OPERATING INSTRUCTIONS

Inspector PIM60 ver 2.0

Vision sensor

SICK
Sensor Intelligence.

WARNING

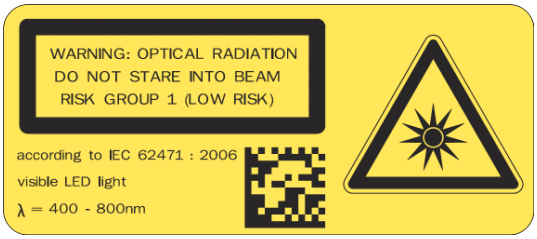
VSPM-6F2113 (Inspector PIM60), VSPM-6B2113 (Inspector PIM60 Base), VSPM-6F2113S19 (Inspector PIM60 Bead)

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

Accessible irradiance at distances > 200 mm:

L_B <4 x 10^4 W/(m^2 sr) within 100 s

L_H <10^6 W/(m^2 sr) within 10 s



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

VSPM-6F2313 (Inspector PIM60-LUT), VSPM-6F2313S20 (Inspector PIM60-LUT Bead)

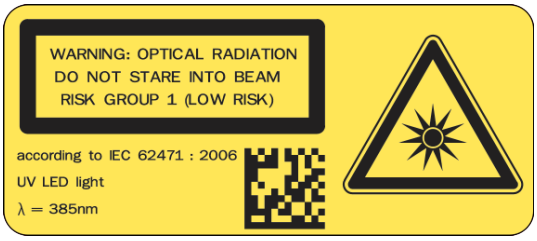
The Inspector is equipped with a LED illumination that must be considered as a lamp system of Risk Group 1 (low risk) according to IEC 62471:2006

Accessible irradiance at distances > 200 mm:

E_S < 3 x 10^{-3} W/m^2 within 10^4 s

E_{UVA} < 33 W/m^2 within 300 s

L_R < 7 x 10^6 W/(m^2 sr) within 10 s



WARNING: OPTICAL RADIATION DO NOT STARE INTO BEAM
RISK GROUP 1 (LOW RISK) according to IEC 62471:2006
UV LED light λ = 385 nm

VSPM-6F2413 (Inspector PIM60-IR), VSPM-6B2413 (Inspector PIM60-IR Base), VSPM-6F2413S18 (Inspector PIM60-IR Bead)

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

Accessible irradiance at distances > 200 mm:

E_{IR} < 100 W/m^2 within 10^3 s

L_{IR} < 1.2 x 10^6 W/(m^2 sr) within 10^3 s

NOTICE: IR EMITTED FROM THIS PRODUCT
RISK GROUP 0 (EXEMPT RISK) according to IEC 62471:2006
IR LED light λ = 850 nm

DISCLAIMER

SICK uses standard IP technology for its products, e.g. IO Link, industrial PCs. The focus here is on providing availability of products and services. SICK always assumes that the integrity and confidentiality of data and rights involved in the use of the above-mentioned products are ensured by customers themselves. In all cases, the appropriate security measures, e.g. network separation, firewalls, antivirus protection, patch management, etc., are always implemented by customers themselves, according to the situation.

The declarations of conformity and certificates can be downloaded from the Internet at: **www.sick.com/Inspector**

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Table of Contents

Introduction

1 Overview

Inspector PIM60 is a cross functional variant within the Inspector Vision Sensor family. It is designed to solve inspection, positioning and measurements tasks to improve quality and efficiency in part production and logistic handling.

Inspector PIM60 is easily configured through the **SOPAS Engineering Tool (ET)** to analyze objects and to communicate inspection results over different interfaces.

After finished configuration, PIM60 is running stand alone and continuously reporting the result over the configured interface.

The main features of Inspector PIM60 are:

Device features

- High-speed inspection, positioning and measurement
- Toolbox for inspection of blobs, patterns, edges, circles, edge counting, and pixel counting
- Toolbox for positioning taught-in, free-form and model shaped objects
- Tool box for measurement of diameters, angles and distances
- Import/Export of configurations
- Image and result calibration, and position alignment
- Ethernet communication through EtherNet/IP and Ethernet Raw
- HMI integration via Web API, including import of customized web pages
- Web access using HTTP
- Exchangeable lens
- Outputs by logical expressions
- Digital input and output extensions via external I/O box (accessory)
- Store inspected images to remote FTP server

SOPAS Engineering tool (ET) PC software

- Single device configuration
- Project handling of multiple devices
- Import/export of configurations
- Image log and statistics view
- Simulated device environment for off-line configuration

1.1 Safety

- Read the operating instructions before using the Inspector.
- Assembly, connection, and configuration 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 damage, use only SICK lens accessories with correct distance rings.
- 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 device and front window before you open it.
- For safe and proper use; if the lens and/or front window are to be replaced, make sure that the new lens and front window accessory are assembled correctly.

2 Applications

There is a broad toolbox available in the Inspector PIM60 and the concept allows for high flexibility in combining all the tools within an application configuration. This section describes a number of examples for solving positioning, inspection and measurement tasks with the toolbox.

2.1 Verify dimensions and locate position of a known shaped object

In this example the Inspector is used to inspect the front window tool supplied with the inspector.

The tasks of the Inspector are to:

- Measure the distance between the pins used for exchanging the window (on the wide end of the tool).
- Measure the width of the tool.
- Measure the inner distance between the pins used for exchanging the lens (narrow end of the tool).
- Get the position of the center of the hole, to use for guidance.

Solution:

1. An Object locator is used to locate the object in the image, in case it moves around in the field of view (FOV).
2. Blob tools are used to finding the centers of the pins for exchanging the window. A distance tool is used for measuring the distance between the reference points.
3. Edge tools are used for determining the positions of the left and right edges of the front window key, and a distance tool is used for measuring the width.
4. Pattern tools are used for locating the pins used for exchanging the lens. The reference point that the pattern tool reports the position of can be moved manually, and in this example they have been placed on the top of the inner side of each pin. A distance tool is then used for measuring the distance between the two reference points.
5. A circle tool is used for finding the position of the center of the hole.

Figure 2.1 Inspector PIM60 verifies the center-to-center distance between the window grippers, the gap of the lens gripper, and the position of the center of the hole.

2.2 Measure distance and angle

In this example a battery lid of a mobile phone is used. The tasks of the Inspector are to:

- Measure the size of the gap between the rear lid edge and the locking hook.
- Measure the angle between the lid edge and the locking hook.

Solution:

1. An object locator is used to locate the object in the image, in case it moves around in the FOV.
2. Edge tools are used to locate the edge of the lid and the inner edge of the locking hook. A distance tool is used to measure the size of the gap.
3. An angle tool is used with the two edges to measure the angle between them.

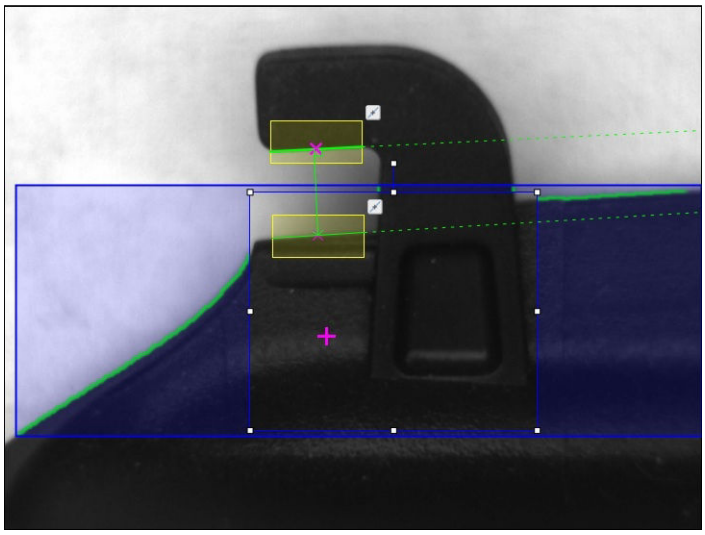


Figure 2.2 Inspector PIM60 locates the object, and measures the size of the gap and the angle of the locking hook.

2.3 Lid integrity verification

In this example a plastic cap for a milk package is used. The tasks of the Inspector are to:

- Measure the diameter of the innermost ring and the outer cap diameter.
- Measure the concentricity between the inner and outer circle.
- Verify that there are prints on the cap.

Solution:

1. An object locator is used to locate the object in the image, in case it moves around in the FOV.
2. Two circle tools are used - one for locating and measuring the diameter of the innermost ring, and another for the outermost circle.
3. A distance tool is used to measure the distance between the centers of the located circles, which can be used as a measurement of the concentricity.
4. An edge pixel counter tool is placed on the interior of the cap, to detect that there is print on the cap.

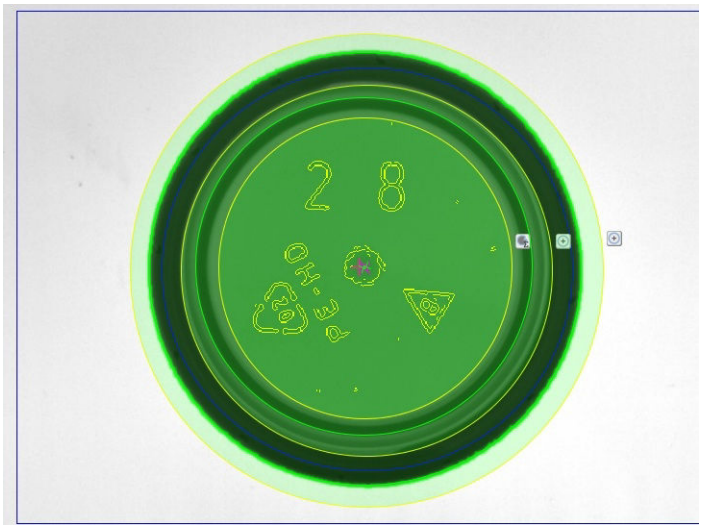
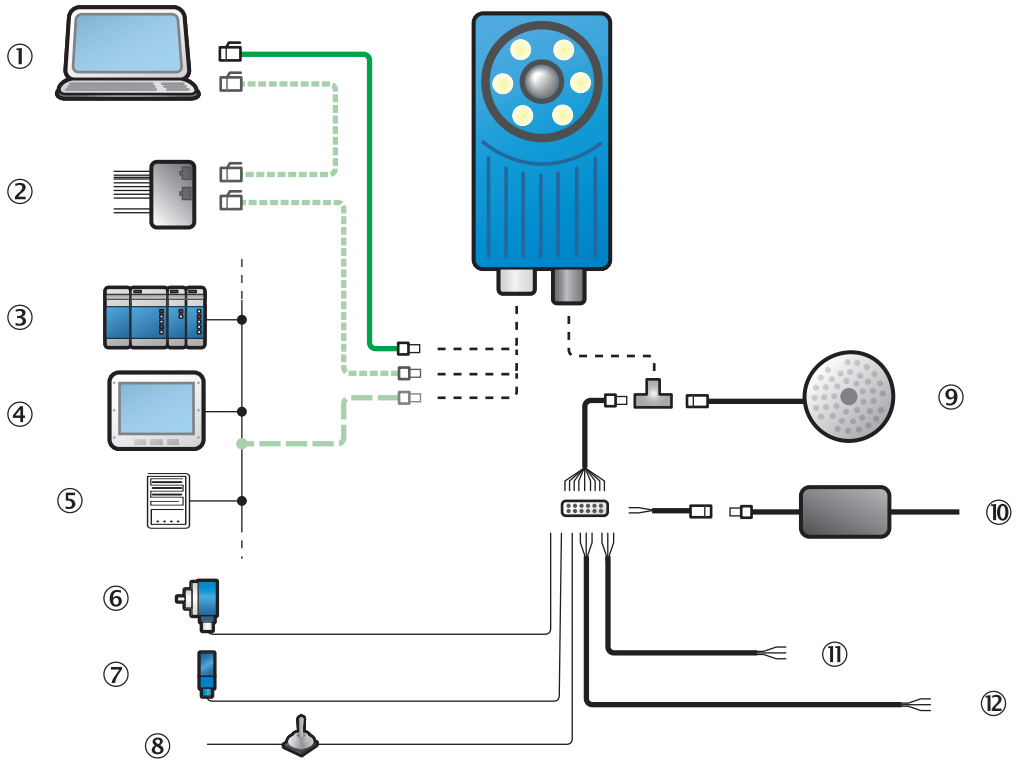


Figure 2.3 *Inspector PIM60 locates the lid, measures the diameter and concentricity, and verifies that there is printing on the cap.*

3 Configuration and machine integration

The Inspector PIM60 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. The following image shows a summary of the available interfaces.



① Configuration and operator interfaces
② I/O extension box
③ Ethernet field bus for result and control
④ Customized HMI interfaces
⑤ File transfer protocols
⑥ Encoder
⑦ Photoelectric switch
⑧ Switch for external teach
⑨ External lighting
⑩ Power supply
⑪ Output signals (1..3)
⑫ External object selection (1..4)

Figure 3.1 Possible interfaces in a configuration setup.

3.1 Initial configuration

The initial tool configuration and interface configuration of Inspector PIM60 is managed with **SOPAS Engineering Tool (ET)** . This is a PC application free to download from www.sick.com, which can be used for monitoring and advanced supervision apart from the initial configuration. After the initial configuration, the Inspector PIM60 is ready to interact without connection to **SOPAS Engineering Tool (ET)** according to its set-up.

3.2 Result and image retrieval

The Inspector PIM60 generates the result after each image acquisition. This result can be read out over the different interfaces; for example as a binary value on the digital outputs or as detailed values over the field buses. Images can also be retrieved over some of the inter-

faces, for view or storage. The following table shows what type of results and images that are available on the different interfaces.

Interface	Available results			
Binary outputs [a]	Pass/fail			
Fieldbus [b]	Pass/fail	Values		
Built-in web server				Current image Image log
Custom HMI [c]	Pass/fail	Values	Statistics	Current image Image log
File transfer protocol [d]				Image log
SOPAS Engineering Tool (ET)	Pass/fail	Values	Statistics	Current image Image log

[a] 3 built-in outputs. Up to 16 outputs with External I/O box.
[b] Ethernet raw, EtherNet/IP.
[c] Using Web API.
[d] Storing on FTP server.

3.3 Configuration and control

The Inspector PIM60 supports external configuration handling and control. Once a configuration is created in **SOPAS Engineering Tool (ET)** 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 PIM60 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 support update of the configuration. The following table shows the possibilities of configuration and control via the various interfaces.

Interface						
Binary inputs [a]	Image trigger Encoder	Switch ref object	Teach/re-teach object			
Fieldbus [b]	Image trigger	Switch ref object	Teach/re-teach object	Calibrate and align device		Change most parameters
Built-in web server		Switch ref object			Load and retrieve configuration	
Custom HMI [c]	Image trigger	Switch ref object	Teach/re-teach object	Calibrate and align device	Load and retrieve configuration	Change most parameters
SOPAS Engineering Tool (ET)		Switch ref object	Teach/re-teach object	Calibrate and align device	Load and retrieve configuration	Create new configuration Change all parameters

[a] 4 built-in inputs. Up to 5 additional inputs for switching reference object with External I/O box.
[b] Ethernet raw, EtherNet/IP.
[c] Using Web API.

3.4 Connections

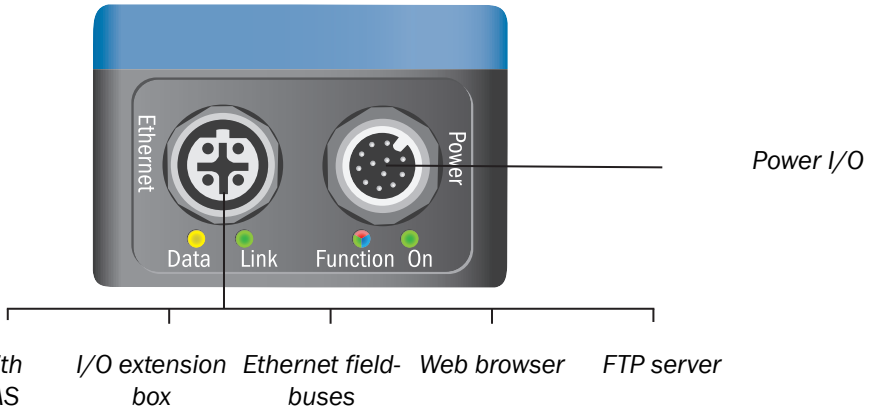


Figure 3.2 Connections Inspector PIM60

4 Toolbox

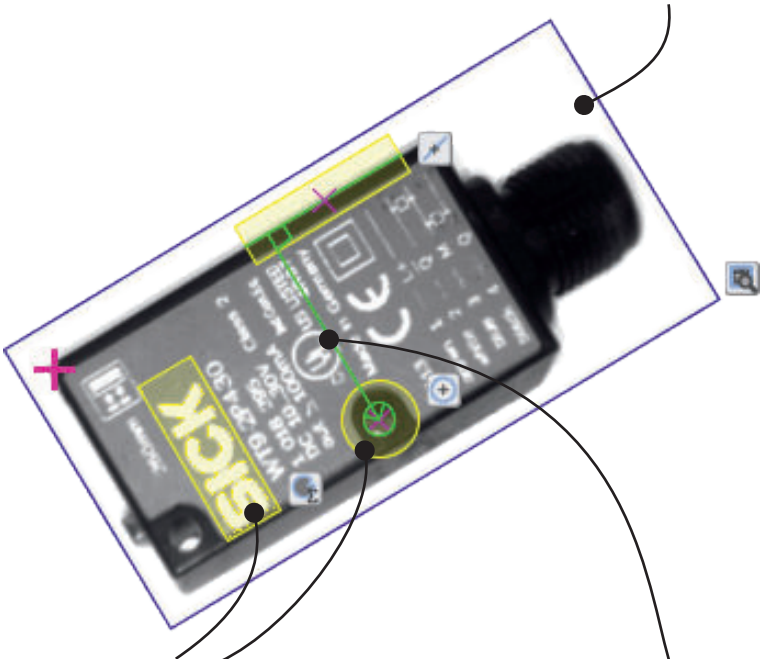
The Inspector's toolbox for image analysis includes the following types of tools:

Positioning tools	Used for locating objects of different shapes, or features such as edges and circles, in the images.
Inspection tools	Used for inspecting areas on located objects, or fixed areas in the images.
Measurement tools	Used for measuring distances and angles between located objects or features.

Of the positioning tools, the Object locator is unique since other tools can be applied relative to the object that is found. This makes it possible to inspect and measure on an object without knowing exactly where in the image it is positioned.

Therefore, a typical image analysis configuration usually consists of one Object locator that locates the object in the image, followed by a number of other tools that inspects details on the object or locates features to measure between.

Object locator finds the taught shape in the image.



Inspection and other positioning tools are applied relative to the found object.

Measurement between found features on the object.

The result from the image analysis can be one or more pass/fail results, based on thresholds set for certain values from the tools, and detailed result values, such as positions of features, counted pixels, or measured distances.

Each reference object in the Inspector PIM60 can contain one Object locator and up to 64 other tools. Up to 8 of these tools can be Blob tools, up to 8 Polygon tools, and up to 4 Edge counter tools.

Positioning tools

Object locator

Locate pre-taught object independent of position, scale and rotation variations.

Use when the shape of the object is always the same.

One Object locator region can be applied per reference object.

Results: Match score.
Position, angle and scale values.

Circle

Locate a circular edge within a region and fit a circle to that edge.

Results: Match score
Position and diameter of the located circle.


Edge tools (Edge)

Locate a straight edge within a region and fit a line to that edge.

Results: Match score.
Position and rotation of the located edge.


Edge tools (Find maximum)

Locate the first or last edge point along the search direction of an inspection region.

Results: Position of the located point.


Edge counter (Linear)

Count the number of edges along a straight path, and measure the distance between the edges (pitch).

Results: Number of edges. Mean, maximum and minimum pitch.
For each edge: Position, angle, polarity, width, and internal angle.


Edge counter (Circular)

Count the number of edges along a circular path, and measure the angle between the edges (pitch).

Results: Number of edges. Mean, maximum and minimum pitch.
For each edge: Position, angle, polarity, width, and internal angle.

Blob

Find clusters of pixels, blobs, within a defined gray range and size of cluster.

Results: Number of found blobs.
For each blob: Size, position, rotation, number of interior edge pixels, and border status.

Pattern

Compare a gray scale pattern pixel by pixel within a region.

Results: Match score, position.

Polygon

Find edges of a pre-defined number of sided polygon (open or closed).

Detect defects on edges inside a closed polygon.

Results: Position of the end points and intersection of edges.
Edge defect score.

Inspection tools

Pixel counter

Count pixels of a certain gray range within a region independent of pattern or clustering.

Results: Number of pixels.

Edge pixel counter

Count edge pixels within a region independent of pattern or clustering.

Results: Number of edge pixels.

Bead tool

Verify completeness, position and width tolerance of string-formed features, for example glue beads.

Results: Pass/fail

Measurement tools

Distance

Measure the distance between located objects and features, such as edges, circles, or patterns.

Results: Measured distance in pixels or millimeters.

Angle

Measure the angle between located edges.

Results: Measured angle in degrees.
Position of intersection.

How To

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.

5.1 Preparations

In this example, we will use the tool used for exchanging the front window and lens, that is supplied with the Inspector. We want to get the position of the tool for picking, and verify the position of the small hole on the tool.

We will verify the position of the hole by measuring the distance between the hole's center and the bottom edge of the tool, and set thresholds on the allowed values. To do this we first need to locate both the edge and the hole, and after this we can define the measurement.

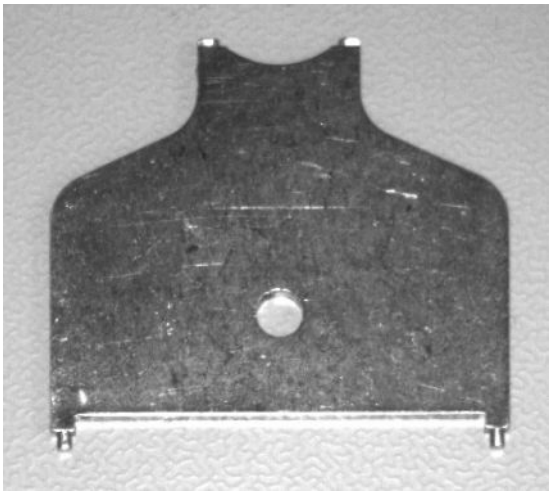


Figure 5.1 Front window key.

5.1.1 Open the box

The Inspector PIM60 is delivered with the following parts:

- Inspector PIM60 device
- Printed Quick Start instructions
- A hex key for adjusting focus
- Tool for removing the front window and changing the lens

For this application example, you will need the Inspector PIM60, the Hex key for adjusting the focus, and the front window key as the object to inspect.

5.1.2 Install SOPAS

SOPAS Engineering Tool (ET) is the PC application for Windows used to configure devices in the Inspector Vision Sensor Family.

Install from sick.com

To install the application:

1. Start your computer and connect to the internet. Go to **www.sick.com** and search for **SOPAS Engineering Tool (ET)**.
2. Download latest version of **SOPAS Engineering Tool (ET)**.
3. Run the installer.
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 so that it is facing the object.

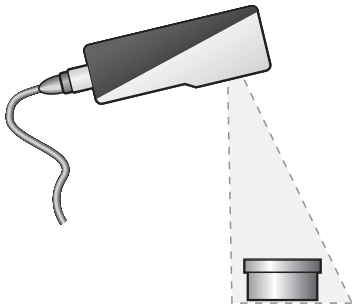


Figure 5.2 Mount the Inspector facing the object.

2. Connect the Ethernet cable between the Inspector and the PC.

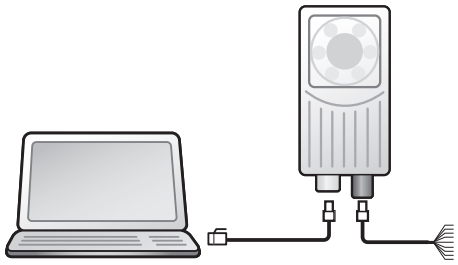


Figure 5.3 Connect the Ethernet cable.

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

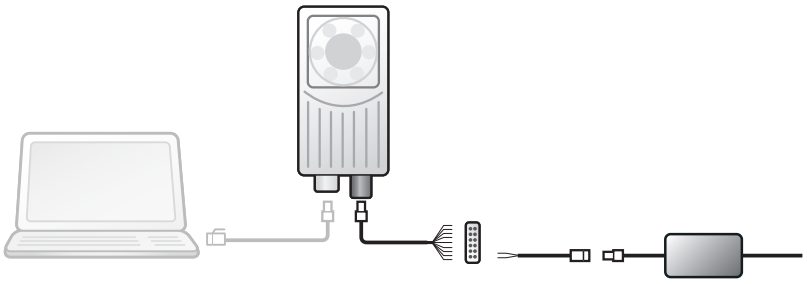


Figure 5.4 Connect to 24V DC power supply.

5.2.2 Connect SOPAS to the Inspector

1. Start **SOPAS Engineering Tool (ET)** application on the PC.
2. Connect to the device. See Chapter 6 *"Connect"*.

5.3 Get a good image

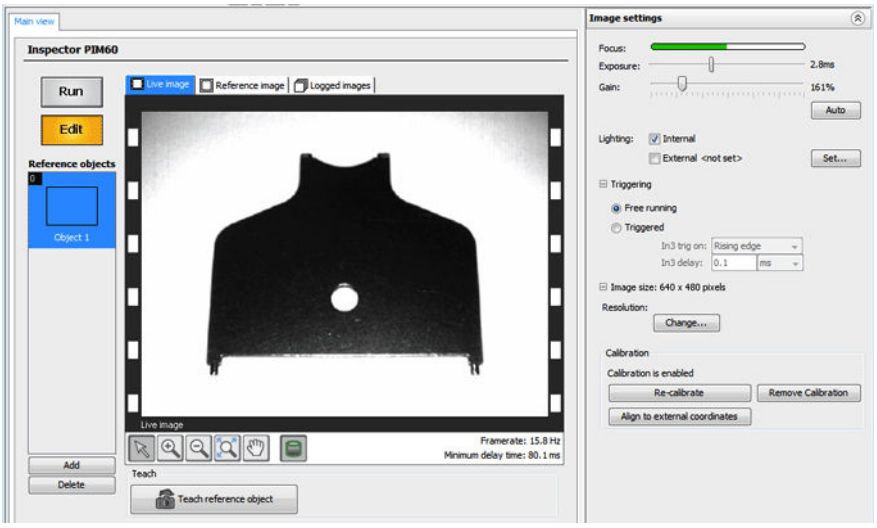


Figure 5.5 Main view and image settings tab.

When the device is connected the live image is shown in the **Main view**.

1. Click **Edit** to switch from Run to Edit mode.
2. Place the object under the view of the Inspector 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.

Too dark *Good image* *Too bright*

Figure 5.6 Image quality by tuning exposure time.

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

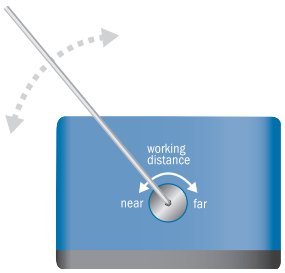


Figure 5.7 Adjusting focus.

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

Figure 5.8 Focus feedback bar.

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

5.3.1 Calibrate the Inspector (optional)

When the focus and exposure is configured, the live image can be calibrated. Calibration of the Inspector 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.

To be able to present values and positions in millimeter, as a unit of measurement instead of pixels, a calibration must be performed.

In addition to calibration, the Inspector can be aligned with an external coordinate system, for example to present positions in a robot's coordinate system.

See Chapter 9, “*Calibrate and align*” (page 40) for information on how to perform calibration and alignment. After the calibration, a reference image can be taken.

5.4 Configure the application

Configuration of the application involves teaching a reference image, and applying tools and result settings to that reference image. The image will be added to the "reference objects" and is used as a reference when analyzing acquired images in runtime.

5.4.1 Teach the reference object

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

Figure 5.9 Teach reference object button.

A reference image will be created in the Reference objects list.

When the new reference object has been created, apply the desired tools in the **Reference image** tab.

Note

It is possible to replace the image for a reference object. Click on the reference object in the **Reference objects** list and choose **Live image** tab and 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 front window key:

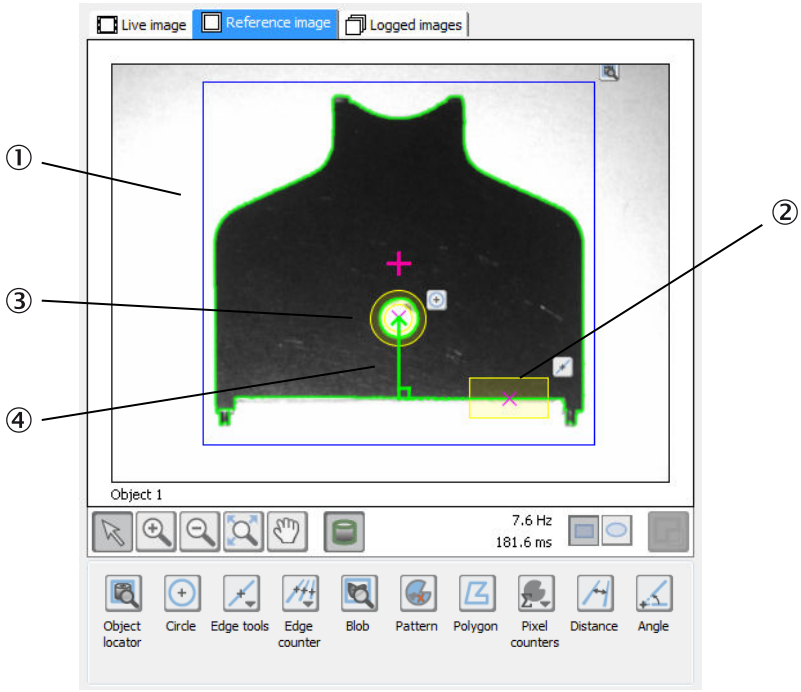


Figure 5.10 Applying tools in the reference image

Add Object locator ①

The Object locator is used for retrieving the location of the object in terms of position and rotation. The location is used for two things: for positioning the additional tools, and for reporting the coordinates for precise picking.

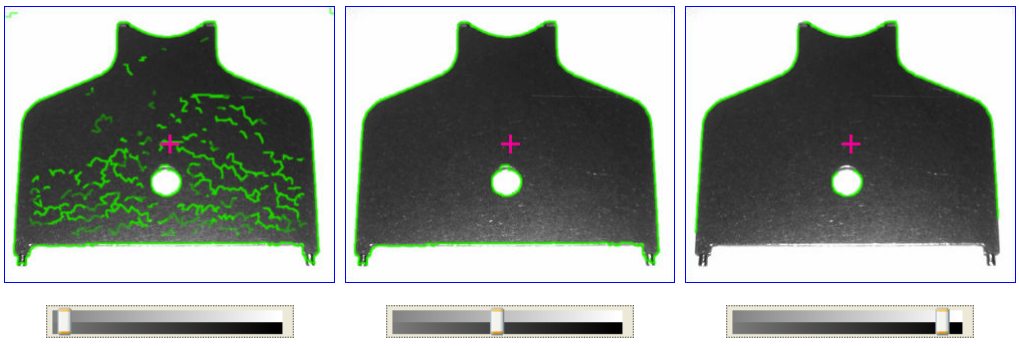
To add an object locator:

1. Click on the **Object locator** button in the toolbox below the image.
2. With the Object locator tool, draw a rectangle over the front window tool in the image, or a part of it.

The blue rectangular region – the *object locator region* – marks which part of the image to be taught. The green contours inside the region show what shape is recognized by the Inspector.

For the object locator to work well, there must be a sufficient amount of green contours in the region. The amount of contours is adjusted with the **Edge contrast** slider in the **Tools** tab.

The Mask tool can be used to mask out areas in an image with noise to obtain a better result. For example noise caused by a rough surface area, or a label on the object..



Bad, too much noise in the image mistaken as contours. | *Good, sufficient amount of contours.* | *Bad, too few contours.*

Figure 5.11 Adjusting the amount of contours.

In the center of the blue object locator region is a purple cross marking the reference point, which is also the position that the Inspector report. If a particular point on the object shall be reported rather than the center of region, for example as a pick point for a robot, move it manually to the appropriate position.

Add an Edge tool ②

An **Edge** tool is used for finding the edge that we are going to measure from. To add the Edge tool:

1. Click on the **Edge tools** button in the toolbox below the image and select **Edge**.
2. With the Edge tool, draw a rectangle over a part of the bottom edge of the front window key.

A green line in the edge tool region shows where the Inspector found an edge, and the thin yellow arrows shows in which direction the Inspector searches for edges. If the incorrect edge is indicated, or if the line is red, adjust the settings so that the right edge is located:

- Rotate the region so that it is somewhat parallel with the edge. In order to locate an edge, the edge must enter/exit the region through the region sides that are parallel with the search direction.
- Decrease the **Edge contrast** setting (move to the left) if the contrast between the bright and the dark side of the edge is low.
- Adjust the settings for **Criteria** and **Polarity** to make the Inspector pick the right edge if there are multiple edges in the region.

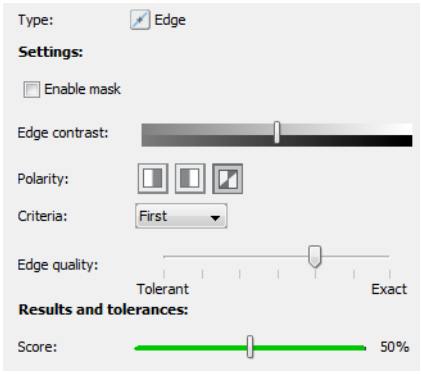


Figure 5.12 Settings for the Edge tool.

Add a Circle tool ③

A **Circle** tool is used for finding the small hole. To add the Circle tool:

1. Click on the **Circle** button in the toolbox below the image.
2. With the Circle tool, add a circle region around the hole on the front window key.

A green circle in the circle tool's region shows where the Inspector found the circle, a purple cross marks the center of the located circle, and the yellow circles indicates the max and min diameter that the inspector will look for. If an incorrect circle is found, or if the circle is red, adjust the settings so that the correct circle is located:

- Make sure that the inner yellow circle is entirely inside the hole, adjust by moving the circle region.
- Decrease the **Edge contrast** setting (move the slider to the left) if the contrast between the hole and the rest of the front window key is low.
- Adjust the settings for **Circle fit criteria** and **Polarity** to make the Inspector pick the correct circle if there are multiple circles in the region.

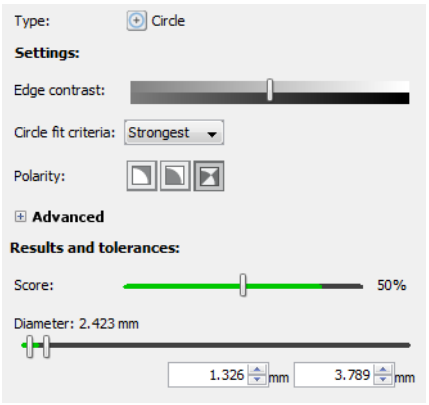


Figure 5.13 Settings for the Circle tool.

Add Distance measurement ④

Now that the Inspector locates the bottom edge and the hole on the front window key, we can measure the distance between them. To add the Distance tool:

1. Click on the **Distance** button in the toolbox below the image.

The features that you can measure between are now marked with white circles.

2. Click on the white circle marking the Edge tool, and then on the white circle marking the Circle tool.

The measurement is now shown as a green line between the edge and the hole.

By default new measurements will be made between the reference points on the located features. However, in this case it is better to measure the distance perpendicularly to the located bottom edge.

3. In the **Tools** tab, set the **Type** of the Distance measurement to **Right angle**.
4. If necessary, adjust the tolerance for the distance.

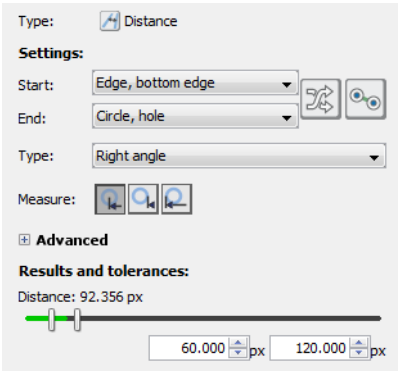


Figure 5.14 Settings for the Distance tool.

Tool relation

By default, all tools will automatically be positioned relative to where the object locator finds the object, which makes the inspections follow the position and rotation of the front window key as it is moved around in front of the Inspector.

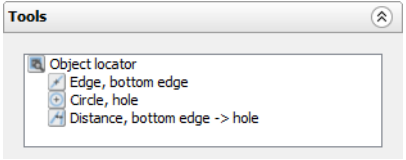


Figure 5.15 Tool relation

5.4.3 Monitor the result

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

The **Results** tab shows the overall result and state of the digital outputs. More information on what results are displayed in the Results tab is found in Chapter 11, "*View result and statistics*" (page 75).

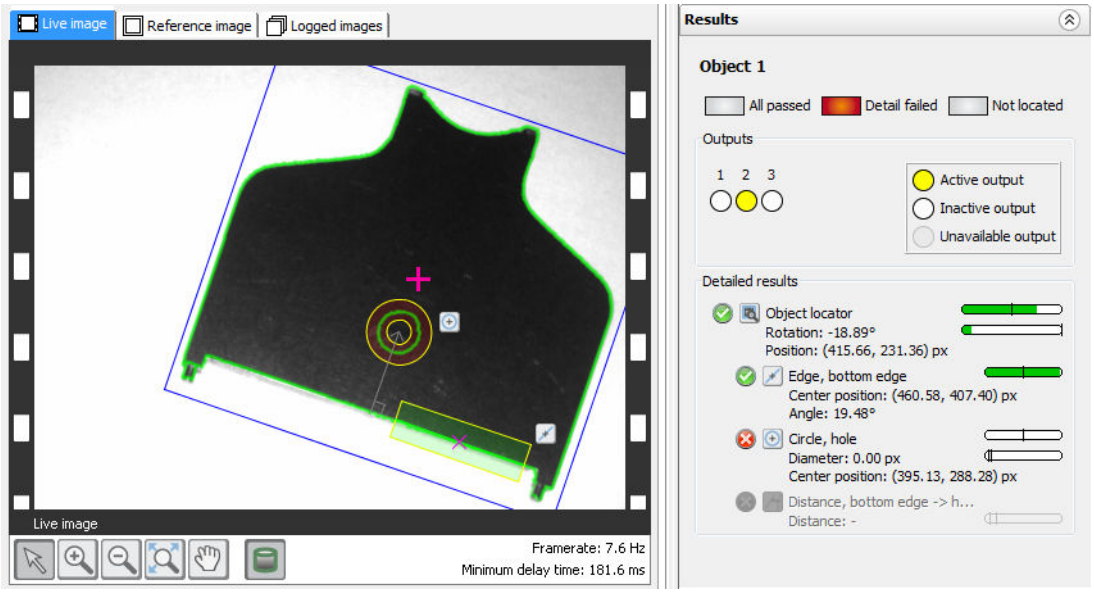


Figure 5.16 Live image and result when hole is missing.

In addition, detailed results such as match score (the green bar) and the location of the reference point is displayed.

5.4.4 Using the result

For positioning applications, this result 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.[1]

Note

The digital outputs are enabled by default for the Inspector PIM60, but they are turned off when the Inspector is in **Edit** mode.

If you want to use the digital outputs even in Edit mode, you can enable them by choosing **Interface and I/O Settings** from the **InspectorPIM60** menu, and then selecting **Enable built-in outputs in Edit mode** on the **Digital I/O** tab in the dialog box.

[1] To be able to present values and positions in millimeter, as a unit of measurement instead of pixels, a calibration must be performed. See Chapter 9, "*Calibrate and align*" (page 40) for more information.

6 Connect

Note

At the first use, the PIM60 will require a SOPAS Device Driver (SDD). When adding the device, a prompt will appear with instructions on how to install the driver. When prompted for SDD installation source, select **From sick.com**.

The main SOPAS Engineering Tool (ET) window is split into two panes, the project view to the left and a list of available devices to the right. Click **Add** to add the PIM60 to the project view. Double click the device icon to connect to the device and access the device main window.

6.1 Manage IP address

Click the **Edit** icon in the device tile to make adjustments to IP settings.

6.1.1 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:

XP	Win 7	
		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.

Other connection problems

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

6.2 Install a SOPAS Device Driver (SDD)

The **Device Catalog** allows you to manage SOPAS Device Drivers (SDD). The **Device Catalog** can be accessed by choosing **New** from the **Project** menu in **SOPAS Engineering Tool (ET)**.

Note

The Inspector PIM60 has two available SDDs; Inspector PIM60 V1.0.0 and Inspector PIM60 V2.0.0. The Inspector PIM60 Bead has a separate SDD. These versions can co-exist.

The following installation functions are available in the Device Catalog window:

Uninstall Uninstalls a SDD. The selected SDD is removed from the Device Catalog.

Install Installs a SDD. An Installation Wizard provides the following installation options:
From sick.com - This option will install SDD files from the SICK website. Make sure to select the correct model of your device to install the correct SDD files.
From file - This option will install the selected SDD and help files (excluding the online help files). Incompatible SDD files are printed orange but will be installed. Already installed SDD files are marked with a STOP sign and will not be installed.

Update Updates an SDD.

6.3 Upgrade or downgrade the firmware

It is possible to upgrade, and downgrade, the Inspector's firmware using a separately distributed PC application called Inspector Download Manager. Contact SICK Technical support, see Section B.1, “*Technical support*” (page 130), for information on how to obtain a copy of the Inspector Download Manager and the firmware installation file.

Warning

It is not possible to run a configuration, .sdv or .spb, made using Inspector PIM60 V 1.0 firmware on an Inspector PIM60 with V 2.0 firmware (or vice versa). The present configuration needs to be redone.

If it is not an option to redo the configuration, it is possible to downgrade from PIM60 V2.0 firmware to PIM60 V1.0 firmware.

6.4 Use a simulated device

How to use a simulated Inspector device instead of connecting to a real Inspector is described in Chapter 23, “*Use the simulated device*” (page 118).

7 Use SOPAS Engineering Tool (ET)

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.

7.1 Framework

This section describes the framework when connected to a real device. For specific controls for the simulated device, see Chapter 23, "*Use the simulated device*" (page 118). The figure below describes the **SOPAS Engineering Tool (ET)** application and **Live Image** tab in the **Main view** after connected to the device.

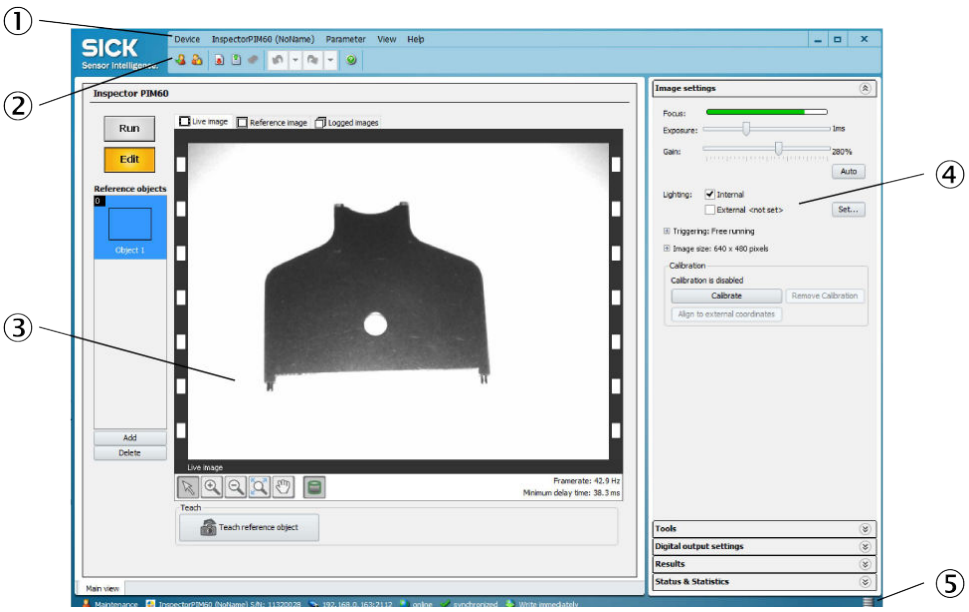


Figure 7.1 SOPAS Engineering Tool (ET) device main window

① Menu bar:
- **Device** menu with for example alternatives for opening, and saving device configuration
- **InspectorPIM60** menu, see Section 7.3, "*InspectorPIM60 menu*" (page 34)
- **Parameter** menu with the possibility to for example to load data to the device
- **View** menu. Select visible views in the GUI.
- **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 PIM60

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 the **Add** button to create a new reference object. Click the **Delete** button to remove the selected reference object.

Right-clicking a reference object opens a context menu which provides the following additional functions: **Copy to new reference object**, **Remove object**, and **Rename 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 21, "*Improve speed*" (page 114).

7.2.1 Live image tab

Live Image
The **Live image** tab contains view control buttons, a teach button, and a button for turning the graphical overlay on or off. 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.

All tool regions - except for Polygon and measurement tools - in a reference object can be copied and pasted by right-clicking on the region. An object locator can only be copied from one reference object to another, since a reference object can have only one object locator.

7.2.3 Logged images tab

The **Logged images** tab lists 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 **InspectorPIM60** menu. When the Inspector PIM60 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 graphical overlay and one folder without graphical overlay in the saved images.

7.3 InspectorPIM60 menu

Run

The menu item is shown when **SOPAS Engineering Tool (ET)** is in Edit mode. To switch the Inspector to **Run** mode:

1. Choose **Run** from the **InspectorPIM60** 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 menu item is shown when **SOPAS Engineering Tool (ET)** is in Run mode. To switch the Inspector to **Edit** mode, choose **Edit** from the **InspectorPIM60** 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 22.3, “*Record live images to PC*” (page 117).

Interfaces and I/O Settings

To view or change interface settings, choose **Interfaces and I/O settings** from the **InspectorPIM60** 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 83) to Chapter 17, “*Use web interface*” (page 97).

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 87).

Ethernet Result Output

To configure the device to send Ethernet based result output, choose **Ethernet Result Output** from the **InspectorPIM60** menu. For more information, see Section 16.2, "*Output results*" (page 94).

Device Info

To see information about the current device, choose **Device Info** from the **InspectorPIM60** 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 PIM60 (device). The name can be changed. The name appears next to the **InspectorPIM60** menu.
Serial no	The serial number of the connected Inspector PIM60 (device).
Save System Dump	To save the contents of the memory of the Inspector, click **Save system dump**. 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 PIM60 (device).
Netmask	The netmask of the current Inspector PIM60 (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 **InspectorPIM60** 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 **InspectorPIM60** menu. For more on image log see Chapter 22, "*Log and store images*" (page 115).

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 18, "*Store images on an FTP server*" (page 101) and Chapter 22, "*Log and store images*" (page 115).

Save Settings in Flash Memory

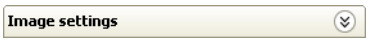
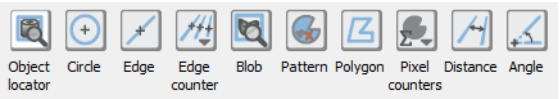
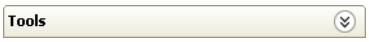
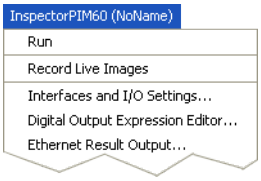
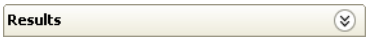
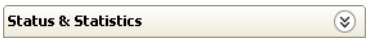
To save all device data (settings) in the Inspector's flash memory, choose **Save Settings in Flash** from the **InspectorPIM60** menu. A progress bar is displayed during the process. When saving to flash memory the function LED will flash white. The Inspector will stop analyzing images until the flash memory is updated. For more information about device data, see Chapter 24, "*Handle device data*" (page 120).

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 **InspectorPIM60** menu. For more information about device data see Chapter 24, "*Handle device data*" (page 120).

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 PIM60 has been established. For more information on how to connect, see Section 5.2, "*Connect*" (page 23) and Chapter 6, "*Connect* " (page 30):

SOPAS Engineering Tool (ET) GUI reference	Description
	To be able to change the settings click **Edit**.
	Adjust the image settings to obtain a good image for the application and decide on how to capture the image, see Chapter 8, "*Adjust image*" (page 37).
	Click **Teach reference object** to start configuring the application. See Section 5.4.1, "*Teach the reference object*" (page 25).
	Depending on the application type choose one or more of the tools in the **Reference image** tab
	Configure the settings for the tools, see Chapter 10, "*Use the toolbox*" (page 45).
 or 	Configure the settings for the digital outputs, for example active time and delay, see Section 14.3, "*Use digital outputs*" (page 87). Optionally choose to configure Ethernet based result output from the Inspector PIM60, see Section 16.2, "*Output results*" (page 94). If other interfaces than the default digital outputs are needed, configure this in the **Interface and I/O settings** dialog and **Ethernet result output** menus.
	Click **Run** to set the device in operating mode. If configuration should be permanently stored on the device choose **Save to flash** 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 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.

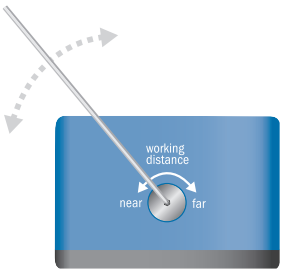


Figure 8.1 Adjust focus

8.2 Adjust image settings

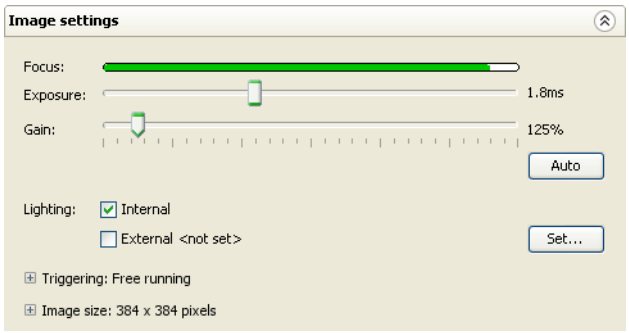
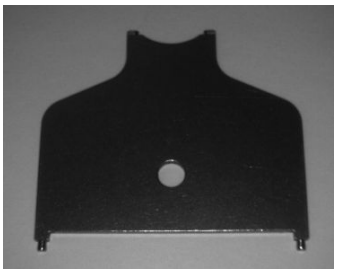


Figure 8.2 Image settings

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

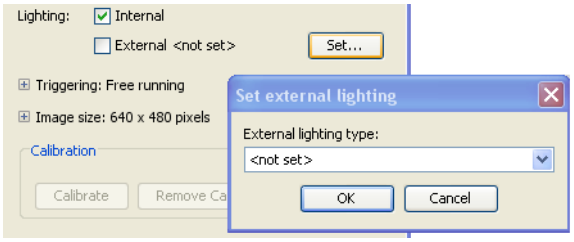


Figure 8.3 Use lighting options.

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 20.5.1, "*Enable Ambient light compensation*" (page 110). To connect to an external light see Section 14.3.6, "*Connect an external light*" (page 90).

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 gray 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.

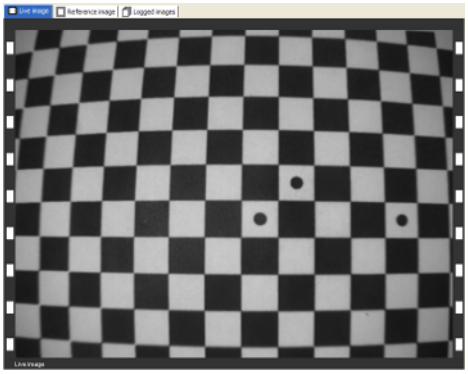
9 Calibrate and align

9.1 Overview

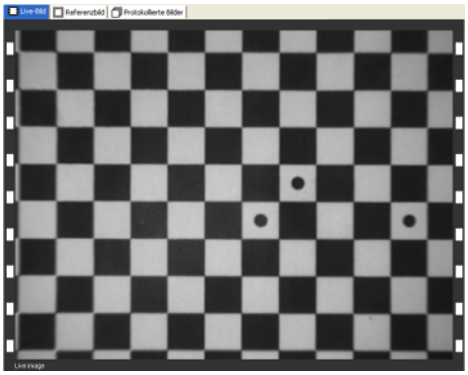
There are two main reasons for calibrating the Inspector:

- To compensate for perspective and lens distortion, and thereby improve the accuracy and robustness.
- To be able to present values and positions in millimeters, as a unit of measurement instead of pixels.

Once calibrated, the images captured by the Inspector will be rectified – that is, de-warped and re-sampled to be straightened and de-warped, and distance measurements and positions will be displayed in millimeters.



-An un-rectified image, where the chessboard looks distorted due to the lens distortion.



The rectified image.

A calibrated Inspector can also be aligned with an external coordinate system, for example to get position coordinates in a robot's coordinate system instead of in the Inspector's. Aligned coordinates can be output on Ethernet. However, in SOPAS the positions are always displayed in the Inspector's coordinate system.

When using a calibrated Inspector, you should redo the calibration in the following cases:

- After changing lens, or removing and remounting the lens.
- After adjusting focus.
- When replacing the Inspector.
- When the working distance is changed.

Note

The same calibration will be used for all reference objects in the **Reference objects** list.

Calibration will not be used for objects with a reduced field of view. See Chapter 8, "*Adjust image*" (page 37) for more information about adjusting the field of view.

When copying a configuration from a calibrated Inspector to another Inspector, you must first calibrate the other Inspector. Importing a configuration from a calibrated Inspector will not replace any existing calibration, but there must be a calibration available for the tool settings, thresholds and other parameters that rely on measurements in mm instead of pixels.

9.1.1 Calibration target

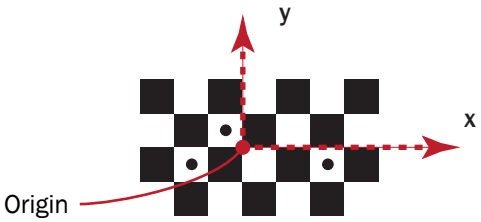
The Inspector uses a chessboard pattern for calibration. There is a PDF containing a chessboard pattern for printing on the **www.sick.com** PIM60 product pages. It is also possible to create your own pattern.

If you print the provided calibration pattern, note the following:

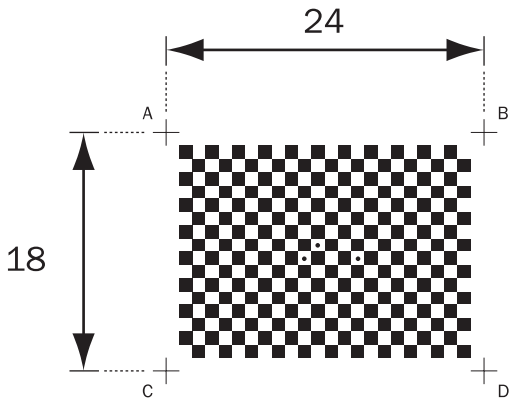
- Make sure that you print the PDF without scaling (or scale set to 100%), alternatively measure the actual size of the squares after printing.
  If the PDF is not printed at 100%, the square size printed on the pattern will not be accurate.
- Mount the pattern on a flat surface before using it.

If you create your own calibration pattern, note the following:

- No more than 50 x 50 squares should be visible in the image.
- Mount the pattern on a flat surface before using it.
- If the following pattern with three dots are visible in the image, the Inspector will use them for positioning the origin of the coordinate system. Otherwise, the Inspector will place the origin on the square corner closest to the center of the image.



- If you are aligning the Inspector, the four control points (A-D) should be placed at the corners of a rectangle that is 24 squares wide, 18 squares high, and aligned with the squares in the chessboard pattern.

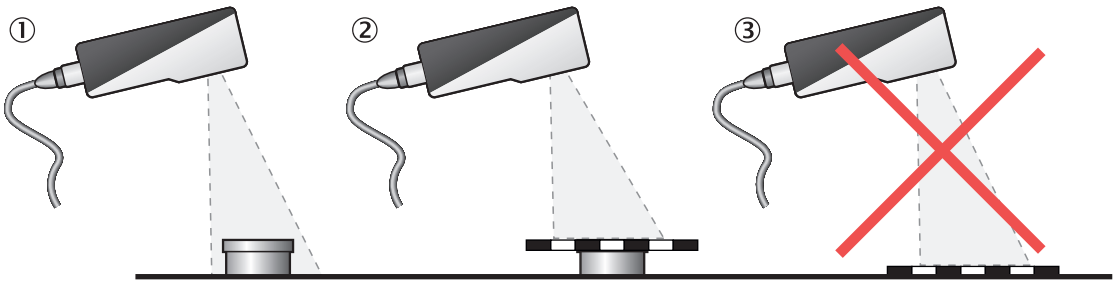


9.2 Calibrate

To calibrate the Inspector, do the following:

1. Place the calibration pattern in front of the Inspector.

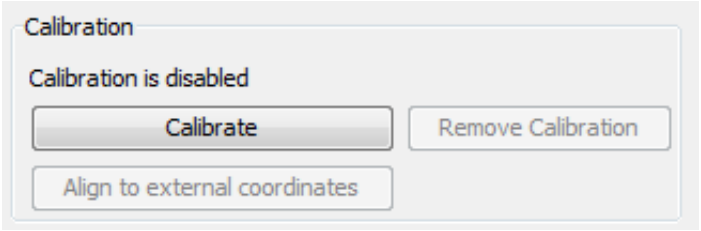
- Place the pattern at the same distance from the Inspector as where the inspections are made. For example, if you are inspecting lids on jars, don't place the pattern directly on the conveyor belt:



① Intended inspection height
② Correct calibration height
③ Incorrect calibration height

- It is not necessary to see the entire chessboard in the image. However, at least 4 x 4 squares should be visible.
- The chessboard should preferably cover the entire image.
- The minimum length of a square's side should be 15 pixels.

2. If necessary, adjust focus, exposure and gain, see Chapter 8, “*Adjust image*” (page 37).
3. In the Image settings tab, click **Calibrate**.



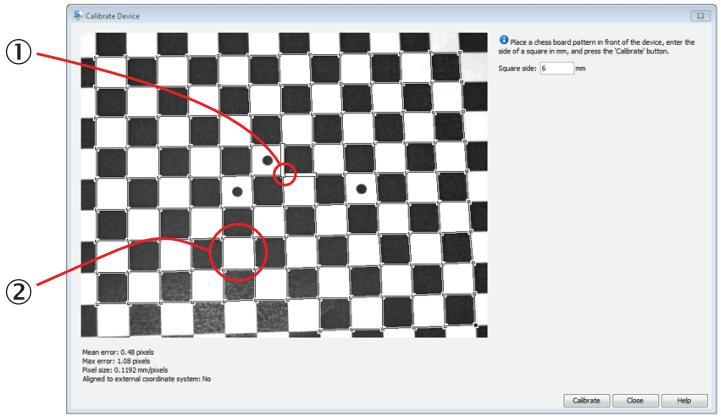
Note

If the Inspector is already calibrated, the button is named **Re-calibrate** instead.

The **Calibrate device** window is displayed, showing an un-rectified live image of the calibration pattern.

A grid is displayed over the chessboard pattern.

The origin is shown as two thicker lines with the y-axis drawn on top of the x-axis.



① Origin
② Grid dots

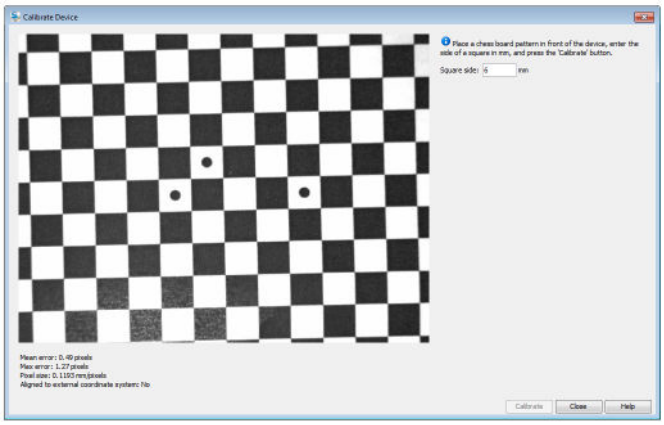
Note

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

4. Enter the length (in mm) of the side of the squares in the calibration pattern. Use a period (".") as a decimal separator.
5. Click **Calibrate**.

The calibration process is started, and may take more than one minute.

When the calibration process is finished, the rectified live image is shown in the window. The calculated mean and max error (in pixels) is shown below the image, together with the pixel size (in mm).



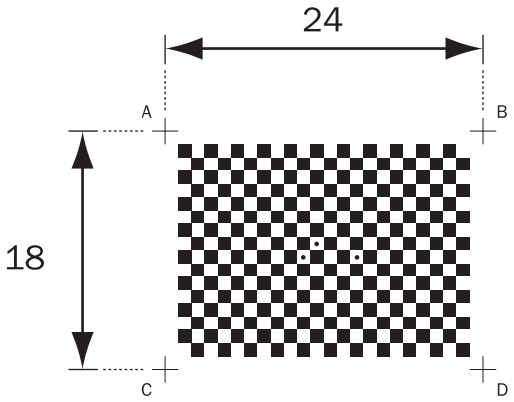
6. Click **Close** to start using the calibrated device.
   To redo the calibration, click **Re-calibrate** in the Image settings tab to open the Calibration wizard again.

   To remove the calibration, click **Remove calibration** in the image settings tab.

9.3 Align to external coordinates

Alignment is a transformation of the sensor coordinates to an external coordinate system. The procedure to find the transform is based on the known relation between the control points (A, B, C and D) and the origin of the external system, as well as the origin of the sensor.

Using the calibration pattern requires only to derive the control points within the external system, as the relation between the control points and the senor origin are known.

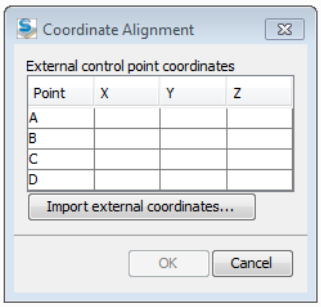


1. Calibrate the Inspector. See Section 9.2, “*Calibrate*” (page 41).
2. Measure the external control point coordinates (A, B, C, and D points on the calibration pattern).

Note

If the alignment to external coordinates is performed at a later stage, make sure that the external control point coordinates has the same relation as during the calibration.

3. Click the **Align to external coordinates** button and enter the external control point coordinates (X,Y, and Z values) into the **Coordinate alignment** window. Use a period (".") as a decimal separator.



The **Import external coordinates** button offers a possibility to import the control point coordinates into SOPAS using a text file.

Note

It is possible to enter the values into a Microsoft Excel worksheet and saving the data to csv-file.

The values in the text file must be entered in the following format:

$x_A;y_A;z_A$
$x_B;y_B;z_B$
$x_C;y_C;z_C$
$x_D;y_D;z_D$

Where:

- $x_A;y_A;z_A$ is the X,Y, and Z coordinates for the control point A etc.

10 Use the toolbox

10.1 General

The toolbox in the Inspector PIM60 contains three types of tools:

Positioning tools	Used for locating objects of different shapes, or features such as edges and circles, in the images.
Inspection tools	Used for inspecting areas on located objects, or fixed areas in the images.
Measurement tools	Used for measuring distance and angle between located objects or features.

Of the positioning tools, the Object locator is special since it can be used for positioning other tools. This makes it possible to inspect and measure on an object without knowing exactly where it is positioned in the image.

Each reference object can contain one Object locator, and up to 64 other tools. Up to 8 of these tools can be Blob tools, up to 8 Polygon tools, and up to 4 Edge counter tools.

10.1.1 Add positioning and inspection tools

To locate an object or feature in the image, or inspect a part of the object in view, do the following:

1. Make sure the Inspector is in Edit mode, and that the reference object is displayed in the SOPAS window.
2. Click on one of the positioning or inspection tools in the toolbar.
3. Click and drag in the image to mark the region in which the tools should operate. You can select the shape of the region from the shape buttons at the bottom right of the image.

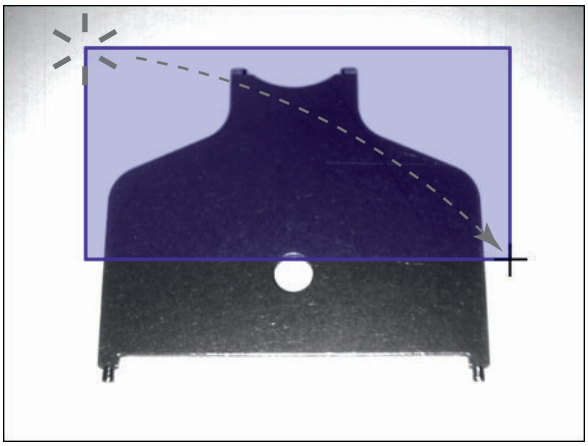


Figure 10.1 Add object locator by drawing a rectangle in the reference image.

Once the tool has been added to the reference object, it can be modified in the following ways:

- Move the region by clicking inside it and dragging it to the new location.
- Resize the region by clicking and dragging the square handles on the sides of the region.
- Rotate the region by clicking and dragging the rotation handle on the top of the region.
- Change the shape of the region by selecting a different shape in the Tools tab.
- Mask out parts of the region by adding masks, using the Mask tool in the toolbar.
- Change other settings for the tool in the Tools tab.

10.1.2 Add measurement tools

To measure a distance or angle, you must first add tools that locates the features that you want to measure between, for example Edge or Circle tools.

Once the features can be located, do the following:

1. Make sure the Inspector is in Edit mode, and that the reference object is displayed in the SOPAS window.
2. Click on one of the **Measure** tools in the toolbar.
   The features that you can measure between are highlighted with a white circle in the image.
3. Click on the features in the image that you want to measure from and to.
   The measurement is displayed as a green line between the features.
4. If necessary, adjust the setting to get the measurement result you want.
   For example, when measuring between two edges you can either measure the distance between the reference points on the found edges, or the orthogonal distance (right angle) from one edge to the point on the other edge.

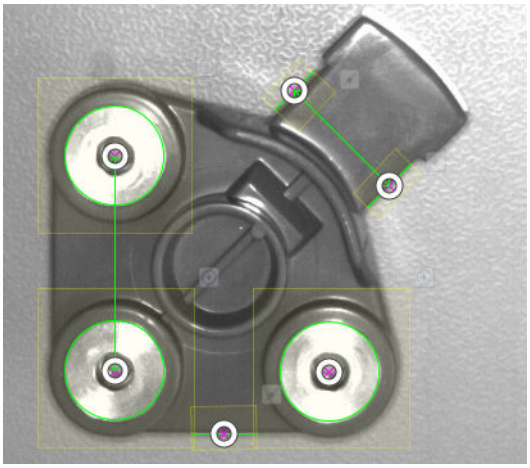


Figure 10.2 Features are marked with white circles. Defined measurements are shown as green lines.

To change the features used by an existing measurement, click Select features () in the Tools tab, and select the features to use instead in the image. You can also select the locator tools directly from the menus Start and End respectively.

To change the direction of the measurement, which could be useful when measuring orthogonal distances between edges, click Change direction () in the Tools tab.

10.1.3 Common tool settings

Settings for the tools used in the reference object are available in the Tools tab. Selecting a tool's area in the image will select the tool in the list of tools, and display the current settings for that tool. Similarly, selecting a tool in the tool list will select the area in the image.

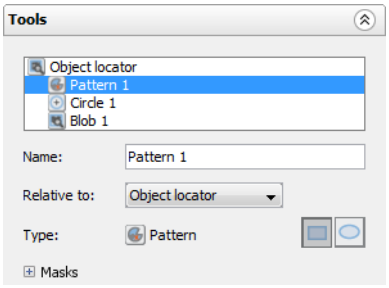


Figure 10.3 Common settings for most tools.

Many of the settings for a tool are specific for the type of tool. These tool specific settings are described in the following sections. There are however a number of settings that several tools have in common:

Name A custom name that you can give to a tool, for easier identification of the specific tool. This name is displayed in the tools list, and can also be used when specifying the result that the Inspector should output.

Relative to Sets whether the tool's area should be positioned relative to the located object, or in a fixed position in the image.
By default, all tools will be positioned relative to the located object if the Object locator is used.

Type Shows the name and icon of the tool's type.

Shape Sets the basic shape of the tool's area to be either rectangular ( ) or elliptical ( ).
The shape of Polygon, Edge, Circle, and Measurement tools can not be changed.

Masks The **Masks list** shows all mask regions that are attached to the tool's area.

- 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**.

Note

Masks can not be used on Polygon, Edge counter tools or Measurement tools.

The Circle and Edge tools can each have one mask, but they are handled differently from other masks. See Section 10.3, “*Circle*” (page 49) and Section 10.4, “*Edge tools (Edge)*” (page 52) for more information.

The entire region for a tool must always be inside the reference image. When the Inspector is analyzing captured images, regions relative to an object locator may end up outside the image. In this case the corresponding tool will fail.

10.1.4 Search direction of edge based tools

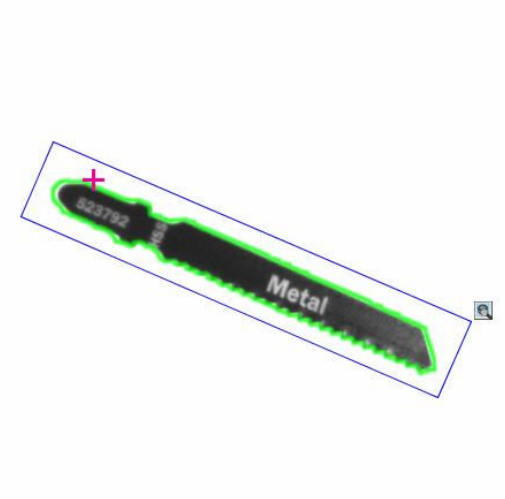
The direction in which edges are searched for in the region is indicated by the yellow arrows on the region in the reference image. To change the search direction, simply rotate the region.

10.2 Object locator

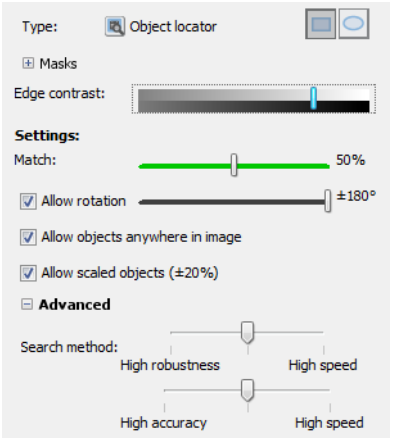
Object locator The Object locator is used to locate an object that has a known shape. The method uses a pattern matching

function that recognizes and compares edges in the image.

The reference point (purple cross) is by default placed in the center of the object locator region, but can be moved manually to the particular point on the object that should 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***

10.2.1 Setting

The edges that will be searched 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 is outside the object if it is difficult to make the pixels in the area around the object disappear with the **Edge strength** setting.

Match

The **Match** setting determines 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 **Allow rotation** is enabled, the allowed rotation can be set between zero and ±180°. Disable **Allow rotation** 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 to determine 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 disabled, 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 (±20%)	The **Allow scaled objects** setting is used when objects appear at different distance from the Inspectors lens. Disable **Allow scaled objects** if the inspected objects always have the same size in the image as the reference object. Disabling **Allow scaled objects** will speed up and make the inspections more robust. When selected, the Inspector will locate objects that are scaled up to ±20%.
Advanced – Search Method	See Section 20.1, "*Object locator*" (page 108).

10.2.2 Results

The object locator reports Located if an object in the image passes all thresholds that are defined in the setting. If any of the thresholds fails, the result is Not located.

In addition to the Located/Not located result, the object locator produce the following values:

- The Match score [percent].
- The X and Y position of the reference point on the located object [pixels or mm].
- The rotation of the located object, relative the object in the reference image [degrees or radians].
- The size (scale) of the located object, relative to the object in the reference image.

10.3 Circle

 **Circle**	The Circle tool locates a circle within the region. It can be used for example for verifying the diameter of a circular hole, or as a end point of a distance measurement. See Section 10.13, "*Distance*" (page 71) for more information.

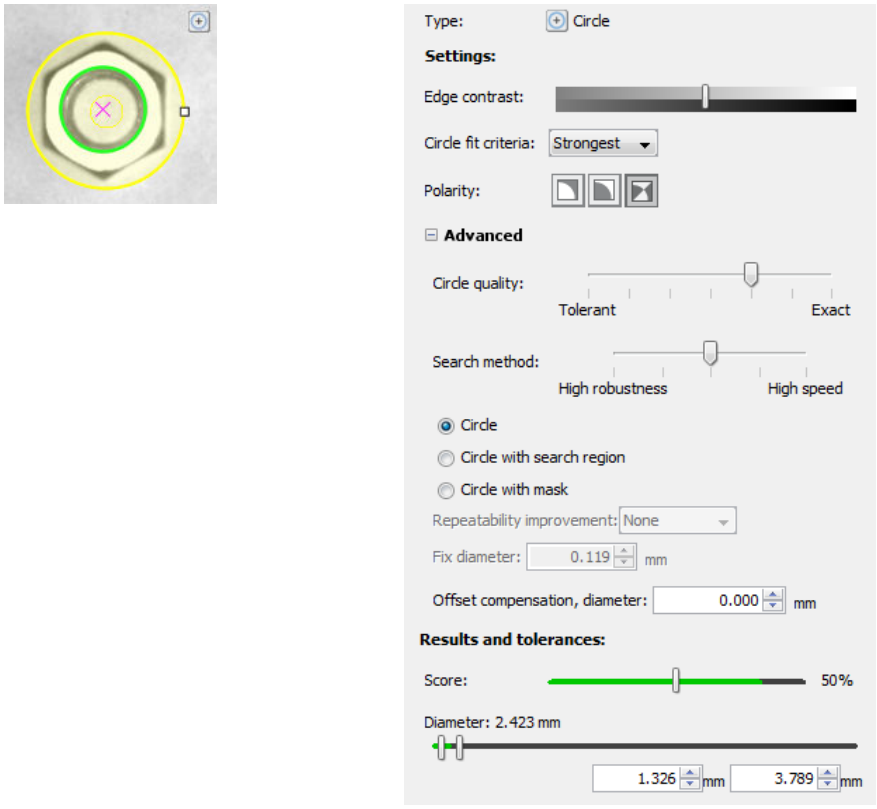


Figure 10.4 Circle tool.

10.3.1 Settings

Edge contrast

The Edge contrast setting specifies the required contrast of the circle's edge - that is, the minimum difference in intensity between the dark side and the bright side of the edge. Move the slider to the left to detect circles that have a small difference between the dark and the bright side. Move the slider to the right to limit the circles to those with a large intensity difference between the sides.

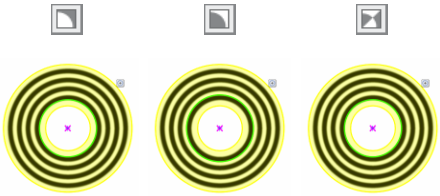
Circle fit criteria

Strongest	The circle with the strongest edge contrast.
Smallest	The smallest circle found that is larger than the minimum diameter.
Largest	The largest circle found that is smaller than the maximum diameter.

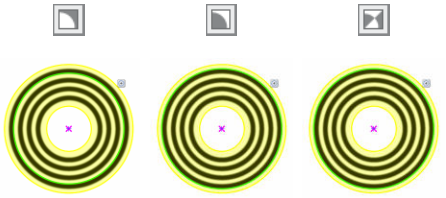
Polarity

Sets the transition of the circle's edge from the centre of the circle – from bright to dark, from dark to bright, or any.

Circle fit: Smallest

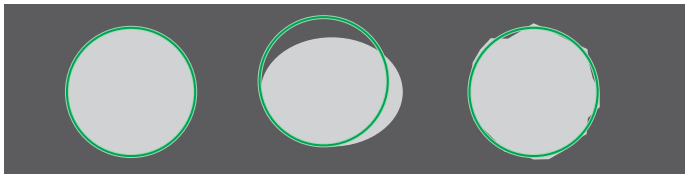


Circle fit: Largest



Circle quality

Move the Circle quality slider to the left (towards Tolerant) to allow the Inspector to locate circles that are not perfectly circle shaped, or where the circle's edge is rough.
Move the slider to the right (towards Exact) to make the Inspector ignore circles that are not round enough.



Perfect circle *Elliptical circle* *Rough circle*

Search method

Adjusts the method used for searching for the circles. Move the slider towards "High speed" if your application requires high inspection speed and you are locating circles in a small region with high contrast. Move the slider towards "High robustness" if you are locating circles in a large region, or if the region contain for example much background clutter, heavy shadows, low contrast, or much occlusion.

Circle

When selected, the Circle tool will find circles where the circle's perimeter is located between the specified minimum and maximum diameter.

Circle with search region

When selected, the Circle tool will search for circles anywhere within a search region.

Note

Due to performance reasons, the inner circle area must be equal to at least 1/15th of the search region area.

Circle with mask

When selected, you can mask out a section of the circle to prevent the Inspector to search for the perimeter in that area. This can be useful for example when locating circles that are partially covered.
To change the width and the position of the mask, click and drag the white bars in the region.

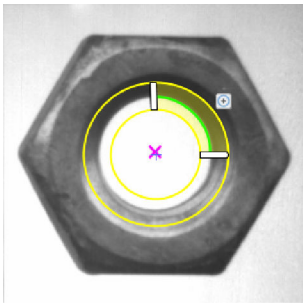


Figure 10.5 Circle with mask.

Repeatability improvement When **Circle with mask** is selected, you can improve the robustness of the tool by using the **fix diameter** or the **fix position** parameter.

Offset compensation A fixed value that will be added to (or subtracted from) the fitted circle's diameter.
This is useful if there is a systematic measurement error in the application, and you would like to set limits or get results that are adjusted for this error. Note that the circle shown in the image is not affected by this compensation.

10.3.2 Results and tolerances

The Circle tool will pass if the located circle passes both these tolerances:

Score Reflects how well the fitted circle matched the circle's edge in the region. Adjust the score threshold so that the Circle tool gets the red failed status when no circle is present in the region.

Diameter Sets the minimum and maximum allowed diameter for the located circle.

In addition to the Pass/Fail results, the Circle tool produces the following values:

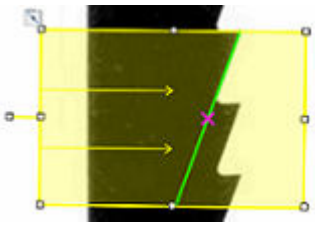
- The Score for the fitted circle [0...100].
- The diameter of the fitted circle [pixels or mm].
- The X and Y position of the center on the fitted circle [pixels or mm].

10.4 Edge tools (Edge)

The Edge tool locates an edge within the region. It can be used for verifying the presence of an edge in the area, find the first or last point in the search direction, and also as a part of a distance or angle measurement. See Section 10.13, “*Distance*” (page 71) for more information.

Edge Locates a straight edge within a region and fit a line to that edge.

When **Edge** is selected, the Edge tool will fit a line to the edge inside the area that best matches the settings for the tool.



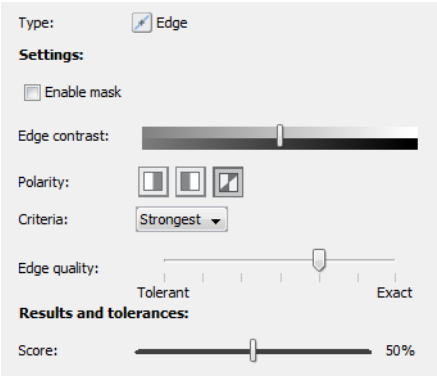


Figure 10.6 Edge settings.

10.4.1 Settings

Enable mask

When selected, you can mask out a part of the region, to make the Edge tool ignore edges inside that area. This can be useful for example when locating an edge that is partially covered by a label. To resize the mask, click the masked area and drag the white bars in the region.

Edge contrast

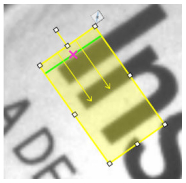
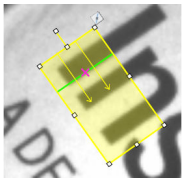
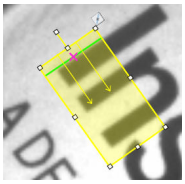
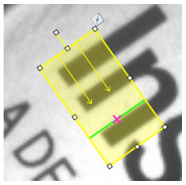
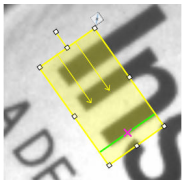
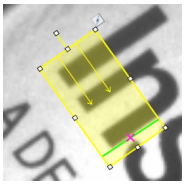
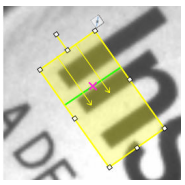
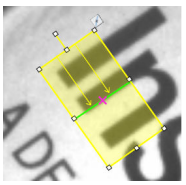
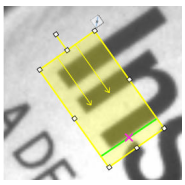
The Edge contrast setting sets the required contrast of the edge - that is, the minimum difference in intensity between the dark side and the bright side of the edge. Move the slider to the left to detect edges that have a small difference between the dark and the bright side. Move the slider to the right to limit the edges to those with a large intensity difference between the sides.

Polarity

Sets the transition of the edge in the search direction – from bright to dark, from dark to bright, or any.

Criteria

If there are multiple edges in the region that have the required edge strength, the criteria sets which of the edges that should be located:

	Polarity: Bright to dark	**Polarity: Dark to bright**	**Polarity: Any**
Criteria: First The first edge found in the search direction.			
Criteria: Last The last edge found in the search direction.			
Criteria: Strongest The edge with strongest contrast.			

Edge quality

Move the Edge quality slider to the left (towards **Tolerant**) to allow the Inspector to locate edges that are not perfectly straight, or when the edge is noisy.
Move the slider to the right (towards **Exact**) to make the Inspector ignore edges that are not straight enough.

10.4.2 Results and tolerances

Score

Reflects how well the fitted line matched the edge in the region. Adjust the score threshold so that the Edge tool gets the red failed status when no edge is present in the region.

In addition to the Pass/Fail result, the Edge tool produces the following values:

- The Score for the fitted edge [0...100]. (Only for Edge, not Find maximum).
- The X and Y position of the center on the fitted edge [pixels or mm].
- The rotation of the fitted edge, relative to the image [degrees or radians].

Tip

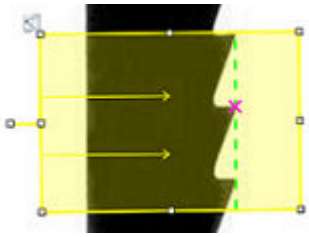
If you need the positions of the end points of an edge, use a Polygon tool instead of an Edge tool. See Section 10.9.3, "*Algorithm - Single edge tool*" (page 65) for more information.

10.5 Edge tools (Find maximum)

The Find maximum tool locates the first or last edge point along the search direction of an inspection region.

Find maximum

The **Find maximum** tool will place a line at the first (or last) point in the search direction, of the first (or last) edge with the set edge contrast. This line will always be perpendicular to the search direction.



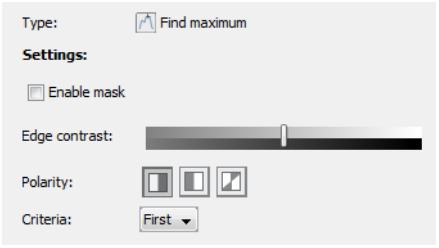


Figure 10.7 Find maximum settings.

10.5.1 Settings

Enable mask

When selected, you can mask out a part of the region, to make the Edge tool ignore edges inside that area. This can be useful for example when locating an edge that is partially covered by a label.
To resize the mask, click the masked area and drag the white bars in the region.

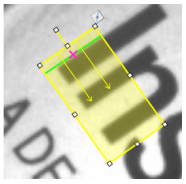
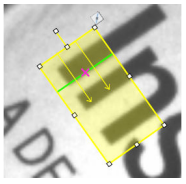
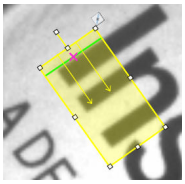
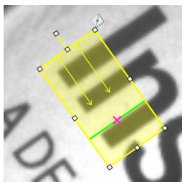
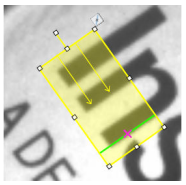
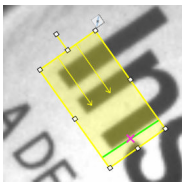
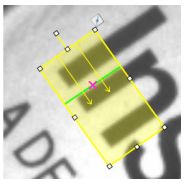
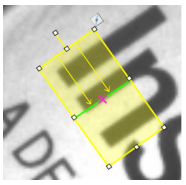
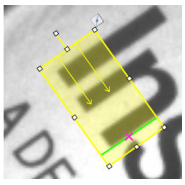
Edge contrast

The Edge contrast setting sets the required contrast of the edge - that is, the minimum difference in intensity between the dark side and the bright side of the edge. Move the slider to the left to detect edges that have a small difference between the dark and the bright

side. Move the slider to the right to limit the edges to those with a large intensity difference between the sides.

Polarity Sets the transition of the edge in the search direction – from bright to dark, from dark to bright, or any.

Criteria If there are multiple edges in the region that have the required edge strength, the criteria sets which of the edges that should be located:

	Polarity: Bright to dark	**Polarity: Dark to bright**	**Polarity: Any**
			
Criteria: First The first edge found in the search direction.			
Criteria: Last The last edge found in the search direction.			
Criteria: Strongest The edge with strongest contrast.			

Edge quality Move the Edge quality slider to the left (towards **Tolerant**) to allow the Inspector to locate edges that are not perfectly straight, or when the edge is noisy.
Move the slider to the right (towards **Exact**) to make the Inspector ignore edges that are not straight enough.

10.5.2 Results and tolerances

Score Reflects how well the fitted line matched the edge in the region. Adjust the score threshold so that the Edge tool gets the red failed status when no edge is present in the region. Not valid for **Find maximum**.

In addition to the Pass/Fail result, the Edge tool produces the following values:

- The Score for the fitted edge [0...100]. (Only for Edge, not Find maximum).
- The X and Y position of the center on the fitted edge [pixels or mm].
- The rotation of the fitted edge, relative to the image [degrees or radians]. Not valid for **Find maximum**.

Tip

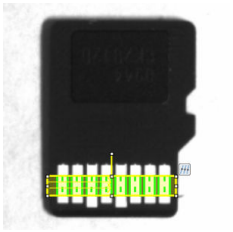
If you need the positions of the end points of an edge, use a Polygon tool instead of an Edge tool. See Section 10.9.3, “*Algorithm - Single edge tool*” (page 65) for more information.

10.6 Edge counter

The Edge counter tool locates multiple edges within the region and calculates the distance between each edge and its neighbour. It can be used for verifying the number of edges in the area, or for verifying an even distribution of the edges.

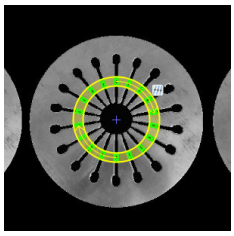
The Edge counter tool is available in two variants:

Linear — Locates edges along a line. Pitch is measured in pixels or mm.



Circular — Locates edges along a circle. Pitch is measured in degrees.

Useful for example when counting spokes, or inspecting the teeth on a cog wheel.



You select which variant to use by selecting it from the popup menu that appears when you click on the Edge counter icon in the toolbar.

10.6.1 Settings

Edge contrast — Sets the required contrast of the edges - that is, the minimum difference in intensity between the dark side and the bright side of an edge. Move the slider to the left to detect edges that have a small difference between the dark and the bright side. Move the slider to the right to limit the edges to those with a large intensity difference between the sides.

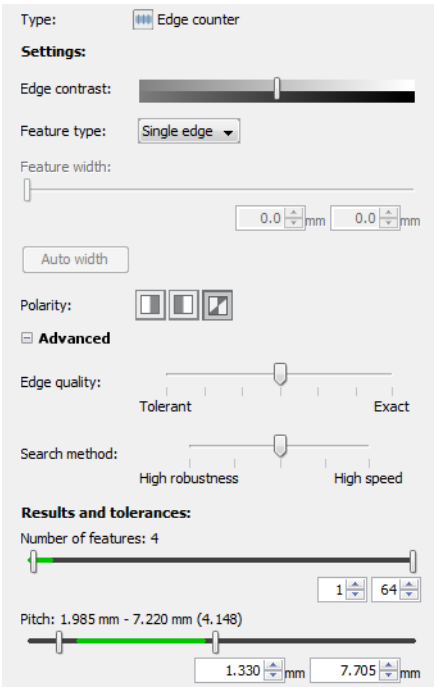
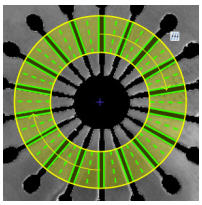


Figure 10.8 Edge counter settings.

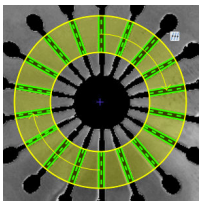
Feature type

Sets whether the tool should locate line features or single edges:

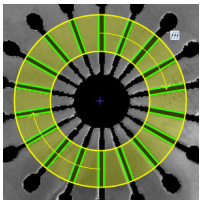
Bright Bright lines on dark background



Dark Dark lines on bright background



Single edge Single edges, which are transitions from dark to bright, or from bright to dark



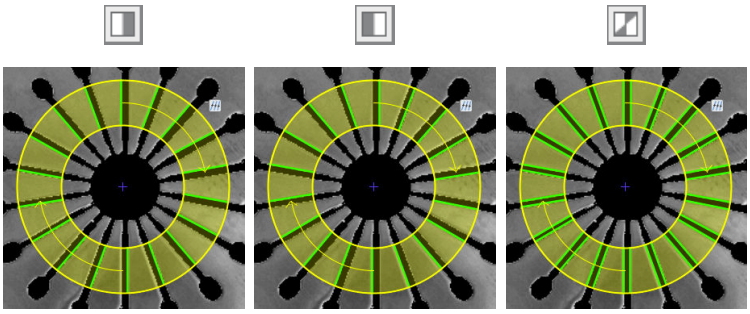
When set to Bright or Dark, the pitch is measured from the center of the located features.

Feature width

When Feature type is set to Bright or Dark, the Feature width setting sets the minimum and maximum allowed width of the located features.
Clicking **Auto width** will set the allowed feature width according to the features that the Inspector locates in the region in the reference image.

Polarity

When Feature type is set to Single edge, the Polarity setting sets the transition of the edge in the search direction – from bright to dark, from dark to bright, or any.



Edge quality

Move the Edge quality slider to the left (towards **Tolerant**) to allow the Inspector to locate edges that are not perfectly straight, or when the edges are rough.
Move the slider to the right (towards **Exact**) to make the Inspector ignore edges that are not straight enough or if the edges are narrowly spaced.

Search method

Adjusts the method used for searching for the edges. Move the slider towards **High speed** if your application requires high inspection speed and you are locating edges in a small region with high contrast. Move

the slider towards **High robustness** if you are locating edges in a large region, or if the region contain for example much background clutter, heavy shadows, low contrast, or much occlusion.

10.6.2 Results and tolerances

The Edge counter tool will pass if these tolerances are met:

Number of features The number of single edges or line features that are allowed in the region.

Pitch The minimum and maximum distance between two adjacent edges or features.

Note

The calculated mean pitch value is shown in parentheses next to the **Pitch** setting.

In addition to the Pass/Fail result, the Edge counter tool produces the following values:

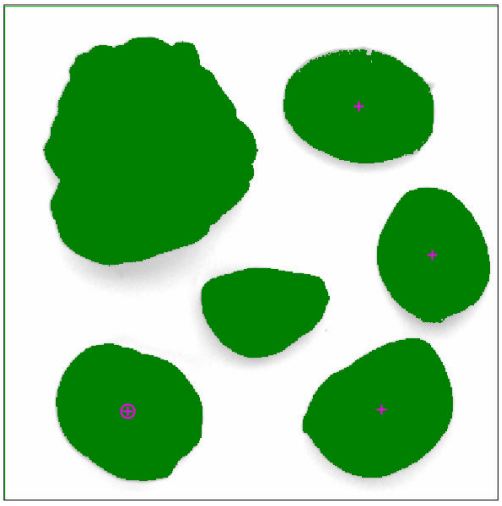
- Number of edges
  - The edge counter supports at most 64 edges. When more edges are located, the GUI will show "`>64`" as a result for edges found. The Ethernet result output will output 65 edges.
- Mean, maximum and minimum pitch [pixels or mm]
- For each edge when locating single edges:
  - The X and Y position of the center on the fitted edge [pixels or mm]
  - The rotation of the fitted edge, relative to the image [degrees or radians].
  - The polarity of the edge
- For each feature when locating line features:
  - The X and Y position of the fitted center on the feature [pixels or mm]
  - The rotation of the fitted centre of the feature, relative to the image [degrees or radians].
  - The width of the feature [pixels or mm]
  - Internal angle - that is, the angle between the two edges defining the feature [degrees or radians]

10.7 Blob

Blob

The Blob tool is used to locate the position of one or more free-form shapes (the so-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 Engineering Tool (ET)**, **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 criteria 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. If the Blob tool is used by a Distance measurement, the position of the first blob will be used in the measurement.

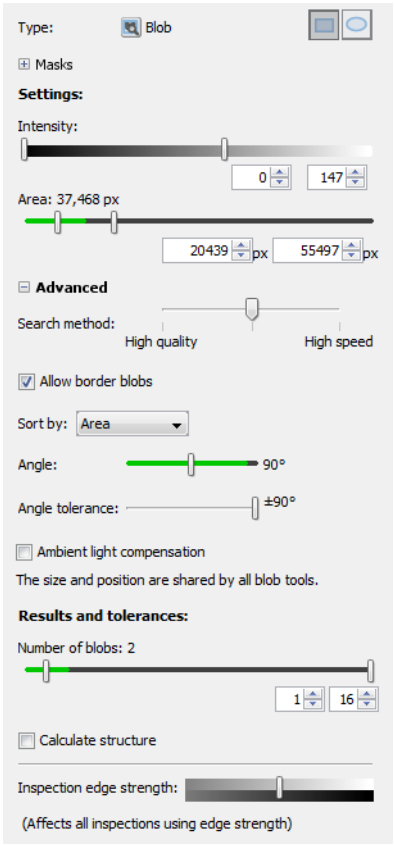


Figure 10.9 Blob tool configuration tab.

10.7.1 Settings

The following settings can be done for the blob tool:

Intensity — Choose the **Intensity** interval with the sliders, for pixels to be selected to be inside a blob.

Area — Choose the blob **Area** interval for a shape to be selected as a blob.

Note

For area calculation, the area of the holes in the found blobs is included in the area that is calculated.

Calculate Structure — Enable or disable calculate structure

Inspection Edge Strength — See information about Inspection Edge Strength in Section 10.2, "*Object locator*" (page 47), and note in Section 10.12, "*Edge pixel counter*" (page 71). The settings of Inspections Edge Strength affects all inspections in the same reference object.

Advanced settings

- Search method — Adjusts the method used for searching for the blobs:
- Move the slider towards "High speed" if your application requires high inspection speed and the region contains little disturbance or noise apart from the blobs themselves.
- Move the slider towards "High robustness" if the region contains much disturbances or noise.

- 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 **Results** tab as well as in the Ethernet result output.

- Angle — Choose the **Angle** of rotation for the blob. The calculated/reported angle is always a positive value between 0° and 180°. See Section 10.7.3, "*Use blob angle*" (page 61) for explanation on how the angle is calculated and reported.

- Angle tolerance — Choose the Angle tolerance which is between 0° to ±90°. See Section 10.7.3, "*Use blob angle*" (page 61).

- Ambient light compensation — See Section 20.5, "*Blob*" (page 110).

10.7.2 Results

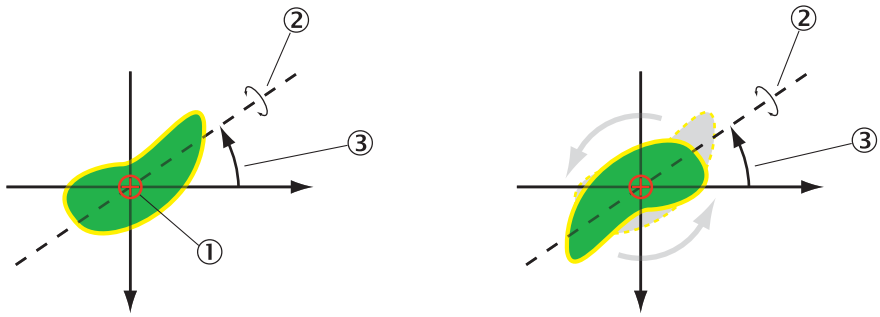
Number of blobs — Sets the number of blobs that should be found by the blob tool. Up to 15 blobs can be found within an ROI. If this slider is set to 16, the result will be set to passed if 16 or more blobs are found.

In addition to the Pass/Fail result, the blob tool produces the following values:

- The number of found (and qualified) blobs.
- For each found blob:
  - The X and Y position of the center of gravity [pixels or mm].
  - The area [pixels or mm]
  - The angle [degrees or radians]
  - The structure value [pixels]
  - Whether or not the blob touches the border of the blob region.
- The upper and lower intensity threshold after compensating for ambient light.

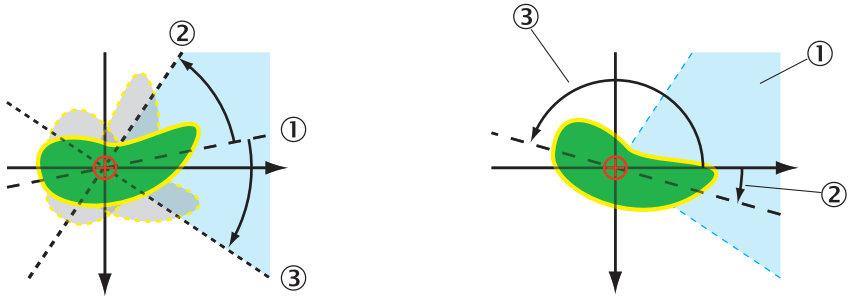
10.7.3 Use blob angle

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 0º and 180º, 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 ±45º, 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

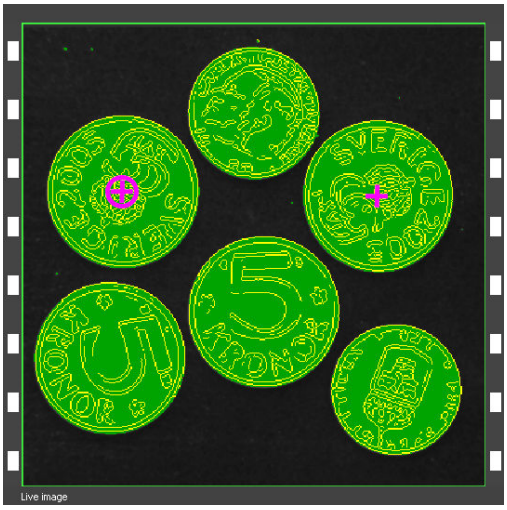
① Allowed range of blob rotation
② Actual rotation of the blob
③ Reported angles of rotation, since the Inspector PIM60 always reports an angle in the interval 0º to 180º.

10.7.4 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.

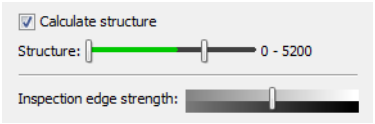
In the example image below the **Structure** criteria, or more specifically the number of edges inside a located blob, is used to evaluate which side is facing up, heads or tails.

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 1000000.



*The Blob tools **Structure** setting to select blobs.*

Note

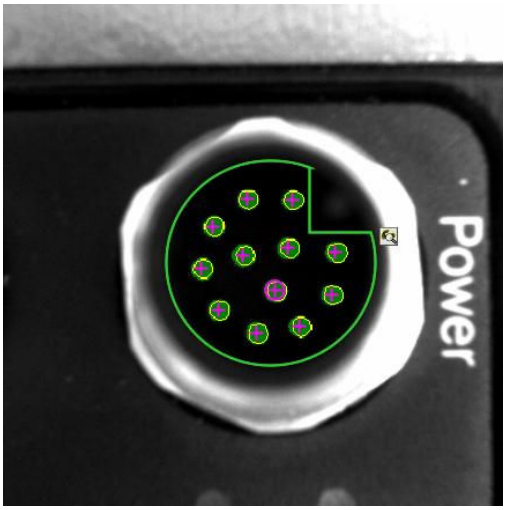
The edge pixels on the edge of the blob are not counted as a part of the *Structure*

10.7.5 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.

10.8 Pattern

Pattern

The **Pattern** tool locates a gray scale pattern pixel by pixel within a region.

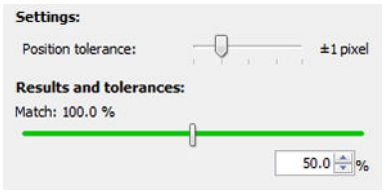


Figure 10.10 Pattern Inspection.

10.8.1 Settings

Reference point

The reference point (purple cross) marks the position of the pattern that is reported in the results, and can be used for measurements.
You can move the reference point from the default location (the center of the region) to the particular point on the object that shall be reported.

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.

10.8.2 Results

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".

In addition to the Pass/Fail result, the pattern tool produces the following values:

- The score value for the located pattern [0...100].
- The X and Y position of the reference point [pixels or mm]

10.9 Polygon (not included in PIM60 Bead P/N 1076617, 1079321, 1079322)

Polygon

The polygon tool is used for localization of corners on an object or localization of an object's edge. The corner positions are estimated with high accuracy which enables for fine localization 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**.

10.9.1 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 green in the reference image, or red if it is not found.

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 **Tools** 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.

10.9.2 Algorithm

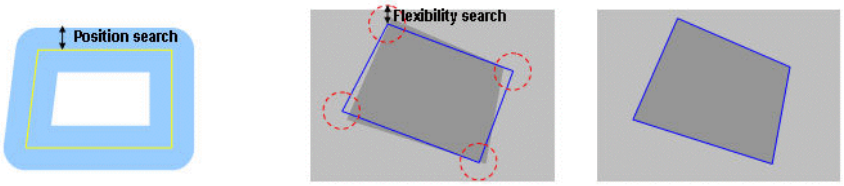
The polygon fitting is performed in two steps:

1. Rigid positioning	*keeps the object shape and size*
2. Flexible fitting	*allows for shape deformation*

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.

10.9.3 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).

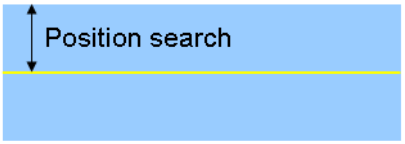


Figure 10.11 Illustration of the search region.

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).

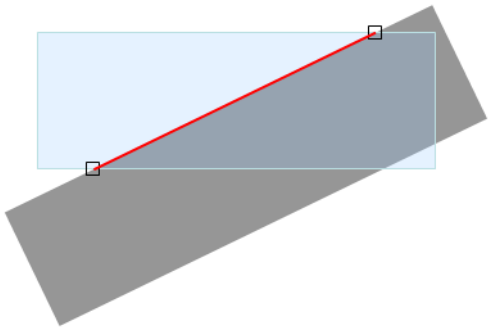


Figure 10.12 No edge will be found if the edge does not cross the left and right borders of the blue search region.

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.

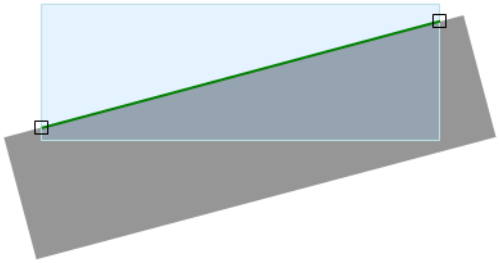


Figure 10.13 Illustration of the estimated corner positions (black squares).

10.9.4 Parameters

The following settings can be made for the polygon tool:

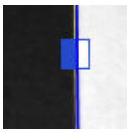
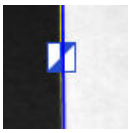
Position search — A search area can be defined by using the **Position search** parameter. Controls the extent of the rigid positioning. Avoid having values larger than approximately half of the object side since the Inspector PIM60 may find other edges than the wanted.

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.

		
Correct polarity chosen.	Wrong polarity chosen.	Polarity not chosen.

10.9.5 Defect detection

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

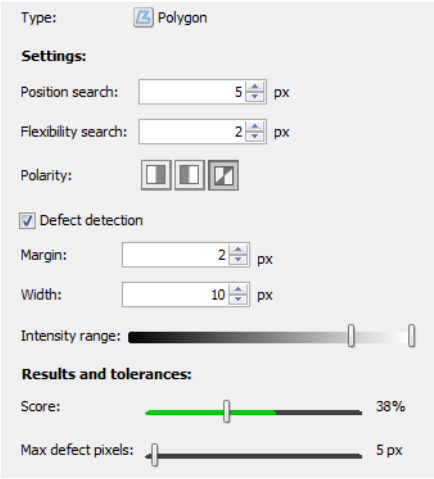


Figure 10.14 The polygon tool parameters.

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.

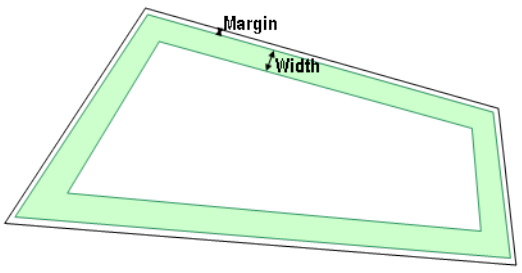


Figure 10.15 Pixels inside the green strip are inspected to find defects.

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 detec-

tions. 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

10.10 Bead tool (only included in PIM60 Bead P/N 1076617, 1079321, 1079322)

Bead tool

The **Bead tool** verifies completeness, position and width tolerance of string-formed features, for example glue beads.

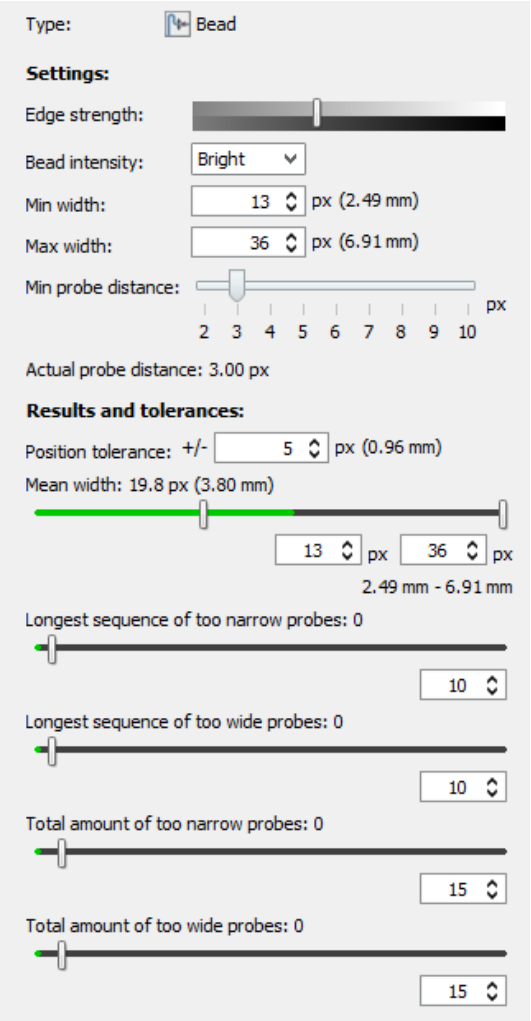


Figure 10.16 Bead tool settings.

10.10.1 Adding a bead tool

- Select the Bead tool icon below the reference image to start positioning the Bead tool. Click once for each corner point, connecting lines are drawn automatically. The shape should be drawn in the center of the bead. When the basic shape of the bead is completed, specify the width in the settings panel.
- A maximum of 16 corners can be used when the Bead tool is applied.
- To complete the Bead tool without placing all 16 corners, move the mouse pointer near the end point of the last drawn line, make sure that the mouse pointer changes icon and click to finish the bead.
- After completing the beat tool, adjust the minimum and maximum width so that the edges of the string are within the desired width span.

10.10.2 Settings

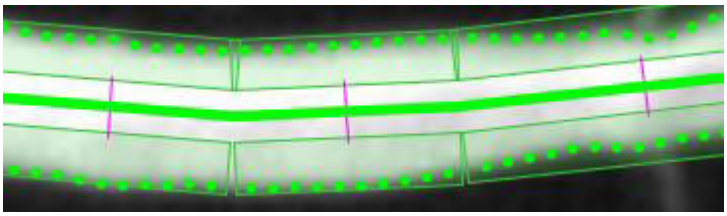


Figure 10.17 Bead tool probes. Center and width.

Edge strength	Set the required contrast of the edges, that is, the minimum difference in intensity between the dark side and the bright side of an edge. Move the slider to the left to detect edges that have a small difference between the dark and the bright side. Move the slider to the right to limit the edges to those with a larger intensity difference between the sides.
Min width	Set the minimum width (in pixels) of the bead string to search after.
Max width	Set the maximum width (in pixels) of the bead string to search after.
Bead intensity	Set the intensity of the bead string. Use the **Bright** setting if the bead is brighter than the background and the **Dark** setting if the bead is darker than the background.
Min probe distance	Set the distance (in pixels) between each probe pair used by the algorithm. A short probe distance will provide a more precise trace of the bead string. The maximum probe pair count is 256. The actual probe distance can change depending on the length of the drawn bead string. If the probe pair limit has been reached, the distance between them will be increased in order to cover the entire bead.

10.10.3 Results and tolerances

Position tolerance	Set the number of pixels the Bead tool is allowed to move in any direction from the position in the reference image. This is visualized by a pink line along each bead segment.
Longest sequence of too narrow probes	Set the number of consecutive probe pairs that are allowed to have a width which is smaller than specified. This tolerance is useful for detecting gaps in the bead.
Longest sequence of too wide probes	Set the number of consecutive probe pairs that are allowed to have a width which is greater than specified.

Total amount of too narrow probes Set the number of total probes (consecutive or not) that are allowed to have a width smaller than specified.

Total amount of too wide probes Set the number of total probes (consecutive or not) that are allowed to have a width greater than specified.

10.10.4 Improve speed

To improve Bead tool speed:

- Increase probe distance
- Reduce the size of the search region, that is the difference between min and max width.
- Decrease position tolerance.

10.11 Pixel counter

Pixel counter

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

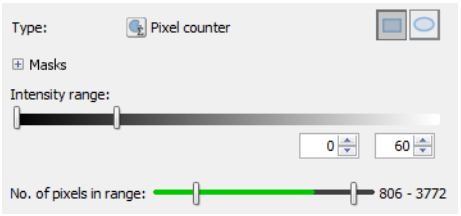


Figure 10.18 Pixel Counter Inspection.

10.11.1 Settings

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

10.11.2 Results

In addition to the pass/fail result based on the No. of pixels in range setting, the pixel counter can output the number of pixels in the range as a value.

10.12 Edge pixel counter

Edge pixel counter

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.

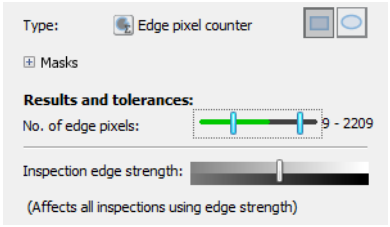


Figure 10.19 Edge Pixel Counter Inspection.

10.12.1 Settings

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

10.12.2 Results

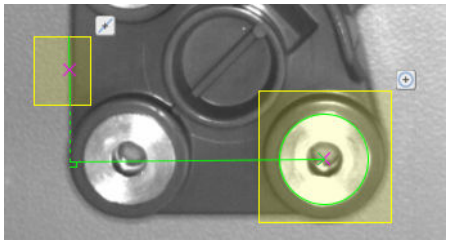
In addition to the pass/fail result based on the No. of edge pixels setting, the Edge pixel counter tool can output the number of edge pixels as a value.

10.13 Distance

Distance

The Distance tool measures the distance between located features; edges, circles, edge intersections [a], patterns, blobs, and known shapes located with the Object locator. When blobs are used in a measurement, the position of the first blob located by the tool according to the sorting order will be used.

[a] An edge intersection can be located with the Angle tool.



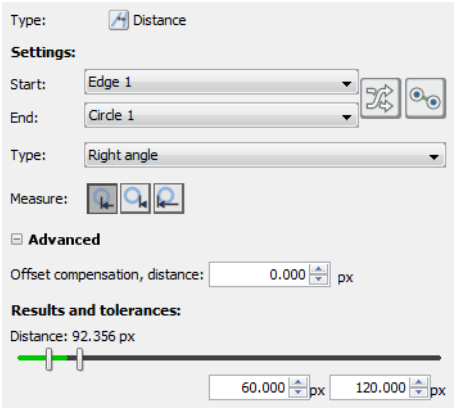


Figure 10.20 Measure distance.

10.13.1 Settings

Start and End

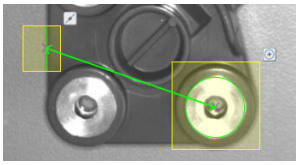
Select the objects or features to measure from and to respectively.
To change which features to measure between, you can do any of the following:

- Choose the start and end features from the **Start** and **End** menus respectively.
- Click **Change direction** to switch the measurement direction - that is, change place of the start and end features.
- Click **Select features**, and select the new features in the image.

Type

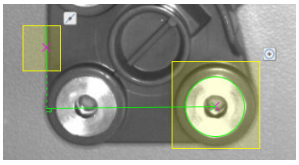
When at least one edge is used in the measurement, select which distance to measure:

Point-to-point The distance from the reference point on the edge.



Right angle The orthogonal distance from the edge.

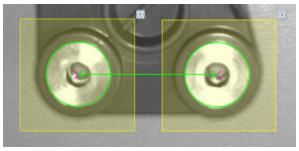
When measuring between two edges, select which of the edges to measure from by clicking Change direction.



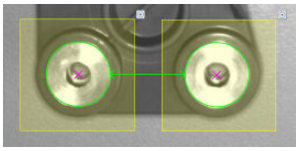
Measure

When at least one circle is used in the measurement, select which distance to measure:

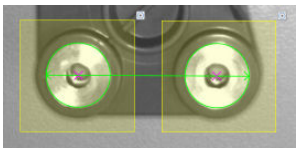
From the center of the circle.



Minimum distance - from the nearest point on the circle's perimeter.



Maximum distance - from the point on the circle's perimeter that is furthest away.



Offset compensation A fixed value that will be added to (or subtracted from) the measured distance.
This is useful if there is a systematic measurement error in the application, and you would like to set limits or get results that are adjusted for this error. Note that the distance shown in the image is not affected by this compensation.

10.13.2 Results and tolerances

Distance Sets the minimum and maximum allowed distance between the two features.

In addition to the pass/fail result based on the Distance setting, the Distance tool produces the following values:

- The measured distance [pixels or mm].
- A Valid result, indicating whether any of the features used by the measurement could not be located (the corresponding locator tool failed).

To get the distance in millimeters instead of pixels, you must first calibrate the Inspector. See Chapter 9, “*Calibrate and align*” (page 40) for more information.

10.14 Angle

Angle

The Angle tool measures the angle between two edges located by Edge tools. In addition to the angle, the tool also calculates the intersection point between the two edges, which can be reported in the result, or can be used for distance measurements.

Note

If the edges are almost parallel, no intersection point will be calculated, and any measurement using the intersection point will therefore fail.

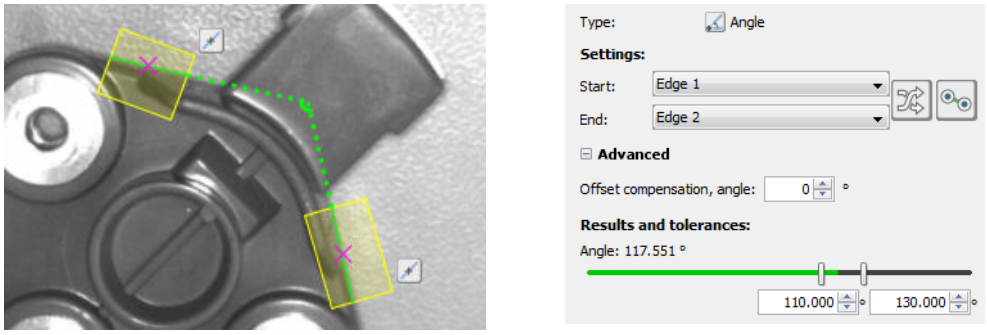


Figure 10.21 Measure angle.

10.14.1 Settings

Start and End

Select the Edge tools to measure from and to respectively.
To change which features to measure between, you can do any of the following:

- Choose the start and end features from the **Start** and **End** menus respectively.
- Click **Change direction** to switch the measurement direction - that is, change place of the start and end features.
- Click **Select features**, and select the new features in the image.

Offset compensation

A fixed value that will be added to (or subtracted from) the measured angle.
This is useful if there is a systematic measurement error in the application, and you would like to set limits or get results that are adjusted for this error. Note that the angle shown in the image is not affected by this compensation.

10.14.2 Result and tolerances

Angle Sets the minimum and maximum allowed angle between the two edges.

In addition to the pass/fail result based on the Angle setting, the Angle tool produces the following values:

- The measured angle [degrees or radians].
- The X and Y position of the intersection of the two edges [pixels or mm].
- A Valid result, indicating whether any of the features used by the measurement could not be located (the corresponding locator tool failed).

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 digital outputs can be configured in the **Digital output settings** tab.

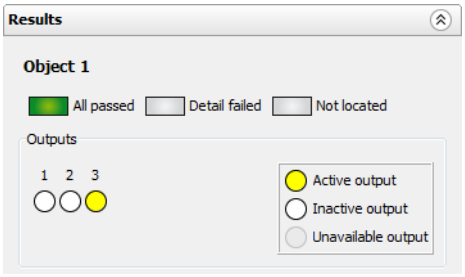


Figure 11.1 Example Output result.

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

Overall results
Three different results are presented:

All passed The object was located and all detailed inspections passed as well.

Detail failed The object was located but at least one detailed inspection failed.
A detailed inspection that is not related to an object locator failed.

Not located The object was not located at all.
The object was located but at least one detailed inspection was out of view.

It is possible to get both **Detail failed** and **Not located** in the same image, if the reference object has both an object locator and a detailed inspection that is not related to the object locator. However, it is not possible to get **All passed** at the same time as any other result.

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
Gray	Not available output

Active output can correspond to either a high or a low signal. See Section 14.3.5, “*Invert output signals*” (page 90).

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

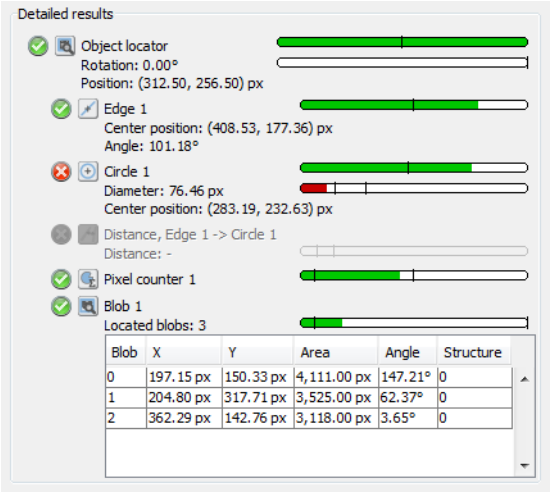


Figure 11.2 Detailed results of different tools

For each tool, the overall result is indicated by the bullet in front of the tool name:

Pass	The result was within the thresholds.
Fail	The result was outside the threshold, or no object or feature was found.
Not valid	The tool could not produce a result, for example if the tool area was partly outside the image, or one of the features used in a measurement was not found.

The bar to the right of the tool name shows the value used for the pass/fail result. The used thresholds are shown as black lines on the bar.

Object locator, Pattern	The **Match** value.
Edge	The **Score** value.
Find maximum	The **Position** value.
Circle	Two bars are shown for the circle tool, one for the **Score** value, and one for the **Diameter**.
Edge counter	Two bars are shown for the Edge counter tool, one for the **Edges** or **Features found** value, and one for the **Pitch**.
Polygon	The **Score** value. If defect detection is selected, the number of defect pixels is shown in a separate bar below the score.
Pixel counter, Edge pixel counter	The number of counted pixels or edge pixels.
Distance, Angle	The measured distance or angle.

In addition to the pass/fail result and values, some tools display additional result values in the Detailed results:

Object locator, Edge	The position and rotation of the located object or edge.
Circle	The position of the center of the located circle, and the diameter.
Distance, Angle	The measured distance or angle.
Blob	Instead of a bar, the number of located blobs is displayed, together with the position, rotation, area, and calculated structure of each blob.

For uncalibrated devices, the position is measured from the upper left corner of the image.

For calibrated devices, the position is measured from the place where the origin was placed with the chessboard pattern. (See Chapter 9, “*Calibrate and align*” (page 40) for more information).

If the Inspector is calibrated the values are displayed in millimeters (mm), otherwise in pixels.

More detailed results can be obtained through the Ethernet based interfaces, see Chapter 16, “*Use Ethernet Raw*” (page 94) for more information..

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.

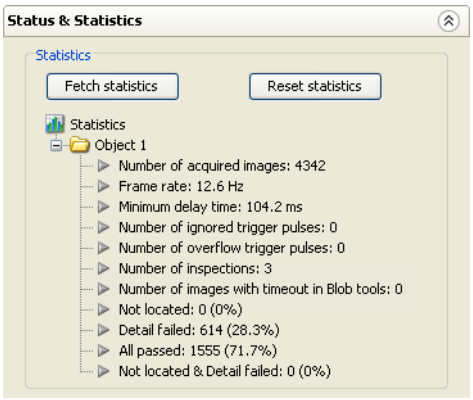


Figure 11.3 Statistics tab

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.
Number of images with timeout in Blob tools	The total number of captured images where the Blob tool timed out and reported no found blobs. The Blob tool can time out when the image is cluttered and high speed is used.
Not located	The total number of captured images where an **Object locator** did not locate a shape, or an inspection related to the object locator was outside the image. 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 PIM60 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. The following table gives an overview of the times taken, in milliseconds:

Reference object configuration	Typical time for reference object selection
Only **Object locator**	500 ms
Object locator plus four **Blob** inspections	700 ms
Object locator plus four **Pixel Counter** inspections	700 ms
Object locator plus four **Edge Pixel Counter** inspections	600 ms
Object locator plus four **Pattern** inspections	700 ms
Object locator plus one **Polygon** inspections	700 ms (5 corners)
Object locator plus four **Edge tools** inspections	700 ms
Object locator plus four **Edge counter** inspections	900 ms
Object locator plus two **Distance** inspections	800 ms (4 edges)
Object locator plus two **Angle** inspections	700 ms (4 edges)
Object locator plus four **Circle** inspections	600 ms
Four **Pixel Counter** inspections	100 ms
Only one **Blob** inspection	200 ms

12.2.1 Select object using SOPAS

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 Engineering Tool (ET)** 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 86)
- To use the digital inputs on the I/O Extension box, see Section 14.4, “*Set up the connection I/O extension box*” (page 90)
- To use the default web pages, see Chapter 17, “*Use web interface*” (page 97)
- To use the interface EtherNet/IP, see the reference manual for Inspector PIM60
- To use the interface Ethernet Raw, see the reference manual for Inspector PIM60
- To use the interface Web API, see the reference manual for Inspector PIM60

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 Engineering Tool (ET)** 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
- All tools: Object locator, Circle, Edge, Blob, Pattern, Polygon, Pixel counter, Edge pixel counter, Distance, and Angle
- Digital Output Settings
- Ethernet Result Output

Other settings – made from the **InspectorPIM60** 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 PIM60 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 126) for explanation of which device is supported of which interfaces.

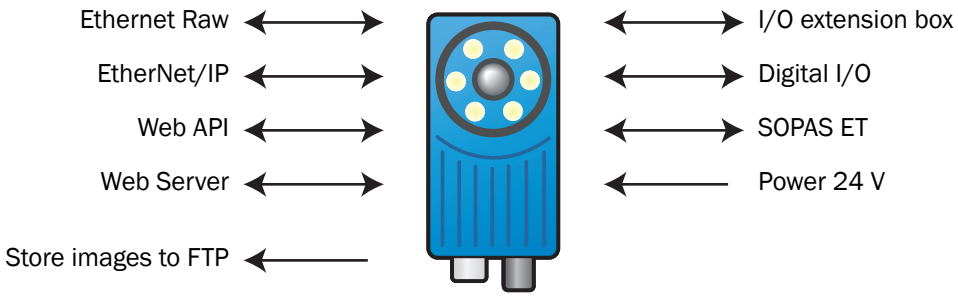


Figure 13.1 Overview interfaces to Inspector PIM60

The enabling and configuration of the optional interfaces are made via the **Interface and I/O settings** and **Store Images to FTP** dialogs accessed via the **InspectorPIM60** menu. See figure below. SOPAS ET is enabled simply by a connection between it and a device.

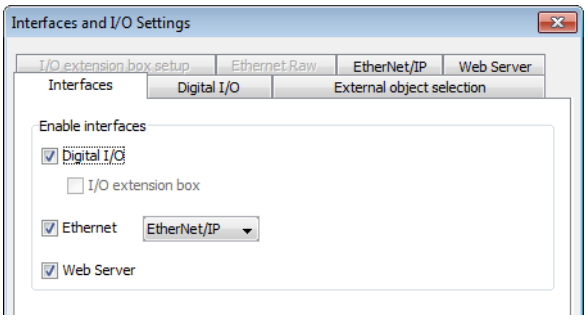


Figure 13.2 Interfaces and I/O settings dialog for Inspector PIM60

13.2 Simultaneous use and restrictions of the interfaces

Not possible combinations of interfaces

The interfaces can be used simultaneous except for the following restriction:

- Only one of Ethernet Raw and EtherNet/IP can be used at a time.
- The I/O extension box and EtherNet/IP can not be used at the same time. The built-in digital I/O can however be used at the same time as EtherNet/IP.

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 Engineering Tool (ET)**
3. Send images over web server and Web API

When SOPAS is connected to a device, live images are not sent by the device's web server or the Web API.

Configuration restriction

It is not recommended to have **SOPAS Engineering Tool (ET)** in online mode while sending configuration changes via other interfaces. This can cause problems with the connection between **SOPAS Engineering Tool (ET)** and Inspector PIM60. 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 Engineering Tool (ET)** has lost connection to Inspector PIM60. An attempt to reconnect will be done. When the sent command has been executed, the **SOPAS Engineering Tool (ET)** is able to connect to Inspector PIM60 again. A synchronization dialog will also appear, select **Use Device Settings** to update **SOPAS Engineering Tool (ET)** with the latest configuration.

It is also recommended to avoid changing settings in **SOPAS Engineering Tool (ET)** while sending configuration changes via other interfaces.

14 Use digital I/O

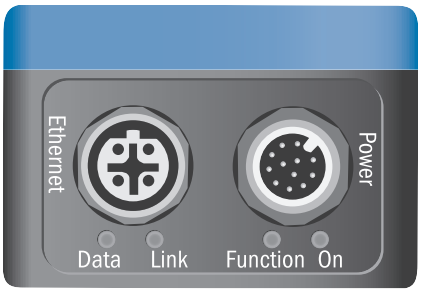
14.1 Overview digital I/O

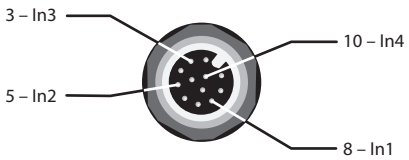
Digital Inputs

The Inspector PIM60 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 PIM60 and set the usage of the input in **SOPAS Engineering Tool (ET)**. 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 PIM60 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 PIM60 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 128) 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.

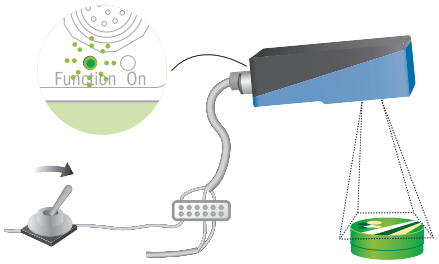
The number of outputs can be increased up to 19, when using I/O extension box, however it is not possible to set any output delay on the external output.

14.2 Use digital inputs

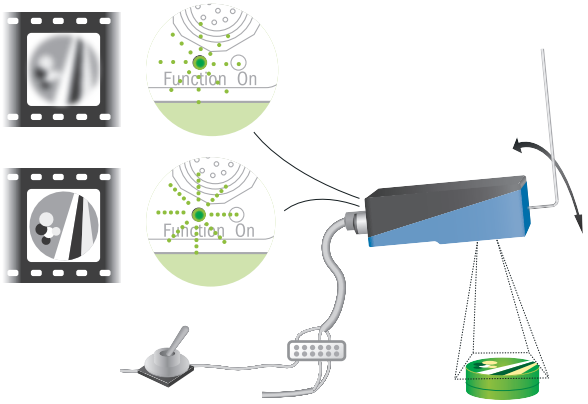
14.2.1 Use external teach

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

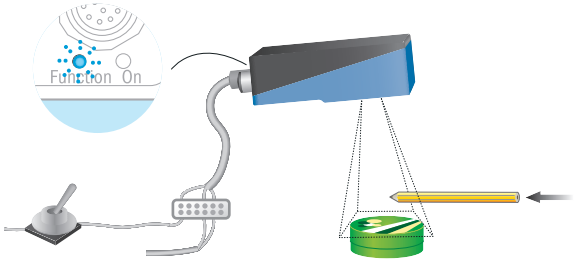
1. Choose **Interfaces and I/O Settings** from the **InspectorPIM60** menu, and select **Use external teaching** in **Digital I/O** tab.
2. Make sure the Inspector is in **Run** mode. Place an object in front of the Inspector and connect **in2** (pin 5, cable color is pink on DOL-1212 cables) to +24 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.



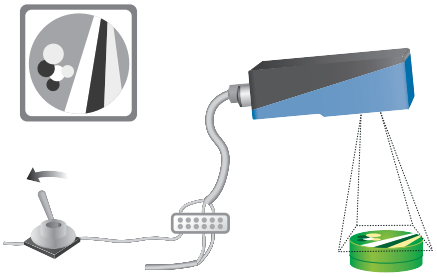
3. Adjust focus by turning the focus screw. The frequency with which the **Function** LED is flashing indicates how focused the images are – the faster it flashes, the better the focus. If re-focus is needed due to distance change between the object and Inspector turn the mechanical focus screw and adjust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



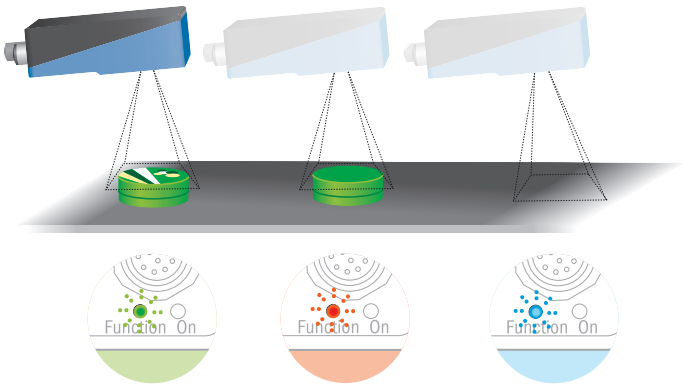
4. Find the field of view (that is, the area covered in the captured image) by using a finger, a pen or similar. When the finger/pen enters the field of view, the color of the **Function** LED changes from green to blue. The LED color reacts on motion in the image. Ensure that the finger/pen is moving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



5. 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.



6. 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

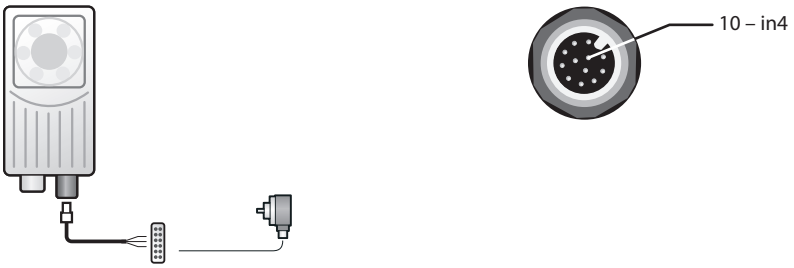
To use an external trigger for triggering the Inspector PIM60 to capture the images, do the following:

1. Connect the image trigger to **in3** (pin 3, cable color is white on DOL-1212 cables) on the Inspector.
2. Choose **Interfaces and I/O Settings** from the **InspectorPIM60** menu, and select **Enable image trigger (In3)** in the **Digital I/O** tab.
3. 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



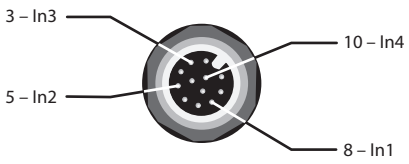
To use an encoder for controlling delay times for image triggering and/or output signals, do the following:

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 **InspectorPIM60** 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.

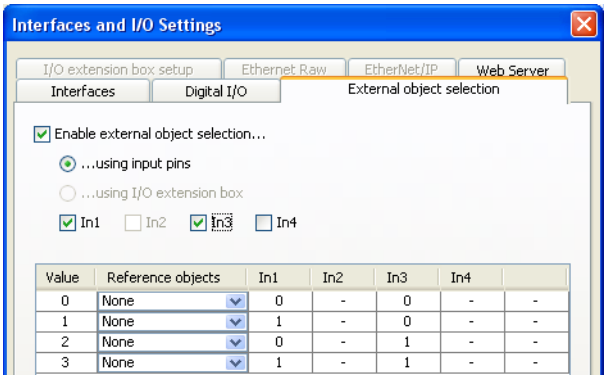
14.2.4 Select reference objects with inputs



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 **InspectorPIM60** 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 90).

14.3 Use digital outputs

The result from each inspection made by Inspector PIM60 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	**Not located** – The object was not located, or a detailed inspection was out of view
Out2	6	Red	**Detail failed** – The object was located but at least one of the detailed inspections failed
Out3	7	Green	**All passed** – 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.

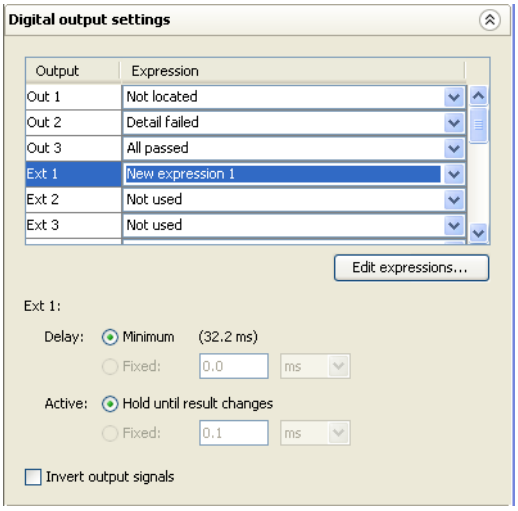


Figure 14.1 Digital output settings tab - I/O box enabled

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 PIM60 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 PIM60 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 PIM60, 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.

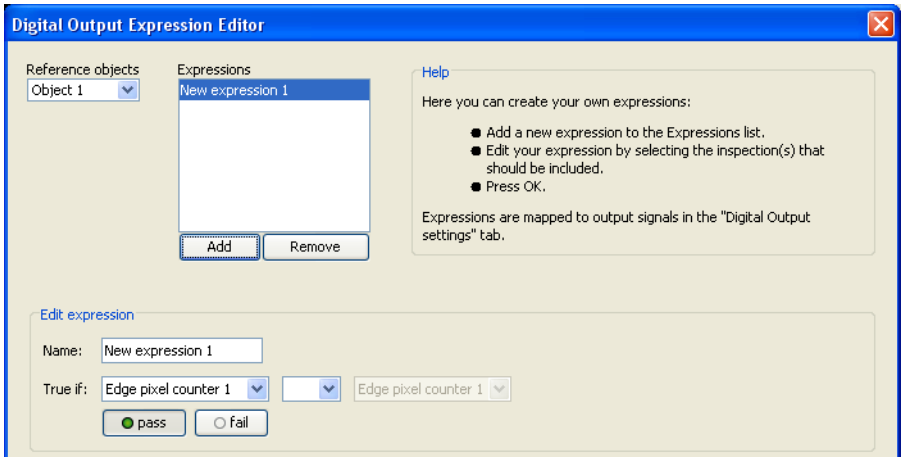


Figure 14.2 Digital Output Expression Editor

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 86).

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 77).

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 Engineering Tool (ET)** see Section 8.3.2, "*Use external lighting*" (page 38).

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 PIM60. For details about the steps see the reference manual for the Inspector PIM60.

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 PIM60. See Section 6.1, "*Manage IP address*" (page 30) how to view the IP address for the Inspector PIM60.
3. Open the **Interfaces and I/O Settings** dialog under the **Inspector PIM60** 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 Engineering Tool (ET)** 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 PIM60 can be controlled and results retrieved 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. Choose **Interfaces and I/O Settings** from the **InspectorPIM60** menu.
2. On the **Interfaces** tab, select **Ethernet** and choose **EtherNet/IP** from the menu.
3. On the **EtherNet/IP** tab, choose input assembly to be used.
   For more information on the available assemblies, see the reference manual for Inspector PIM60.
4. If configurations changes via EtherNet/IP should be allowed, select **Allow changes via EtherNet/IP**.
5. Switch the Inspector to Run mode.
6. Set up the communication on the PLC. For information on how to do this, please refer to the documentation for your PLC.

Note

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

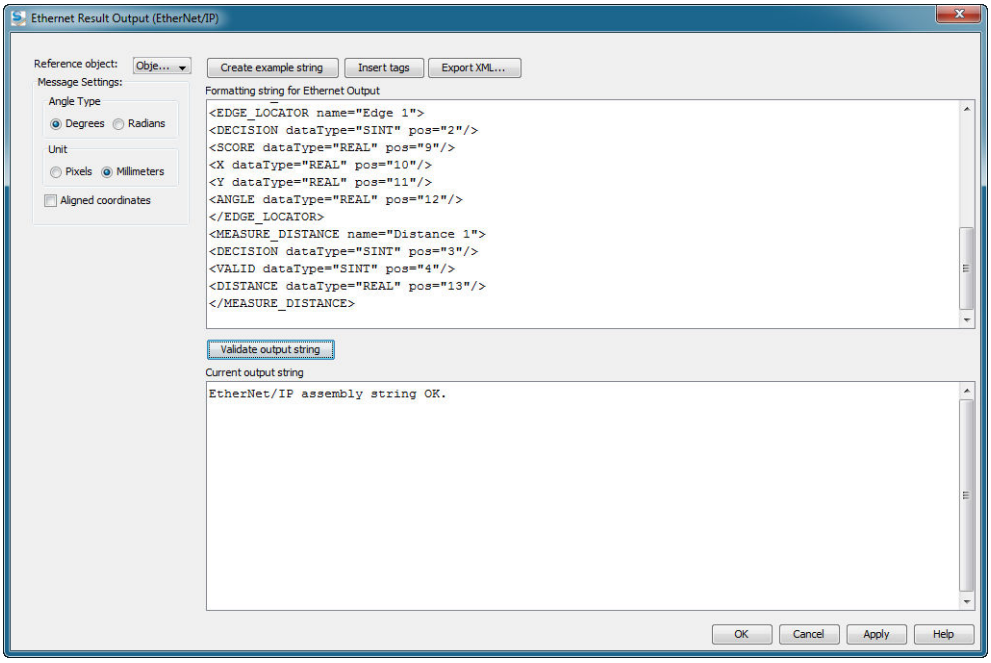
To specify the contents of the EtherNet/IP assembly, use the **Ethernet Result Output** dialog on the **InspectorPIM60** menu.

15.2 Output results

1. Choose **Ethernet Result Output** from the **InspectorPIM60** menu.
2. Choose a **Reference object** from the list.
3. Set **Message Settings**.
4. Click **Create example string**.
5. Edit the formatting string to format the output as required.
   Clicking **Insert tags** will show a menu where you can select the tags available for each tool.
6. Click **Validate output string** to validate the formatting string.

By clicking **Export XML...**, you can export the current formatting string to a file, which can then be opened in an XML editor for editing.

To import an edited formatting string, copy the string from the XML editor and paste it into the **Formatting string for Ethernet Output** field. Remove the `<MESSAGE>` and `</MESSAGE>` tags from the **Formatting string for Ethernet Output** field before clicking **Validate output string**.



15.3 Control the sensor via EtherNet/IP

The Inspector PIM60 has two Output assemblies 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 92).

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 PIM60.

16 Use Ethernet Raw

Coordinate and angle results, as well as other detailed results and information, can be reported by the Inspector PIM60 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:

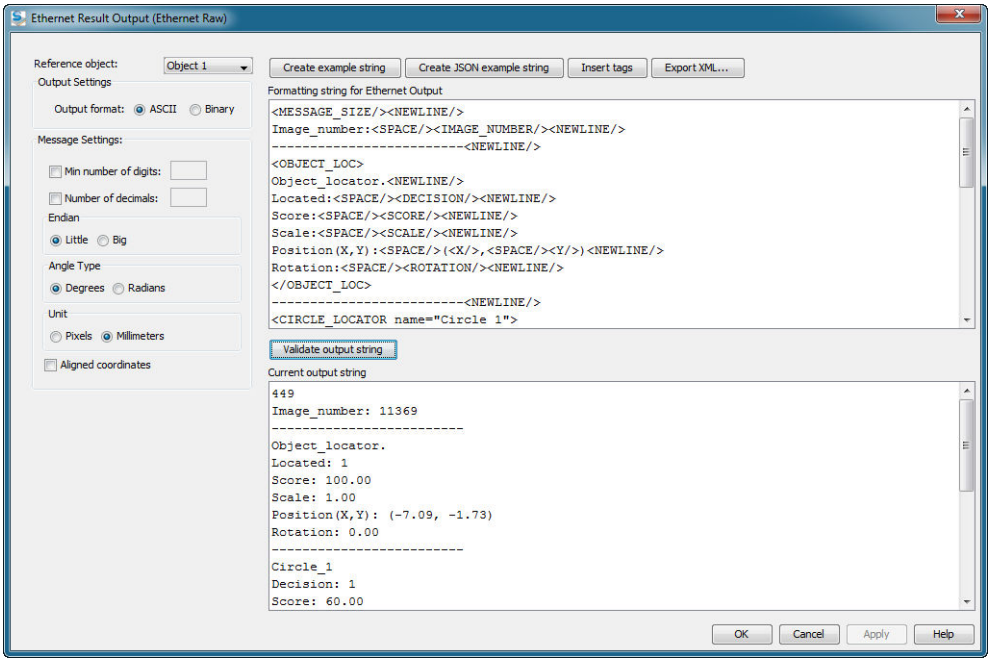
1. Choose **Interfaces and I/O Settings** from the **InspectorPIM60** menu
2. On the **Interfaces** tab, select **Ethernet** and choose **Ethernet (Raw)** from the menu.
3. On the **Ethernet Raw** tab, select the Ethernet protocol (**TCP** or **UDP**) to be used for the communication.
   For UDP, also enter the IP address of the PC/PLC in **Receiver IP address**.
4. If necessary, change the **Port** number. The default TCP port number that the Inspector PIM60 listens to is `2114`.
5. If configurations changes via Ethernet Raw should be allowed, select **Allow changes via Ethernet Raw**.

16.2 Output results

1. Choose **Ethernet Result Output** from the **InspectorPIM60** menu.
2. Choose a **Reference object** from the list.
3. Set **Output Settings.** Select whether the results should be sent in ASCII (text) or binary format.
4. Set **Message Settings.**
5. Click **Create example string** or **Create JSON example string** depending on the output format requirement.
   Clicking **Insert tags** will show a menu where you can select the tags available for each tool.
6. Edit the formatting string to format the output as required.
7. Click **Validate output string** to validate the formatting string.

By clicking **Export XML...**, you can export the current formatting string to a file, which can then be opened in an XML editor for editing.

To import an edited formatting string, copy the string from the XML editor and paste it into the **Formatting string for Ethernet Output** field. Remove the `<MESSAGE>` and `</MESSAGE>` tags from the **Formatting string for Ethernet Output** field before clicking **Validate output 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**, 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 PIM60 supports a set of commands in order to read and/or modify parts of the configuration without using the **SOPAS Engineering Tool (ET)** PC application. By default, port 2115 is used for this communication. For image trigger port 2116 is used by default. 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 (**InspectorPIM60** menu). To enable the Ethernet Raw tab, first choose **Ethernet Raw** in the **Interfaces** tab in the same dialog.

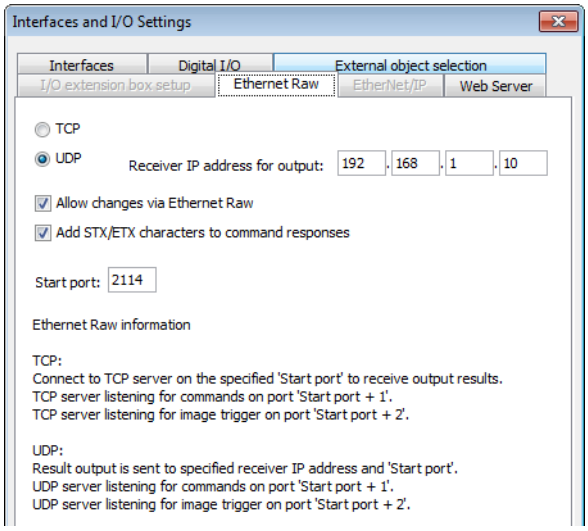


Figure 16.1 Ethernet Command Channel

Note

When using the command channel for changing the configuration it is recommended not to use **SOPAS Engineering Tool (ET)** for configuration simultaneously.

For more information about using command channel and Ethernet Raw see the reference manual for Inspector PIM60.

16.4 Communicate with Simatic S7 controls

The Inspector PIM60 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 PIM60.

17 Use web interface

There are two main ways to connect to an Inspector PIM60 through the web interface:

- Use a web browser to open web pages served by the Inspector's built-in web server.
- Retrieve and change parameters, settings, etc. directly through the Web API from custom application.

The Inspector PIM60 is delivered with a set of web pages that you can use for viewing live images, current reference image, and logged images, and also switch between reference objects in the configuration. You can backup the current configuration to a PC, as well as restore the Inspector's configuration from a saved backup.

It is possible to create custom web pages, upload them to the Inspector, and access them through the built-in web server. When you create custom web pages, all functions available through the Web API can be used.

17.1 Set up connection to the web server

To set up connection to the web server do the following:

1. Choose **Interfaces and I/O Settings** from the **InspectorPIM60** menu.
2. Click on the **Interfaces** tab, and select **Web Server**.
   If this box is checked it will be possible to connect the Inspector PIM60 via the web server and the Web API.
3. Click on the **Web Server** tab, and select **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 Engineering Tool (ET)**.

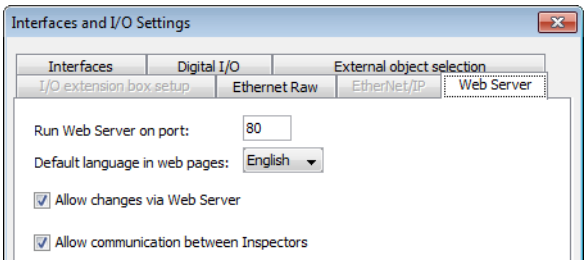


Figure 17.1 Set up connection to the web server

Note

Activating the web server will have impact on maximum frame rate.

17.2 Default web page

To open the default web page on the Inspector PIM60, start a web browser and type in the IP address of the Inspector in the address field.

By default, the web server listens to port 80, but if you have specified a different port for the web server in **Interfaces and I/O Settings**, you need to add the used port number after the IP address, for example:

`http://169.254.184.60:8080`

The web server can be used with Internet Explorer 8, Mozilla Firefox 14 or Chrome 30.

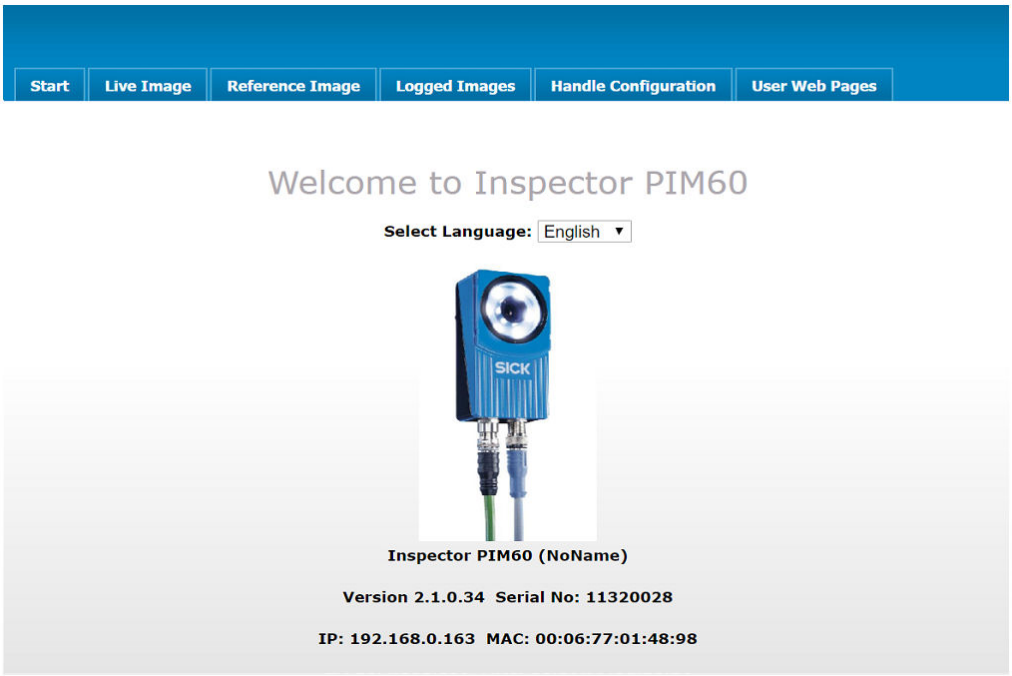


Figure 17.2 Main window in Web Server.

The default web pages have following tabs:

Start — View information about the Inspector, such as IP address, MAC address, version number of current firmware, and serial number.

Live Image — View the current live image.
- Show or hide the overlay graphic in the image with the **Show Overlay**, the **Simplified Overlay**, and the **Hide Overlay** buttons.
- Change the refresh rate by pausing the image and changing the value in the **Refresh interval** field.
- Magnify parts of the image by moving the mouse pointer over the image while the live image is paused.

Reference Image — View the current reference image.
To switch to another reference object in the current configuration, click on the **Handle Configurations** tab, and then on **Select Reference Object**. You must be logged in to be able to switch reference object.

Logged Images — View the logged images on the Inspector.
- Show or hide the overlay graphic in the image with the with the **Show Overlay**, the **Simplified Overlay**, and the **Hide Overlay** buttons.
- Browse through the images with the arrow buttons on the sides of the displayed image, or click on the thumbnails below the image.

The maximum number of images that can be displayed is 5.

Handle Configuration — Used for backing up the current configuration to a PC, restoring a configuration from a saved backup, and switching reference object.

User Web Pages — Used for uploading and removing custom web pages.

For the functions that requires you to log in - change reference object, restore configuration from backup, and handle user web pages - use the following login:

User	`Maintenance`
Default password	`Inspector`

If the password for the Inspector has been changed using SOPAS, use the password that has been set for user level **Maintenance**.

17.2.1 Backup and restore configuration

To backup or restore configurations, click on the **Handle Configuration** tab, and then on **Save Backup** or **Restore Backup**.

You must be logged in to be able to backup and restore configurations.

Note

Configuration files saved in SOPAS (`.sdv` files) can not directly be used for restoring from the web page. To use a configuration file from SOPAS, export it as an `.spb` file first.

When restoring a configuration from a backup file, the Inspector will be stopped if in Run mode, and it will be rebooted when the backup file has been uploaded. The restored configuration will automatically be stored in the Inspector's flash memory, replacing any previous configuration.

17.2.2 Upload and remove custom web pages

To upload or remove custom web pages, click on the **User Web Pages** tab.

- To upload a file to the Inspector, click **Browse...** to locate the file, and then click **Upload** to store the file on the Inspector.
  When the file is stored on the Inspector, it will be added to the list of already uploaded files. All files uploaded to the Inspector will be placed in the `user` folder, and can be accessed by:

  `http://<ip address>/user/<file name>`

- To remove a file that has been uploaded to the Inspector, click **Delete** after the file's name in the list of files already uploaded.

You must be logged in to be able to upload and remove custom web pages.

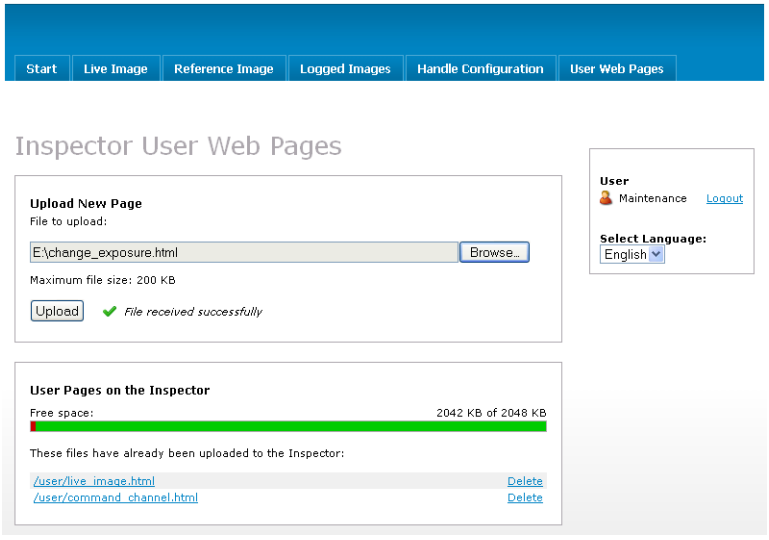


Figure 17.3 Page for uploading and removing custom pages.

Note

The space available for custom web page files on the Inspector PIM60 is limited to 2 MB, and the maximum size of each file that can be uploaded is 200 KB.

A maximum of 236 files can be uploaded to the Inspector PIM60.

17.3 Creating custom web pages

When you create custom web pages to be uploaded to the Inspector, you can use all functions available in the Web API. For more detailed information see the reference manual for Inspector PIM60.

17.4 Web API

With the Web API interface you can build your own applications that communicate with Inspector PIM60 over the HTTP protocol. 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 PIM60.

18 Store images on an FTP server

The Inspector PIM60 can store logged images on an FTP server, which enables the user to review the images.

For detailed information on how to store images on an FTP server, see Chapter 22, “*Log and store images*” (page 115). See also Chapter 13, “*Interfaces*” (page 81)

19 Improve image quality

19.1 Change lens

It is possible to change the lens on Inspector PIM60 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 PIM60 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.

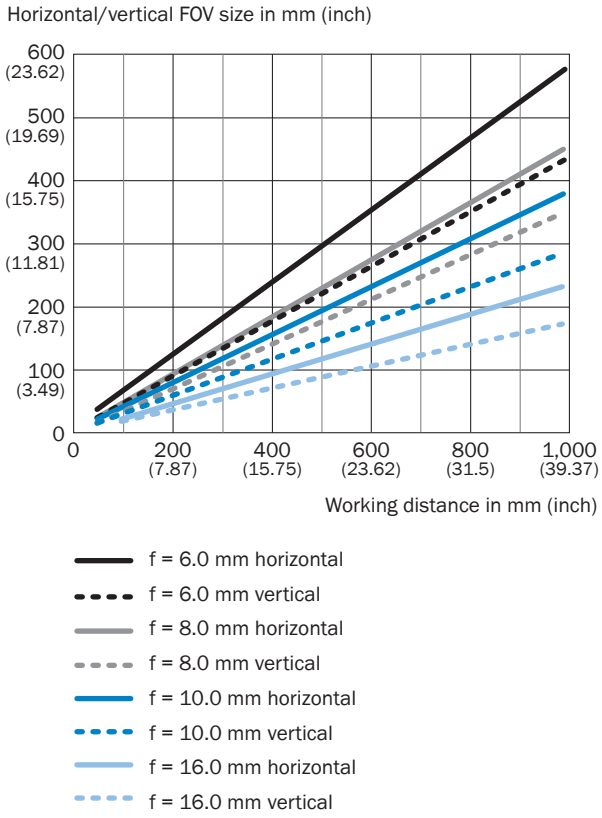


Figure 19.1 Theoretical FOV size (640x480 pixels)

Table 19.1 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 and the Inspector before you remove the front window.

19.2 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

19.2.1 Dome

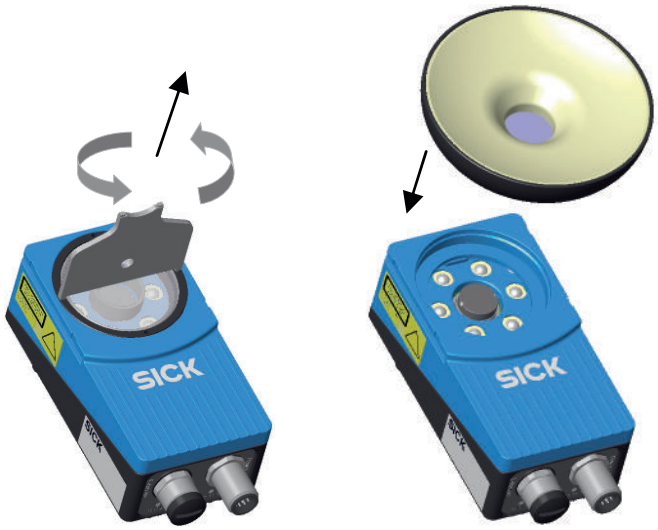
It is possible to replace the front window with a Dome lighting. The Dome lighting diffuses the internal lighting in order to improve performance when working with glossy objects.

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.

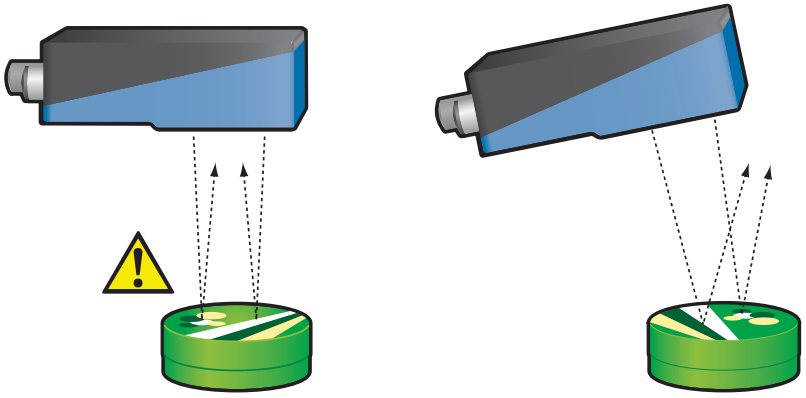
After replacement, the Dome must be securely fastened so that there is no risk of it falling off during operation.

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 and the Inspector before you remove the front window.

19.2.2 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

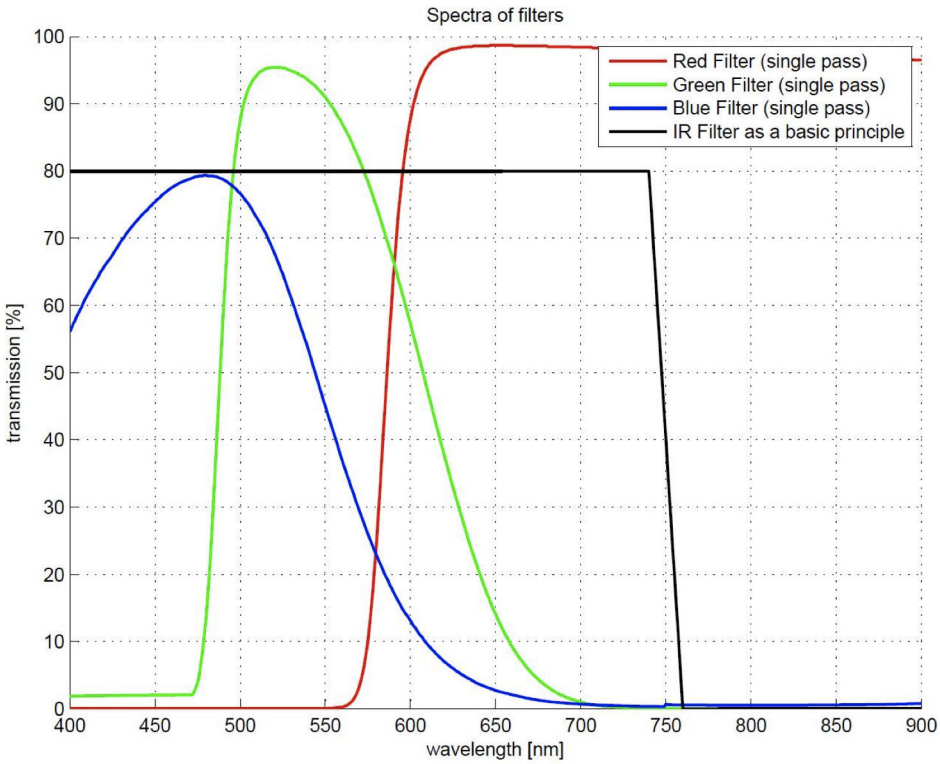
The tilt should be as little as possible but enough to be able to succeed with the configured application. If the device is tilted too much then the perspective will be distorted. Due to this, tilted device is not recommended when inspecting objects that has free rotation or small objects that move a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

19.3 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 and align*” (page 40)

19.4 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.

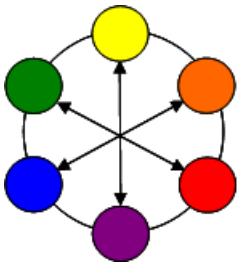
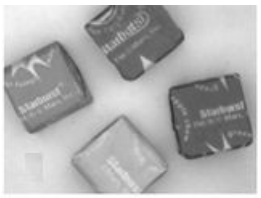
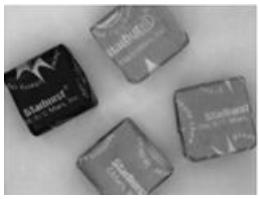
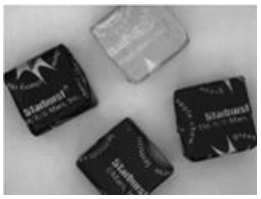


Figure 19.2 Opposing colors

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

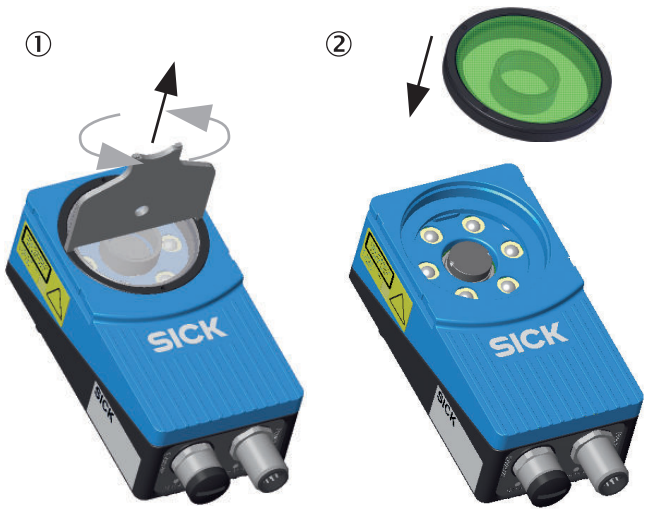
Original photo in color

 *Standard window - no color*	 *Using red color filter*
 *Using green color filter*	 *Using blue color filter*

19.4.1 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.



19.5 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 38).

20 Improve robustness

If the Inspector PIM60 for example fails to locate correct objects or locates objects with defects, 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 19, "*Improve image quality*" (page 102). If this is fulfilled the next step is to adjust the tool settings.

20.1 Object locator

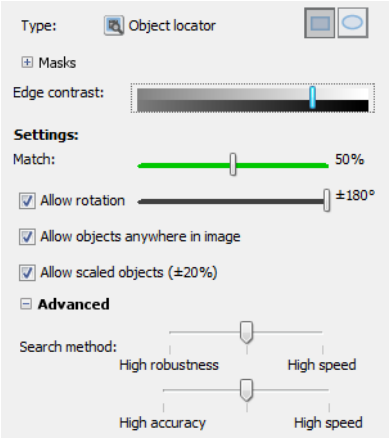


Figure 20.1 Object locator settings

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 25) and Section 2.1, "*Verify dimensions and locate position of a known shaped object*" (page 12).

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

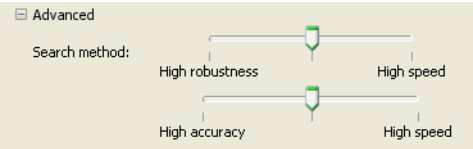


Figure 20.2 Advanced Object locator settings

Switch to a more robust search method for locating the objects, by changing the **Search method** setting (under **Advanced** on the **Tools** 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.

20.2 Circle

If a circle tool has problems locating the circle correctly, try the following:

Adjust polarity and circle fit criteria
Adjust the settings for **Circle fit criteria** and **Polarity** to make the Inspector pick the right circle if there are multiple circles in the region.

Adjust search method

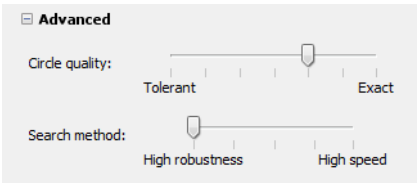


Figure 20.3 Advanced Circle settings

Switch to a more robust search method for locating the objects, by changing the **Search method** setting (under **Advanced** on the **Tools** tab). The **Search method** slider determines the trade-off between **High robustness** and **High speed**.

20.3 Edge

If an edge tool has problems locating the edge correctly, try adjusting the settings for **Criteria** and **Polarity** to make the Inspector pick the right edge if there are multiple edges in the region.

20.4 Edge counter

If an edge counter has problems locating the edges correctly, try the following:

Adjust polarity
Adjust the settings for **Polarity** to make the Inspector pick the right edges in the region.

Adjust search method
Switch to a more robust search method for locating the objects, by changing the **Search method** setting (under **Advanced** on the **Tools** tab). The **Search method** slider determines the trade-off between **High robustness** and **High speed**.

20.5 Blob

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

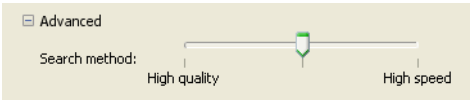


Figure 20.4 Advanced Blob tool settings

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.

20.5.1 Enable Ambient light compensation

The ambient light compensation can be used to handle variations in the surrounding (ambient) light. The compensation is done by comparing the brightness in an area in the captured image with the brightness in the corresponding area in the reference image, and then adjusting the blob tool's Intensity thresholds accordingly.

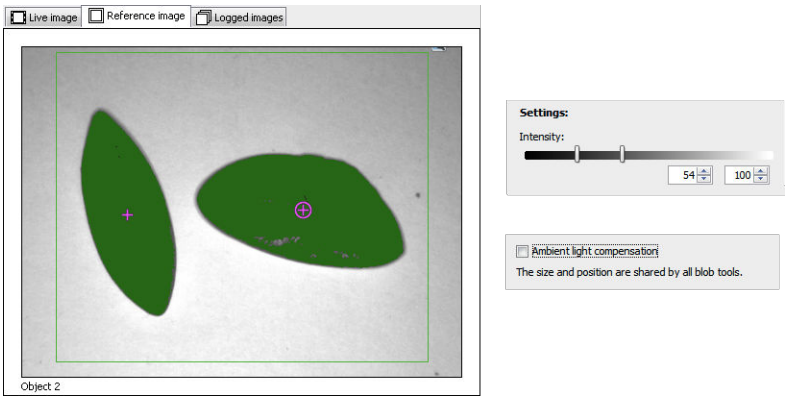


Figure 20.5 The Intensity thresholds are adjusted for locating the objects in the Reference image.

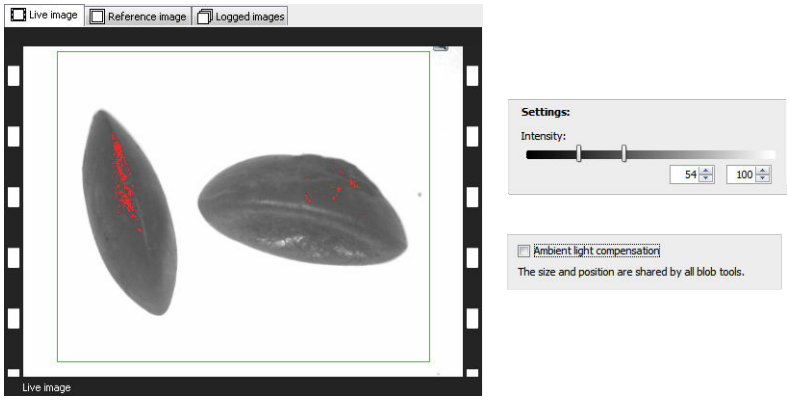


Figure 20.6 Without ambient light compensation, objects may not be detected if the ambient light changes a lot.

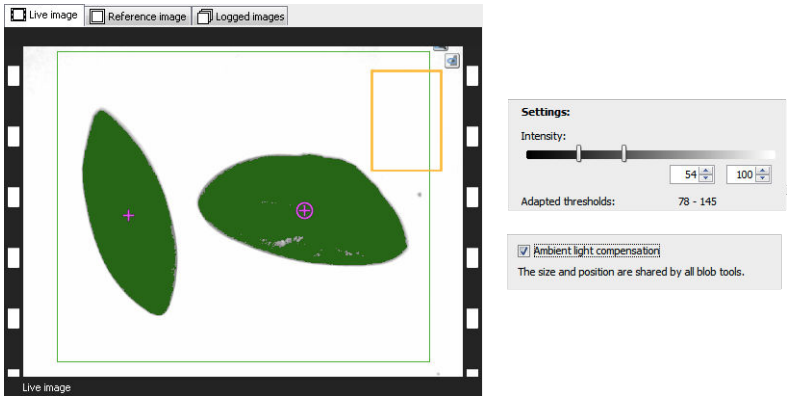


Figure 20.7 With ambient light compensation, the Intensity thresholds are adjusted so that the objects are properly detected.

When placing the area to be used for ambient light compensation, note the following:

- The area should be placed somewhere within the Inspector's field of view where there are no blobs during the inspection.
- Use masks to give the area a suitable shape.
- The compensation is improved if the area contains similar gray level as the blobs that should be detected.
- If the reference object has multiple blob tools, the same area is used for compensation of all blob tools.

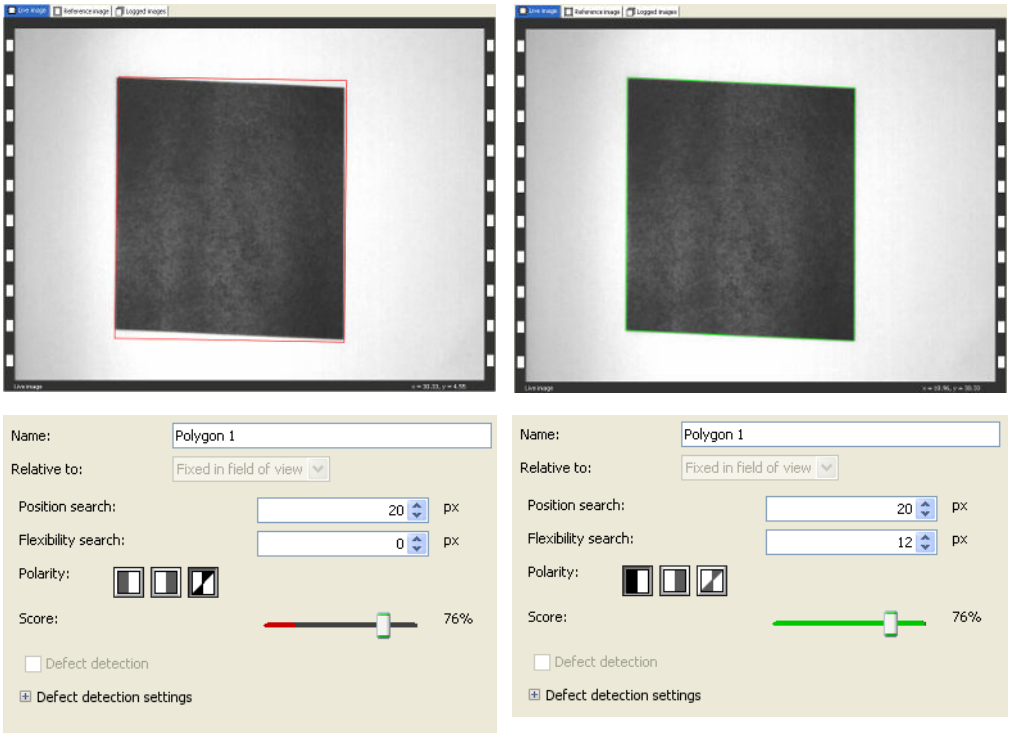
20.6 Polygon

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 PIM60 may find other edges than the wanted. However, 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 10.9, “*Polygon (not included in PIM60 Bead P/N 1076617, 1079321, 1079322)* ” (page 64).



Object not found, Flexibility search 0. *Object found, Flexibility search 12.*

Figure 20.8 Flexibility search

Note

High image quality is needed for the polygon tool to work. Edges with high intensity are preferred over edges close to the defined polygon.

Polarity

If possible, use a specific polarity. This significantly decreases 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 “Any polarity” mode needs to be chosen. Try to avoid these situations by improving the lighting setup, for example using a backlight.

20.7 Pattern, Pixel counter, Edge pixel counter

If the Inspector has problems correctly inspecting details on objects, 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 make note of the results 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 **Change region** buttons on the **Tools** 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** or **No. of edge pixels** on the **Tools** tab.

Stable intensity is needed for robust pixel countings

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.

20.8 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 an orientation which most closely matches the orientation of the objects to be inspected.

21 Improve speed

There are a number of ways to improve the inspection speed if it is not fast enough. Parameter settings that can be used to improve speed are listed below. 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 deselect rotation.
- Reduce search region by deselecting **Allow objects anywhere in image**.
- Deselect **Allow scaled objects**.
- Adjust **Search method** to **high speed** under Advanced settings.

Circle
- Avoid selecting **Circle with search region** under Advanced settings.
- If search region is enabled, increase minimum diameter.
- Adjust **Search method** to **high speed** under Advanced settings.
- Reduce the distance between the diameters in **Min / max diameter**.

Edge
- Reduce the size of the tool's region.

Edge counter
- Adjust **Search method** to **high speed** under Advanced settings.
- Reduce the size of the tool's region.

Blob
- Reduce the size of the search region.
- Adjust **Search method** to **high speed** under Advanced settings.

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

Polygon
- Decrease **Position search**.
- Decrease **Flexibility search**.

Pixel counter, Edge pixel counter, Distance, Angle
- 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**.

22 Log and store images

22.1 Use image log

The Inspector PIM60 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 Engineering Tool (ET)** while the Inspector PIM60 is storing images to FTP.

Log settings

To change which images the Inspector PIM60 should log, choose **Log settings** from the **InspectorPIM60** 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 PIM60 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 PIM60.

22.2 Store images on a FTP server

The Inspector PIM60 can store logged images on a FTP server, which enables the user to review the images.

Setting up

To make the Inspector PIM60 store logged images to an FTP server, do the following:

1. Choose **Store Images to FTP** from the **Inspector PIM60** menu.

2. 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.
3. 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 path to the folder in which the images should be stored. This folder will be created on the FTP server if it does not already exist.
4. Click **Test connection** to test the connection to the FTP server. The Inspector will try to log in to the FTP server.

Note

The **Test connection** function only tests the connection to the FTP server, it does not test the possibility to read/write files and folders.

Note

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

Warn for unsent images

When the Inspector PIM60 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 PIM60 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 PIM60 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:

1. 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.
2. Use **SOPAS Engineering Tool (ET)** 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

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 tolerance in the pass/fail criteria to allow for minor differences.

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 Engineering Tool (ET)**.

22.3 Record live images to PC

To record images captured by the Inspector as files on the PC, choose **Record Live Images** from the **InspectorPIM60** 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.

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 PIM60 captures.

23 Use the simulated device

SOPAS Engineering Tool (ET) has a 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 tolerance in the pass/fail criteria to allow for minor differences.

23.1 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 Engineering Tool (ET)**

23.1.1 When connected to an Inspector

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

23.1.2 From SOPAS Engineering Tool (ET)

See the **SOPAS ET Manual** (available from the **Help** menu in **SOPAS Engineering Tool (ET)** main window) for instructions.

23.2 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.

23.3 Select images to be used

To use saved images with the simulated device, the images must be in bitmap (.BMP) file format (8 bit gray scale). In order to retrieve images to PC, see Chapter 22, "*Log and store images*" (page 115). 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.

23.4 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 simulated device was started via the **Emulator** tab, then you can copy device data by:

1. In the simulated device, select **Save Device File** from the **Project** menu.
2. Connect to an Inspector, see Chapter 6 *"Connect"*.
3. Load device data to device, see Section 24.4, “*Copying device data from one Inspector to another*” (page 121).

24 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
- Calibration and alignment configuration (device-unique)

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.

24.1 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 **InspectorPIM60** 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 are changed in **SOPAS Engineering Tool (ET)** **Edit** mode, the user will be prompted to save to flash memory when switching to **Run** mode.

Please note that it may take several minutes to save the settings in flash memory. The more configured reference objects, 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.

24.2 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 (`.sdv`) on the PC, and the file can be opened in **SOPAS Engineering Tool (ET)**. The file will contain all device data including the reference images and a reference to the Inspector used.

The device data saved with **SOPAS Engineering Tool (ET)** can not directly be imported by an Inspector through the Web API interface. To use a configuration created in **SOPAS** through the web interface, you must instead export the configuration as an `.spb` file. Export the configuration by clicking **Edit→Export SOPAS Parameter backup**. See the reference manual for Inspector PIM60 for more information.

24.3 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, set up a connection with an Inspector and download the saved device data (see Section 24.4, "*Copying device data from one Inspector to another*" (page 121)).

24.4 Copying device data from one Inspector to another

Warning

It is not possible to run a configuration made using Inspector PIM60 V 1.0 firmware on an Inspector PIM60 with V 2.0 firmware (or vice versa). The present configuration needs to be redone. See Section 6.3, "*Upgrade or downgrade the firmware*" (page 31) for more information.

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

1. Connect to the source Inspector.
2. Save the device file, choosing **Save Device File as** from the **File** menu.
3. Connect to the destination Inspector.
4. Download the device data to the destination Inspector with the **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**.

24.5 Export and import device data through web server or Web API

It is possible to export the device data through the Web interface as well as the Web Server. For more information on how to do this through the Web see commands section in the Reference manual for Inspector PIM60.

The device data exported through the web interface can be imported again by an Inspector through the web, or imported in **SOPAS Engineering Tool (ET)**.

24.6 Restore settings to factory default

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

1. Select **Restore Settings** from the **InspectorPIM60** menu and click on **Factory defaults**. 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.

Appendix

A Technical data

A.1 Dimensional drawings

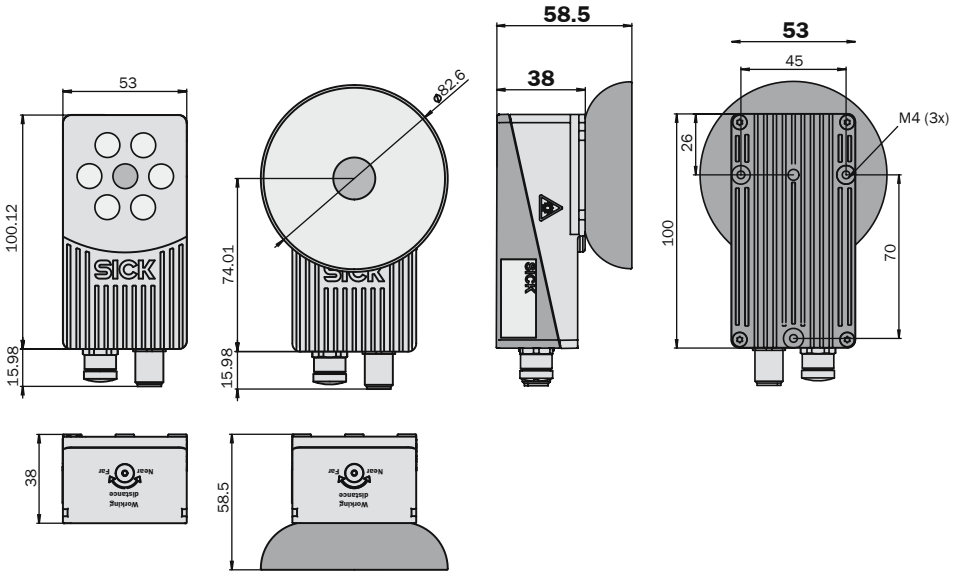


Figure A.1 Inspector PIM60

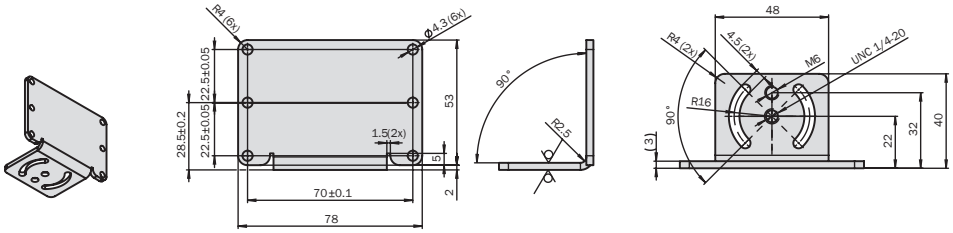


Figure A.2 Inspector angle bracket

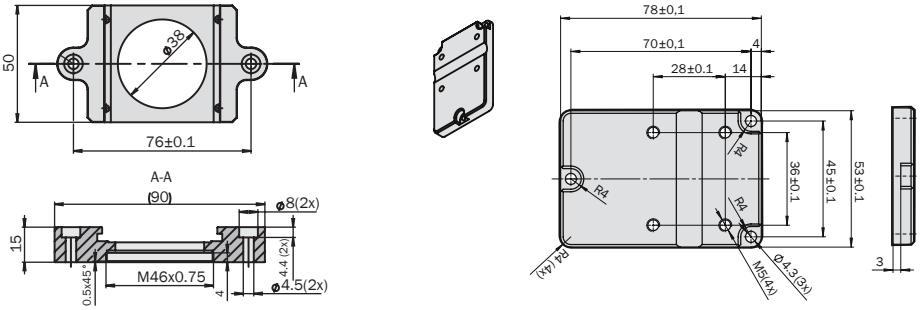
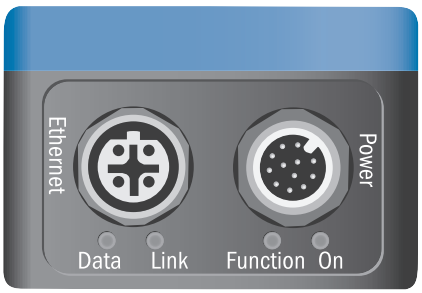


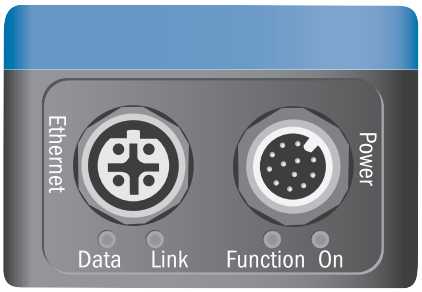
Figure A.3 Inspector light/filter adapter and Inspector universal adapter

A.2 Inspector connectors

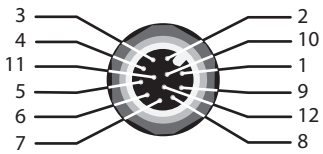


Inspector PIM60
Ethernet - 10/100 Mbit/s

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 PIM60
Ethernet - 10/100 Mbit/s



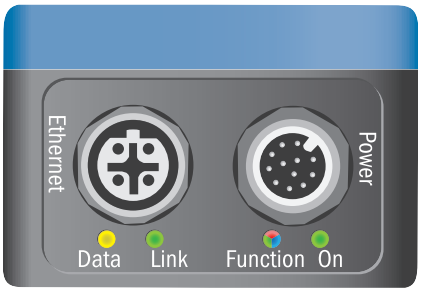
Inspector connector pinning – Power In/Out, 12 pin, M12 connector			
Pin	**Color**[a]	**Signal**	**Signal description**
1	Brown	Power	24 V power supply
2	Blue	GND	Ground 0 V
3	White	In3	Image trigger + External object selection (24 V)
4	Green	Out1	Output 1 – Object not located (B-type)[b]
5	Pink	In2	External teach + External object selection (24 V)
6	Yellow	Out2	Output 2 – Inspection failed (B-type)[b]

Inspector connector pinning – Power In/Out, 12 pin, M12 connector			
Pin	**Color**[a]	**Signal**	**Signal description**
7	Black	Out3	Output 3 – All pass (B-type)[b]
8	Gray	In1	External object selection (24 V)
9	Red	Ext trigger	External trigger, external illumination, (5 C TTL)
10	Violet	In4	Encoder + External object selection (24 V)
11	Gray/pink		Reserved
12	Red/blue		Reserved

[a]Colors are valid for cable type DOL-1212.
[b]Push-pull output.

A.3 LED description

Inspector PIM60



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
	Anytime	Red, slow flashing	Fatal error
On	All	Green	Power On

A.4 Technical specification

	VSPM-6F2113 PIM60	VSPM-6B2113 PIM60 Base	VSPM-6F2313 PIM60-LUT	VSPM-6F2413 PIM60-IR	VSPM-6B2413 PIM60-IR Base
Working distance	50 ... ∞ mm				
- Internal illumination	50 ... 200 mm				
Field of view, internal illumination	22 x 15 ... 79 x 58 mm[2]				
Optics	Exchangeable				
Factory mounted lens	10 mm	No lens	10 mm	10 mm	No lens
Max performance	200 fps				
Typical performance	40 fps				
Repeatability, position [a]					
- Object locator	± 0.2 pixels				
- Blob	± 0.1 pixels				
- Edge	± 0.05 pixels [b]				
- Find maximum	± 0.5 pixels				
- Circle	± 0.05 pixels [b]				
Repeatability, angle[a]					
- Object locator	± 0.05°				
- Blob	± 0.02°				
- Angle	± 0.02°				
Toolset	Object locator Blob, Pixel counter, Edge pixel counter, Polygon, Pattern Circle, Edge, Find maximum, Edge counter, Distance, Angle				
Calibration	Perspective and lens distortion, mm results Result alignment to external coordinate system				
Number of tools	64 tools, of which max 8 Polygon, max 8 Blob, and max 4 Edge counter				
Reference images	32 objects				
Offline support	Simulated device				
Production control					
- Operator interface	SOPAS Web Server, import of customized pages				
- Data store and retrieve	30 images device log Record images on PC Store images to FTP				
- Ethernet communication	EtherNet/IP Ethernet Raw configurable Web API				
- I/O Extension box	5 inputs for object selection				

	VSPM-6F2113 PIM60	VSPM-6B2113 PIM60 Base	VSPM-6F2313 PIM60-LUT	VSPM-6F2413 PIM60-IR	VSPM-6B2413 PIM60-IR Base
	16 outputs				
Resolution	640x480 pixels				
Light source	White ring light		UV ring light, 385 nm	IR ring light, 850 nm	
- LED class (IEC62471:2006)	Risk group 1 (low risk)		Risk group 1 (low risk)	Risk group 0 (low risk)	
Spectral response	Approx. 400 nm ... 750 nm		Approx. 400 nm ... 750 nm	Approx. 370 nm ... 900 nm	
Supply voltage	24 VDC ±20%				
- Ripple	< 5 Vpp				
- Current consumption	< 450 mA, without load				
Digital outputs	3 outputs 24 V (B-type)[c]				
- Output current	100 mA				
- Default outputs	Not located, detail failed, all passed				
- Configurable outputs	Output by logical expressions Store images to FTP overflow				
Control of external light	5 V TTL				
Digital inputs	4 inputs 24 V				
- Configurable inputs	External trigger, encoder, external teach, reference object selection				
- Max encoder frequency	40 kHz				
Interface	100 Mb Ethernet				
Ambient temperature[d]	Operation: 0 °C ... 45 °C Storage: -20 °C ... 70 °C				
Housing material	Aluminum				
- Window material	PMMA (plastic)	No window	Glass	PMMA (plastic)	No window
Weight	350 g				
Enclosure rating	IP 67	IP 20[e]	IP 67	IP 67	IP 20[e]
Mechanical shock load	EN 60068-2-27				
Vibration load	EN 60068-2-6				
Device specific accessories[f]					
- Lenses, focal length	Focal length: 6 mm, 8 mm, 10 mm, 16 mm				
- Transparent front windows	PMMA (plastic), Glass				
- Front filters[g]	Red (> 588 nm) Green (544 ± 53 nm) Blue (468 ± 62 nm)		–	Red (> 588 nm) Visible block filter	

	VSPM-6F2113 PIM60	VSPM-6B2113 PIM60 Base	VSPM-6F2313 PIM60-LUT	VSPM-6F2413 PIM60-IR	VSPM-6B2413 PIM60-IR Base
- Dome	Optimal for 50 mm working distance		–	Optimal for 50 mm working distance	
- I/O extension box	4 inputs, 8 outputs				
- I/O module	2 extra digital inputs 8 extra digital outputs				

[a]Static object
[b]Also valid for distances between the positions.
[c]Push-pull output.
[d]Rel. Humidity: 35 ... 85%, 95% at storage.
[e]IP 67 is secured after correct assembly of lens and front window.
[f]Full accessory list at www.sick.com.
[g]> 60% transmission.

Most of the specifications in the table above are valid also for the PIM60 Bead variants, but there are some differences. They are listed in the table below.

	VSPM-6F2113S19 PIM60 Bead	VSPM-6F2313S20 PIM60-LUT Bead	VSPM-6F2413S18 PIM60-IR Bead
Light source	White ring light	UV ring light, 385 nm	IR ring light, 850 nm
Toolset	Object locator Blob, Pixel counter, Edge pixel counter, Bead, Pattern Circle, Edge, Find maximum, Edge counter, Distance, Angle		
Number of tools	32 tools, of which max 8 Bead, max 8 Blob, and max 4 Edge counter		
Production control			
- Data store and retrieve	20 images device log Record images on PC Store images to FTP		

EtherNet/IP™ conformance tested CE cULus LISTED

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

Type	Order no.
Inspector Flex Color filter, red	2050675
Inspector Flex Color filter, green	2050677
Inspector Flex Color filter, blue	2050676
Inspector Flex Visible block filter (PMMA)	2061248
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
Distance ring package (package of 3 pcs of 1,5 mm rings)	2066933

For a complete list of accessories for the Inspector, including cabling and external lightings, please visit www.sick.com.

A.6 What's included – Inspector PIM60

The boxed version of the Inspector PIM60 includes:

- Inspector PIM60
- Printed Quickstart
- 2 mm hex key
- Tool for exchange of lens
- Two focused stickers

Languages: English, French, Italian, German, Spanish, and Chinese (simplified).[1]

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 4 3.0GHz
- Windows XP: 512 MB of RAM (Recommended 1024 MB)
  Windows Vista: 1 GB of RAM
  Windows 7: 1 GB RAM (32-bit) or 2 GB RAM (64-bit)
- 1024 x 768 or higher screen resolution, minimum 256 colors (recommended 65536 colors)
- 570 MB free hard disk space
- Ethernet: 100MBit/s recommended

[1] The reference manual is only available in English.

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 Engineering Tool (ET)**, **Project→Export Device**
- Save a system dump file that can be sent to support (SOPAS GUI: **InspectorPIM60→Device Info→Save system dump**)
- If possible, please also provide PASS/FAIL images (**InspectorPIM60→Record Live Images**, or logged images with/without graphics)

B.1.2 Web support

Technical support is available on-line at;

`www.sick.com` **→Service&Support→Support→Support for Vision**

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
`visionhelp@sick.com`	`bildverarbeitung@sick.de`

B.2 Further information

More product and order information is also available on: `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 for the following: • For blobs, the rotation angle of each located blob is calculated, and is available in the Results tab and as Ethernet output. • For angle measurements, the angle between two located edges 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 **SOPAS Engineering Tool (ET)** 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 gray 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 .sdv.
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 contrast	The minimum difference in intensity (gray scale values) between neighboring bright and dark areas that is required for the circle tool and edge tool to consider it an edge (contour).

Edge strength	The minimum difference in intensity (gray scale values) between neighboring bright and dark areas that is required for the object locator to consider it an edge (contour). The minimum difference in intensity (gray scale values) between neighboring bright and dark pixels that is required for the edge pixel counter, and the structure measurement in the blob tool, to consider it an edge pixel.
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 gray 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.
Gray 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 gray level.
Image log	See Logged image.
Image settings	The parameters that control: • The quality of the captured images (exposure, brightness, use of lighting). • When to capture images (free-running or triggered).
Image size	The size of the image captured by the Inspector, measured in pixels (width x height).
Intensity	See gray 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	The reference image is the pre-taught image of the reference object.
Reference object	An object that the Inspector has learned to locate. It includes the reference image, tools and result settings.
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 and the pattern tool is the center of the 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 object 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, the blobs, or the circle. For the object locator the default region is the whole field of view. For the blob tool and circle 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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