the Results tab and as Ethernet output. The term angle is used together with the blob tool.
Search region	The region in the captured image in which the Inspector will try to locate the object or the blobs. For the object locator the default region is the whole field of view. For the blob tool the search region is drawn by the user at the time of creation. The Search region can be changed in the Reference image tab.
SOPAS	SICK Open Portal for Applications and Systems. User interface for configuration of SICK products and systems.
Stand-off	Distance between the lens cover glass and the object.
Structure	Surface characteristic of a blob, for example spots or large reflections inside a blob. The structure can be used to separate one object type from another. Structure corresponds to the number of edge pixels found inside a blob and it can be used as a selection criteria for the Blob tool, for example filtering out blobs with certain surface characteristics.
Target	Another word for object.
Teach	What the user does to make the Inspector learn a new reference object.
Threshold	Another word for a limit that defines what is inside or outside a range. When there is sufficient contrast in an image, a well fitted threshold value can separate objects from the background.
Tool	A method or algorithm to accomplish an image analysis task, for example locating an object in an image.
Toolbox	A set of image processing algorithms used to find important information in the image.
Triggered	The image capture mode when images are taken on an external command, for example when a photoelectric switch goes high.
Web API	HTTP based interface mainly intended for integration with custom made HMI systems.
Web Server	Web interfaces giving access to a set of inspector functions from a standard web browser.

Working distance                      The distance between the lens and the object, see field of view.

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