

# Intelligent Inspection

SensorApps

**SICK**  
Sensor Intelligence.



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**Described product**

Intelligent Inspection (version 1.6)

**Manufacturer**

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**Original document**

This document is an original document of SICK AG.

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# 1 About this document

## 1.1 Information on the operating instructions

These operating instructions provide important information on how to use products from SICK AG. Prerequisites for safe work are:

- Compliance with all safety notes and handling instructions supplied.
- Compliance with local work safety regulations and general safety regulations for product applications .

The operating instructions are intended to be used by qualified personnel.



### NOTE

Read these operating instructions carefully before starting any work, in order to familiarize yourself with the product and its function.

The instructions constitute an integral part of the product and must be accessible to staff at all times.

These operating instructions do not provide information on operating the machine or system in which the product is integrated. For information about this, refer to the operating instructions of the specific machine.

## 1.2 Explanation of symbols

Warnings and important information in this document are labeled with symbols. The warnings are introduced by signal words that indicate the extent of the danger. These warnings must be observed at all times and care must be taken to avoid accidents, personal injury, and material damage.



### DANGER

... indicates a situation of imminent danger, which will lead to a fatality or serious injuries if not prevented.



### WARNING

... indicates a potentially dangerous situation, which may lead to a fatality or serious injuries if not prevented.



### CAUTION

... indicates a potentially dangerous situation, which may lead to minor/slight injuries if not prevented.



### NOTICE

... indicates a potentially harmful situation, which may lead to material damage if not prevented.



### NOTE

... highlights useful tips and recommendations as well as information for efficient and trouble-free operation.

## 1.3 Further information

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### NOTE

Further documentation for the device can be found on the online product page at:

- [www.sick.com/InspectorP61x](http://www.sick.com/InspectorP61x)
- [www.sick.com/InspectorP62x](http://www.sick.com/InspectorP62x)
- [www.sick.com/InspectorP63x](http://www.sick.com/InspectorP63x)
- [www.sick.com/InspectorP64x](http://www.sick.com/InspectorP64x)
- [www.sick.com/InspectorP65x](http://www.sick.com/InspectorP65x)

There, additional information has been provided depending on the product, such as:

- Model-specific online data sheets for device types, containing technical data, dimensional drawing, and specification diagrams
  - EU declaration of conformity and certificates for the product family
  - Dimensional drawings and 3D CAD dimension models of the device types in various electronic formats
  - Other publications related to the devices described here
  - Publications dealing with accessories
- 



### NOTE

Important information about the integratable VI55I illumination unit can be found in the “VI55I ring illumination unit” technical information (part number: 8018486, [www.sick.com/8018486](http://www.sick.com/8018486)).

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### NOTE

Important information about the integratable VI83I illumination unit can be found in the “VI83I ring illumination unit” technical information (part number: 8017270, [www.sick.com/8017270](http://www.sick.com/8017270)).

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## 2 Safety information

### 2.1 Intended use

Intelligent Inspection is a SensorApp for the InspectorP6xx family of 2D cameras. The Intelligent Inspection SensorApp is available on request.

Intelligent Inspection uses Deep Learning-based and vision-based quality inspection by applying embedded image analysis tools to images acquired by the InspectorP6xx camera. The results are sent to a control system via external interfaces.

### 2.2 Improper use

Any use outside of the stated areas, in particular use outside of the technical specifications and the requirements for intended use, will be deemed to be incorrect use.

- The device does not constitute a safety component in accordance with the respective applicable safety standards for machines.
- The device must not be used in explosion-hazardous areas, in corrosive environments or under extreme environmental conditions.
- The device must not be operated in the temperature range below 0 °C.
- Any use of accessories not specifically approved by SICK AG is at your own risk.



#### WARNING

##### Danger due to improper use!

Any improper use can result in dangerous situations.

Therefore, observe the following information:

- Product should be used only in accordance with its intended use.
- All information in these operating instructions must be strictly observed.
- Shut down the product immediately in case of damage.

### 2.3 Internet protocol (IP) technology



#### NOTE

SICK uses standard IP technology in its products. The emphasis is placed on availability of products and services.

SICK always assumes the following prerequisites:

- The customer ensures the integrity and confidentiality of the data and rights affected by its own use of the aforementioned products.
- In all cases, the customer implements the appropriate security measures, such as network separation, firewalls, virus protection, and patch management.

### 2.4 Limitation of liability

Relevant standards and regulations, the latest technological developments, and our many years of knowledge and experience have all been taken into account when compiling the data and information contained in these operating instructions. The manufacturer accepts no liability for damage caused by:

- Non-adherence to the product documentation (e.g., operating instructions)
- Incorrect use
- Use of untrained staff
- Unauthorized conversions or repair

- Technical modifications
- Use of unauthorized spare parts, consumables, and accessories

With special variants, where optional extras have been ordered, or owing to the latest technical changes, the actual scope of delivery may vary from the features and illustrations shown here.

### 2.5 Modifications and conversions

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#### NOTICE

Modifications and conversions to the device may result in unforeseeable dangers.

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Interrupting or modifying the device or SICK software will invalidate any warranty claims against SICK AG. This applies in particular to opening the housing, even as part of mounting and electrical installation.

### 2.6 Cybersecurity

To protect against cybersecurity threats, it is necessary to continuously monitor and maintain a comprehensive and holistic cybersecurity concept. A suitable concept comprises organizational, technical, procedural, electronic, and physical levels of defense and provides suitable measures for different types of risks. SICK's products and solutions must be viewed as a component of this concept.

Information on Cybersecurity can be found at: [www.sick.com/psirt](http://www.sick.com/psirt).

### 2.7 Requirements for skilled persons and operating personnel

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#### WARNING

**Risk of injury due to insufficient training.**

Improper handling of the device may result in considerable personal injury and material damage.

- All work must only ever be carried out by the stipulated persons.
- 

This product documentation refers to the following qualification requirements for the various activities associated with the device:

- **Instructed personnel** have been briefed by the operator about the tasks assigned to them and about potential dangers arising from improper action.
- **Skilled personnel** have the specialist training, skills, and experience, as well as knowledge of the relevant regulations, to be able to perform tasks delegated to them and to detect and avoid any potential dangers independently.
- **Electricians** have the specialist training, skills, and experience, as well as knowledge of the relevant standards and provisions, to be able to carry out work on electrical systems and to detect and avoid any potential dangers independently. The electrician must comply with the provisions of the locally applicable work safety regulation.

The following qualifications are required for various activities:

Table 1: Activities and technical requirements

Activities	Qualification
Mounting, maintenance	<ul style="list-style-type: none"><li>■ Basic practical technical training</li><li>■ Knowledge of the current safety regulations in the workplace</li></ul>



Activities	Qualification
Electrical installation, device replacement	<ul style="list-style-type: none"> <li>■ Practical electrical training</li> <li>■ Knowledge of current electrical safety regulations</li> <li>■ Knowledge of the operation and control of the devices in their particular application</li> </ul>
Commissioning, configuration	<ul style="list-style-type: none"> <li>■ Basic knowledge of the computer operating system used</li> <li>■ Basic knowledge of the design and setup of the described connections and interfaces</li> <li>■ Basic knowledge of data transmission</li> <li>■ Knowledge of the programming of image-processing systems and network components</li> </ul>
Operation of the device for the particular application	<ul style="list-style-type: none"> <li>■ Knowledge of the operation and control of the devices in their particular application</li> <li>■ Knowledge of the software and hardware environment for the particular application</li> </ul>

## 2.8 Operational safety and particular hazards

Please observe the safety notes and the warnings listed here and in other chapters of this product documentation to reduce the possibility of risks to health and avoid dangerous situations.

The product is fitted with LEDs in risk group 0. The accessible radiation from these LEDs does not pose a danger to the eyes or skin.

The product is fitted with LEDs in risk group 1 for object illumination.

The product is fitted with LEDs of risk group 0 or 1 for object illumination, depending on type.

### LED radiation of the integratable illumination unit



#### NOTICE

Only the VI55I illumination units from SICK intended for integration in this application can be used as integratable illumination units.



#### NOTICE

Only the VI83I illumination units from SICK intended for integration in this application can be used as integratable illumination units.

#### Risk group 1

- Color of the illumination: visible blue light (aperture angle: wide, medium), visible red light or visible white light
- Color of the feedback LED: visible red light and visible green light
- Color of the feedback LED: visible green light



#### CAUTION

#### Optical radiation: LED risk group 1, visible radiation, 400 nm to 780 nm

The LEDs may pose a danger to the eyes in the event of incorrect use.

- Do not look into the light source intentionally.
- Do not open the housing. Opening the housing will not switch off the light source. Opening the housing may increase the level of risk.
- Comply with the current national regulations on photobiological security of lamps and lamp systems.

### Risk group 2

- Color of the illumination: visible blue light (aperture angle: narrow)
- 



### CAUTION

#### **Warning! Optical radiation: LED risk group 2, visible radiation, 400 nm to 780 nm**

Potentially dangerous optical radiation. Can be damaging to the eyes.

- Do not look into the light source for extended periods of time.
  - Never point the light source at people.
  - Avoid any reflections on people from reflective surfaces. Be particularly careful during mounting and alignment work.
  - Do not open the housing. Opening the housing will not switch off the light source. Opening the housing may increase the level of risk.
  - Comply with the current national regulations on photobiological security of lamps and lamp systems.
- 

If the product is operated in conjunction with external illumination systems, the risks described here may be exceeded. This must be taken into consideration by users on a case-by-case basis.

### **Time-of-flight sensor (invisible infrared light, distance measurement in configuration mode)**

#### **Laser alignment aid**

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### CAUTION

#### **Optical radiation: Laser class 1**

The accessible radiation does not pose a danger when viewed directly for up to 100 seconds. It may pose a danger to the eyes and skin in the event of incorrect use.

- Do not open the housing. Opening the housing may increase the level of risk.
  - Current national regulations regarding laser protection must be observed.
- 

Caution – Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

#### **For both radiation types:**

It is not possible to entirely rule out temporary disorienting optical effects, particularly in conditions of dim lighting. Disorienting optical effects may come in the form of dazzle, flash blindness, afterimages, photosensitive epilepsy, or impairment of color vision, for example.

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### CAUTION

#### **Risk of injury due to hot device surface.**

The surface of the device can become hot during operation.

- Before performing work on the device (e.g. mounting, cleaning, disassembly), switch off the device and allow it to cool down.
  - Ensure good dissipation of excess heat from the device to the surroundings.
-

**WARNING****Electrical voltage!**

Electrical voltage can cause severe injury or death.

- Work on electrical systems must only be performed by qualified electricians.
  - The power supply must be disconnected when attaching and detaching electrical connections.
  - The product must only be connected to a voltage supply as set out in the requirements in the operating instructions.
  - National and regional regulations must be complied with.
  - Safety requirements relating to work on electrical systems must be complied with.
- 

**WARNING****Risk of injury and damage caused by potential equalization currents!**

Improper grounding can lead to dangerous equipotential bonding currents, which may in turn lead to dangerous voltages on metallic surfaces, such as the housing. Electrical voltage can cause severe injury or death.

- Work on electrical systems must only be performed by qualified electricians.
  - Follow the notes in the operating instructions.
  - Install the grounding for the product and the system in accordance with national and regional regulations.
-

### 3 Product description

#### 3.1 Overview

The Intelligent Inspection SensorApp from SICK ensures easy object classification that is not possible with traditional rule-based machine vision. The SensorApp is powered by deep learning technology and available as a licensed option when ordering InspectorP6xx 2D vision sensors from SICK.

In addition to Deep Learning-based image classification, Intelligent Inspection uses traditional rule-based and vision-based quality inspection to ensure that produced items have the exact qualities required regarding presence and measurements of details.

Intelligent Inspection is configured through a web-based graphical user interface, which contains a selection of software tools for image analysis, result output, and communication. The tools are listed and described in "[Tool box - System](#)", [page 28](#) and "[Tool box - Jobs](#)", [page 34](#).

Intelligent Inspection is based on SICK Nova, which allows the user to create and import additional tools. For a description of how to import a tool through SICK AppManager, see "[Installing tools](#)", [page 18](#). Information on SICK Nova tool development is available from the SICK Support Portal, [supportportal.sick.com](https://supportportal.sick.com).

Intelligent Inspection is a SensorApp and software package for Deep Learning. To activate the Deep Learning functionality on your InspectorP6xx 2D vision sensor, you must purchase the Deep Learning classification license.

#### 3.2 System requirements

##### Hardware

**The following devices support the use of Intelligent Inspection.** A trial period of two hours per reboot is enabled when a trial Deep Learning neural network (trained in dStudio) is uploaded to the device.

- InspectorP611
- InspectorP621
- InspectorP631
- InspectorP632
- InspectorP642
- InspectorP652
- InspectorP654
- SICK AppStudio Emulator (full featured)
- SICK AppEngine (as emulator)

##### Software

- The SICK AppManager software ([www.sick.com/SICK\\_AppManager](https://www.sick.com/SICK_AppManager)) is required for installing or updating the SensorApp on a device.
- InspectorP6xx firmware v 3.5.2 (or later) or SICK AppEngine v 1.1.1 is required to run the SensorApp. Download the firmware from the SICK Support Portal, [supportportal.sick.com](https://supportportal.sick.com).
- The dStudio software (<https://dstudio.cloud.sick.com/>) is required for acquiring a trained neural network to be used for the Deep Learning-based image classification.

##### Supported web browsers

- Google Chrome

### 3.3 Solving a Deep Learning application

Deep Learning is a subset of Artificial Intelligence (AI):

- AI is defined as any technique that enables computers to mimic human decision making and problem-solving.
- Deep Learning enables computers to mimic human decision making and problem-solving by finding patterns in data using neural networks.

Deep Learning-based machine vision is well suited for objects with unpredictable characteristics, such as naturally grown objects, deformable objects, and objects with complex and unpredictable defects.

Solving a Deep Learning application involves three important phases:

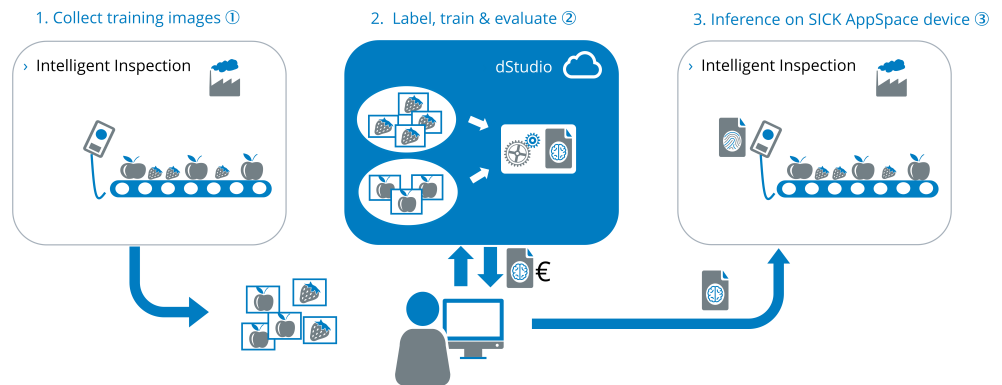


Figure 1: Solving a Deep Learning application

- ① Collect training images (Data collection phase)
- ② Label, train and evaluate (Learning phase)
- ③ Inference on SICK AppSpace device (Inference phase)

#### Data collection phase

The data collection phase includes the following steps:

- Mounting and integration of the device in production.
- Collecting training images. These should be collected under realistic production conditions.
- Storing the images.
- 

The **Image Collection** tool in the Intelligent Inspection SensorApp can be used for collecting and storing training images to an FTP server or SD card. See "[Image Collection](#)", [page 53](#) for more information.

#### Learning phase

The learning phase includes the following steps:

- Labeling the images that represent the planned classes.<sup>1)</sup>
- Defining a dataset and the required classes.
- Uploading the presorted images to the respective classes.
- Creating a project by selecting a neural network type that gets trained with the dataset.
- Initiating or stopping a training session, and monitoring the progress of an active training session.
- Evaluating the results (online: during and after the training, on your device: with the trial model)
- Acquiring a model (trained neural network) for usage on your SICK device.

1) Currently not implemented in dStudio software

The cloud solution dStudio (<https://dstudio.cloud.sick.com/>) guides the user through the learning phase and provides training results that can be evaluated online.

### **Inference phase**

The inference phase includes the following steps:

- Uploading the model to the device.
- Classifying new images with the downloaded model directly on the device.

The **Deep Learning Classification** tool in the Intelligent Inspection SensorApp can be used for uploading the model to the device and classifying new images with the uploaded model. See "[Deep Learning Classification tool](#)", [page 37](#) for more information.

## 4 Operation

### 4.1 Installation

Intelligent Inspection is available via SICK AppPool (<http://apppool.cloud.sick.com/>).

- To run a pre-installed SensorApp, proceed to "User interface", page 19 for instructions on how to open the user interface.
- To install or update the SensorApp on a device, follow the instructions in "Installing or updating the SensorApp on a device", page 16.
- To start, stop or delete an installed SensorApp, use SICK AppManager (see "SICK AppManager", page 15).
- To install additional tools, see "Installing tools", page 18.

#### 4.1.1 SICK AppManager

A PC running the SICK AppManager software is required for the following actions:

- Installing and updating a SensorApp on a device.
- Starting, stopping, and deleting installed SensorApps.
- Reading and changing the device's IP address.
- Installing firmware updates.

Download SICK AppManager from [www.sick.com/SICK\\_AppManager](http://www.sick.com/SICK_AppManager).

#### 4.1.2 SICK AppEngine

SICK AppEngine is supported to run as an emulator and is downloaded via login on [www.sick.com/SICK\\_AppSpace](http://www.sick.com/SICK_AppSpace).

SICK AppEngine can be used for non-production environments, offline configuration, or testing purposes.

##### Install SICK AppEngine

1. Download the SICK AppEngine installer file.
2. Follow the steps in the installer dialog.
3. Open SICK AppEngine, which will automatically start running in demo mode.

A complete installation guide and download can be found via SICK Support Portal ([supportportal.sick.com](http://supportportal.sick.com)).

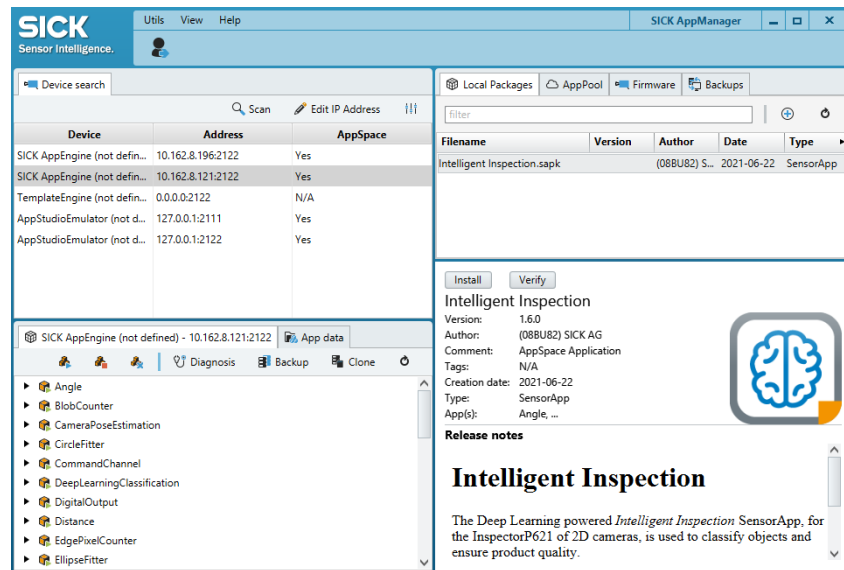


##### NOTE

SICK AppEngine will run for 120 minutes in a demo mode with full functionality and will shut down afterward automatically. The demo mode can be used without applying a license.

---

Start SICK AppManager and use the SICK AppEngine emulator to run Intelligent Inspection.



More information about SICK AppManager can be found via SICK Support Portal ([supportportal.sick.com](http://supportportal.sick.com)).

#### 4.1.3 Installing or updating the SensorApp on a device

The latest version of the Intelligent Inspection SensorApp file (.sapk) is available from SICK AppPool (<http://apppool.cloud.sick.com/>). The use of SICK AppPool requires a SICK ID, which can be obtained at the login page at the link above.

If the PC has Internet access when connected to the device, Intelligent Inspection can be downloaded and installed directly from SICK AppPool using SICK AppManager. If the PC does not have Internet access when connected to the device, the SensorApp must be downloaded to the PC prior to the installation. See [figure 2](#).



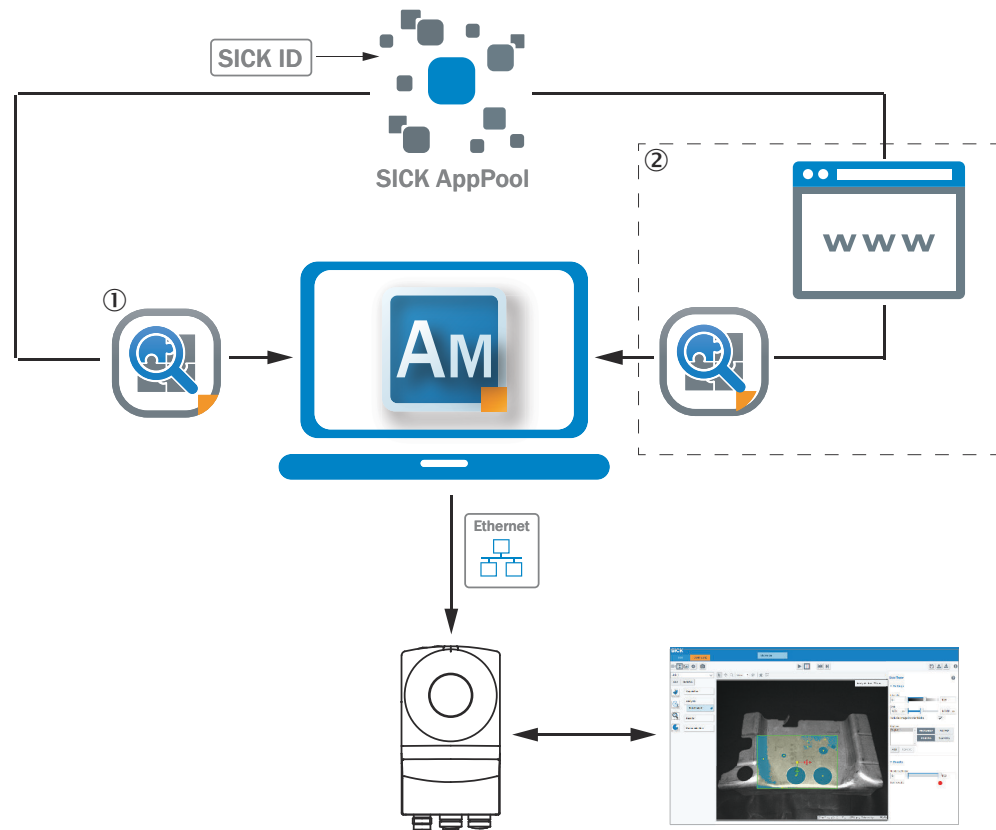


Figure 2: Online and offline solutions for installing a SensorApp via SICK AppManager

- ① Online solution: Download and install the SensorApp directly from SICK AppPool using SICK AppManager
- ② Offline solution: Download the SensorApp from [appool.sick.cloud.com](http://appool.sick.cloud.com) to the PC prior to the installation



#### NOTE

Before starting the installation, make sure that the network communication settings on the PC are correctly set up:

- The PC must be on the same network as the device.
- The PC must not use the same IP address as the device.



#### NOTE

When upgrading or downgrading Intelligent Inspection, the associated configuration file is deleted.

To re-use the existing configuration file, export it before the upgrade or downgrade and re-import it after.

#### To install the Intelligent Inspection SensorApp using SICK AppManager:

1. Connect the device to the PC via Ethernet.
2. On the PC, open SICK AppManager.
3. Under the **Device Search** tab in SICK AppManager, click **Scan** to search for available devices on the network.
4. In the list of available devices, select the device where you want to install the SensorApp.
5. If the device tab (lower left pane) contains any active applications, right-click the applications and delete them.
6. To download and install the SensorApp directly from SICK AppPool:

- a) Click **Login to SICK ID** (below the **Utils** menu in SICK AppManager) to log in to SICK AppPool.
- b) Click the **AppPool** tab.
- c) Select the correct SensorApp in the list of available SensorApps.
- d) Click **Download and install** to download the SensorApp to the PC and install it on the device.

Or:

To install a downloaded SensorApp (.sapk file) from the PC to the device:

- a) Click the **Local Packages** tab in SICK AppManager.
  - b) Drag and drop the SensorApp into the file list.
  - c) Click **Install** to install the SensorApp on the device.
- ✓ The SensorApp is now installed and running on the device.
7. To open the user interface, open a web browser window and type the IP address of the device.

**To downgrade the Intelligent Inspection SensorApp:**

- To re-use the existing configuration file, export it before the downgrade.
- Keep track of installed plug-ins as they will be deleted when downgrading.
- Delete active applications.
- Downgrade by installing the desired .sapk file and re-import the configuration file.

### 4.1.4 Installing tools

In addition to the tools that are included in the SensorApp by default, custom tools can be installed and integrated in the SensorApp. Tools are installed as .sapk files using SICK AppManager. Each file may contain one or more tools.



#### NOTE

The use of additional tools requires that both the SensorApp and the tool are present on the device.

---

Follow the steps below to install tools using SICK AppManager. The device must be connected to the PC via Ethernet.

1. In the SensorApp web user interface, click **Save Permanently** to avoid losing any data during the tool installation process.
2. On the PC, open SICK AppManager and click **Scan** to browse for available devices.
3. In the list of available devices, select the device where Intelligent Inspection is installed.
4. To download and install a tool directly from SICK AppPool:
  - a) Click **Login to SICK ID** (below the **Utils** menu in SICK AppManager) to log in to SICK AppPool.
  - b) Click the **AppPool** tab.
  - c) Select the correct tool in the list of available SensorApps.
  - d) Click **Download and install** to download the tool to the PC and install it on the device.

Or:

To install a downloaded tool (.sapk file) from the PC to the device:

- a) Click the **Local Packages** tab in SICK AppManager.
  - b) Drag and drop the tool into the file list.
  - c) Click **Install** to install the tool on the device.
- ✓ The tool is now installed and running on the device.
5. When the tool installation is complete, reload the web browser to view the installed tool in the user interface.

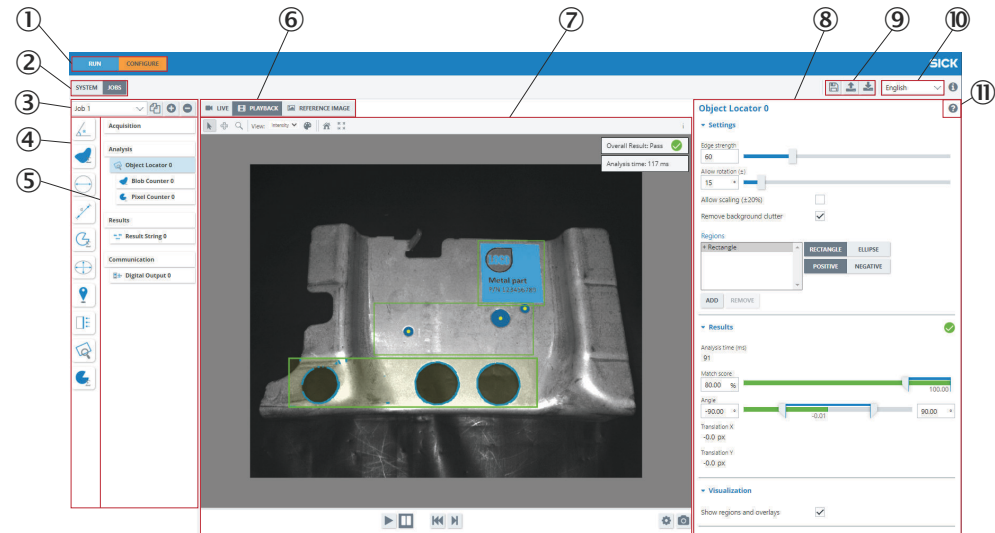
## 4.2 User interface

### Opening the user interface

To open the user interface from a web browser:

1. Open a web browser window.
2. Type the IP address of the device. The default IP address is 192.168.0.1.

### Overview of the user interface



- ① Mode selection (Run/Configure)
- ② System/Jobs switch
- ③ Job list
- ④ Tool box
- ⑤ Tool tree
- ⑥ Image source selection
- ⑦ Image viewer
- ⑧ Tool pane
- ⑨ Save, import, and export options
- ⑩ Language selection
- ⑪ Tool help

## 4.3 Run mode

**Run** is the default mode for the SensorApp. Use **Run** mode for inspection of objects in a real environment, based on the configuration created in **Configure** mode.

In **Run** mode, images are acquired continuously or by an external trigger. All acquired images are analyzed. To decrease the processing time, only some of the acquired images are displayed in the viewer in the user interface.



### NOTE

When the system is in **Run** mode:

- The communication interfaces are active and communicate with the connected external devices.
  - No changes to the tool tree or tool settings are possible.
  - To switch jobs, click the job list in the job handling section in the user interface or use a **Job Selection I/O** tool or **Command Channel** tool via **TCP/IP** or **Fieldbus** to switch jobs via digital inputs (see "[Interfaces tools](#)", page 28).
- 

## 4.4 Configure mode

Use **Configure** mode to set up a configuration for the application of interest.

---



### NOTICE

Click **Save Permanently** in the configuration toolbar to save a configuration to the device's flash memory. If a configuration is not saved before disconnecting the power to the device, all settings are lost.

---



### NOTE

All communication interfaces are inactive in **Configure** mode.

---

Follow the steps below to set up a configuration:

1. Add tools to the **System** tool tree and edit the tool settings, see "[Tool categories - System](#)", page 21.
2. Select an image source for the configuration, see "[Image source](#)", page 22.
3. Select a job, see "[Creating and switching jobs](#)", page 23.
4. Add tools to the job tool tree and adjust the tool settings, see "[Tool categories - Jobs](#)", page 24.
5. Edit the image acquisition settings for the job, see "[Editing the image acquisition settings](#)", page 25.
6. If multiple jobs are required for an application, repeat step 3, 4 and 5 for each job.
7. Save the resulting configuration to the device and export the configuration for back-up, see "[Saving, importing and exporting a configuration](#)", page 27.

### 4.4.1 Tool tree

The Intelligent Inspection SensorApp concept is based on a tool tree structure, which contains defined categories and associated tools. A configuration contains one tool tree for the system level (see "[System settings](#)", page 21) and one additional tool tree for each created job (see "[Job settings](#)", page 22).

The user adapts each tool tree to the application of interest by adding tool instances to the different categories. The available tools for each category are described in detail in "[Tool box - System](#)", page 28 and "[Tool box - Jobs](#)", page 34.

An example of a job tool tree is displayed in [figure 3](#).

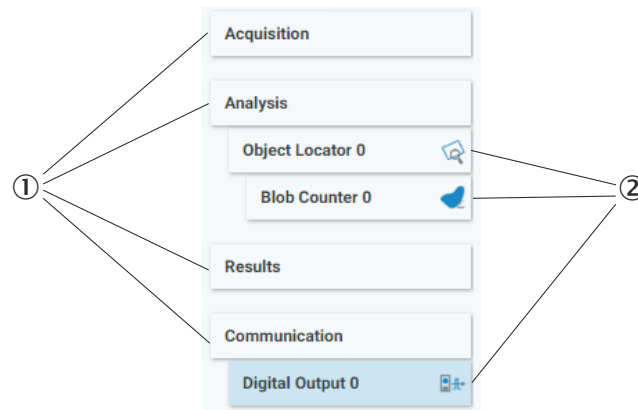


Figure 3: Example of a job tool tree with added tool instances

- ① Categories
- ② Added tool instances

### Adding and removing tool instances

To add a tool instance to a tool tree:

1. Click a category in the tool tree to display its associated tools.
2. Create a new instance of the tool, using one of the following options:
  - a) Click a tool icon to create a new instance of the tool to the selected category or linked to the selected tool.
  - b) Click and drag a tool icon to the correct category or linked to the correct tool in the tool tree to create a new instance of the tool. Possible and correct drop is indicated with green highlight and gray underline.

To remove a tool instance from a tool tree, use one of the following options:

- Hover the mouse over the tool and click "X" to delete.
- Select the tool instance in the tool tree and press **Delete** on the PC keyboard. In the dialog box that appears, click "Yes" to confirm the deletion.

### Editing the tool settings

Click a tool instance in the tool tree to display its tool pane, which contains all the available settings and result parameters. For more information about the settings and result parameters, click the tool help (Help button) in the tool pane.

## 4.4.2 System settings

The **System** page contains a tool tree with tools related to the device interfaces. Tool instances that are added to the **System** tool tree are valid for all jobs.

To access and edit the **System** page, set the **System/Jobs** toggle (figure 4) to **System**.

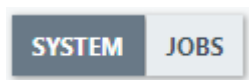


Figure 4: System/Jobs toggle, here set to System

### 4.4.2.1 Tool categories - System

The **System** tool categories are listed below. For descriptions of the individual **System** tools, see "[Tool box - System](#)", page 28. **System** tool instances are applied to all jobs.

**Interfaces**

The **Interfaces** category contains tools that communicate with external devices. Tools in the **Communication** category can use the **Interfaces** tools for communication and data transmission.

**4.4.3 Job settings**

The **Job** page contains settings for individual jobs. Each job consists of a tool tree and a reference image.

To access and edit the **Job** page, set the **System/Jobs** toggle (figure 4) to **Jobs**.

**4.4.3.1 Image source**

Use the image source selection buttons on the **Job** page to select an image source for the configuration. Each option has a set of associated controls, which are displayed below the image viewer.



**NOTE**

The selected image source is only used during the configuration. In **Run** mode, the analysis is based on live images.

**Live image**



Set up the configuration based on live images. The **Live** option is suitable for configuring in the real inspection environment.



**NOTE**

- The **Live** option is not available when using the SICK AppStudio Emulator or SICK AppEngine.

Table 2: Controls available for live images








Control	Name	Function
	Free running	Acquire images continuously.
	Run triggered	Acquire images based on an external trigger.  To enable the <b>Run triggered</b> button: 1 Click the <b>Acquisition</b> category. 2 Select the <b>External trigger</b> in the tool pane.
	Stop	Stop the image acquisition.
	Trigger	Acquire one single image (trigger an image acquisition by clicking the button).
	Single image download	Export the displayed image to a local file on the computer. The saved images are in a format that can be used with playback. The images do not contain result overlays and they are unaffected by image view zoom.
	Update Reference Image	Set the currently displayed image as the reference image. The currently stored reference image is overwritten.

### Playback image



Set up the configuration based on recorded images, without access to a real device.

Table 3: Controls for playback images

Control	Name	Function
	Play	Display and loop through the images in the target folder.
	Pause	Pause the playback.
	First image	Go to the first image in the series.
	Next image	Step to the next image in the series.
	Single image download	Export the displayed image to a local file on the computer. The saved images are in a format that can be used with playback. The images do not contain result overlays and they are unaffected by image view zoom.
	Settings	<p><b>Cycle images (On/Off)</b></p> <p><b>Image folder:</b> The folder where the recorded images are stored. The folder must be a public folder on the device or a folder on an SD card. Examples:</p> <pre>/public/myDirectory</pre> <pre>/sdcard/0/myDirectory</pre> <p>If used as Emulator with SICK AppEngine specify a folder where your images are stored. Example:</p> <pre>C:\myDirectory</pre>
	Update Reference Image	Set the currently displayed image as the reference image. The currently stored reference image is overwritten.


### Reference image



Set up the configuration based on a saved reference image. This option is suitable if there is one particular image that you want to use for the configuration.

- The reference image is job-specific and must be defined for each job.
- To save a reference image, click **Update Reference Image** (available for the **Live** and **Playback** options).
- A reference image is required for setting the region of interest for the **Object Locator** tool.

Table 4: Controls for the reference image

Control	Name	Function
	Reference Image	View the saved reference image.





#### 4.4.3.2 Creating and switching jobs

Create a job for each inspection situation and object type. The job list in the upper left part of the user interface displays the active job.

If there is no configuration saved on the device when opening the SensorApp, a new job ('Job 1') is created automatically.

**Adding and removing jobs**

Use the buttons next to the job list to add and edit jobs to and from a configuration. The **Edit job** button will open up the possibility to clone and remove the currently selected job

Icon	Name	Description
	<b>Edit job</b>	Edit the currently selected job.
	<b>Add job</b>	Add a new job to the configuration.
	<b>Clone job</b>	Create a copy of the currently selected job and add to the configuration.
	<b>Remove job</b>	Remove the currently selected job from the configuration.

**Selecting jobs**

Click the job list to display and switch between existing jobs.

When the device is restarted, the most recent active job is reactivated (Requirement: **Save Permanently** has been done prior to the restart, see "[Saving, importing and exporting a configuration](#)", page 27).

**4.4.3.3 Tool categories - Jobs**

The tool tree structure for each job on the **Job** page is formed as a workflow, consisting of the four categories below. For descriptions of the individual tools, see "[Tool box - Jobs](#)", page 34.

**Acquisition**

The **Acquisition** category contains settings for image acquisition and image quality. Changes to the image acquisition settings are applied to the next acquired image.

**Analysis**

The **Analysis** category contains tools for image processing and image analysis.

**Results**

The **Results** category contains settings and tools for result processing and output handling.

**Communication**

The **Communication** category contains tools for sending results to external devices.

**4.4.3.3.1 Setting the region of interest for a tool**

Some tools in the **Analysis** category operate within a defined region of interest (ROI). For such tools, the tool pane contains a **Regions** list where the ROI can be set.



### Adding regions for a tool instance

When a tool instance is added to the tool tree, it is automatically assigned a rectangular default region which is displayed in the **Regions** list. To add additional regions, click **Add**.

Because at least one region is required for each tool, the **Remove** button is only enabled if the **Regions** list contains more than one item.

### Positive and negative regions



#### NOTE

If the total ROI is negative, the tool is invalid and gives a **Fail** result.

Each region in the **Regions** list is defined as positive or negative. The total ROI for a tool is defined as the union of all the positive regions subtracted by the union of all the negative regions, according to [figure 5](#).

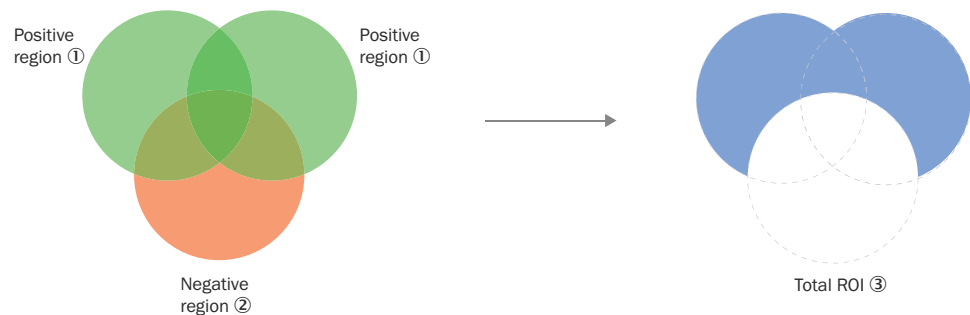


Figure 5: Positive and negative regions and the total ROI

- ① Positive region
- ② Negative region
- ③ Total ROI

### Editing the ROI

To change the size and position of a region:

- Hover over a region in the image viewer to highlight its handles.
- Click and drag the center handle to move a region.
- Click and drag the side or corner handles to resize a region.

### Visualization of results

By default, the ROI for each tool instance is displayed as an overlay in the image viewer. The ROI for the active tool is displayed with a yellow transparent overlay. The ROI border-color corresponds to the tool result (green color for **Pass**, red color for **Fail**).

To hide the overlay for a tool instance, clear the **Show regions and overlays** checkbox in the tool pane.

#### 4.4.3.4 Editing the image acquisition settings

To edit the image acquisition settings for a job, click the **Acquisition** category. The **Acquisition** settings are displayed in the tool pane to the right of the image viewer.



#### NOTE

Changes to the image acquisition settings are applied to the next acquired image.

Setting	Description
Exposure time	The exposure time of the sensor. Increase the exposure time to get a brighter image. Some device types have a lower limit on the maximum exposure time when integrated lighting is enabled. The exposure time will be limited automatically due to eye safety concerns and a warning will display the maximum value when it is exceeded.
Brightness	The brightness (gain factor) for image acquisition. Keep the brightness low to reduce the level of noise. If a brighter image is required, it is recommended to increase the exposure time before increasing the brightness.
Contrast	The contrast level for image acquisition. Increase the contrast to make objects in the image more distinguishable.
Downsample	The downsample factor for the acquired images. The downsample factor is applied both vertically and horizontally. For example, a downsample factor of 2 will resize a 1000 x 1000 px image into a 500 x 500 px image. Downsampling is recommended to save disk space and to decrease the processing time for images with high resolution.
Horizontal FOV	Limit the camera's field of view width (X direction). At least 20% of the total width must be used.
Vertical FOV	Limit the camera's field of view height (Y direction). At least 20% of the total height must be used.
Integrated lighting	Use the integrated light in the device during the image acquisition. This option is only available for devices that support external lighting. If an external light is connected to the device, the integrated and the external lighting can be used in parallel.
External light type	<p>Define the type of external light that is connected to the device:</p> <ul style="list-style-type: none"> <li>For light sources sold by SICK (denoted by ICL), select the correct model in the list to automatically configure the required device settings.</li> <li>For other light sources, select the ACTIVE_HIGH_FLASHING or ACTIVE_LOW_FLASHING setting, depending on whether the light source triggers on an active high (+5 V) or active low (+0 V) signal. See the light source specification for details.</li> </ul> <p>The <b>External light type</b> option is only available when the device is configured for use with external lighting. To configure the device for use with external lighting, use the <b>I/O Configuration</b> tool.</p>
Focus	<p>The focus distance (in mm) for devices with dynamic focus. The lower and upper limits are set based on the possible focus distances for the device.</p> <p>This option is only available for devices with dynamic focus.</p>
External trigger	Enable the use of an external trigger, e.g. a photoelectric switch or a trigger command through the <b>Command Channel</b> , to trigger image acquisition. If a digital input is used, the external trigger must be connected to digital input port 1.
Delay	<p>The delay between the trigger signal and the image acquisition when using an external trigger.</p> <p>This option is only available when an <b>External trigger</b> is selected.</p>
Record images	Record and save all acquired images to a specified target folder. Images are only recorded when the system is in <b>Configure</b> mode and <b>Live</b> images are used as the image source.

Setting	Description
Record directory	The full path to the target folder where the recorded images are saved. The target folder must be a public folder on the device or a folder on an SD card. Examples: /public/myDirectory /sdcard/0/myDirectory If the selected target folder is not valid, an error message appears in the log.
Image correction	Apply a calibration model to all acquired images. This option is only available when a calibration model has been created by the <b>Camera Pose Estimation</b> tool. <b>Correction options:</b> <ul style="list-style-type: none"> <li>• <b>No correction:</b> Do not apply the calibration.</li> <li>• <b>Lens distortion:</b> Remove lens distortion from the acquired images.</li> <li>• <b>Full calibration:</b> Remove lens distortion and perspective from the acquired images, apply a world coordinate system with unit 'millimeters' to each image.</li> </ul>

#### 4.4.4 Saving, importing and exporting a configuration

A configuration includes one or more jobs and a reference image. To save, export or import a configuration, use the buttons in the upper right part of the user interface.



#### NOTICE

If a configuration is not saved before disconnecting the power to the device, all settings are lost.

Button	Name	Description
	Save Permanently	Save a configuration from the device's working memory to the flash memory.
	Export Configuration	Export a configuration from the device's working memory to the connected PC.
	Import Configuration	Import a configuration from the connected PC and save it to the device's working memory. To save the imported configuration permanently to the device, click <b>Save Permanently</b> .

## 5 Annex

### 5.1 Licenses

SICK uses open source software which is published by the rights holders under a free license. Among others, the following license types are used: GNU General Public License (GPL version 2, GPL version 3), GNU Lesser General Public License (LGPL), MIT license, zlib license and licenses derived from the BSD license.

This program is provided for general use without warranty of any kind. This warranty disclaimer also extends to the implicit assurance of marketability or suitability of the program for a particular purpose.

More details can be found in the GNU General Public License.

For license texts see [www.sick.com/licenses/texts](http://www.sick.com/licenses/texts).

Printed copies of the license texts are also available on request.

#### 5.1.1 License handling

To activate licensed functionality you have to use the License Manager sensor app. The app is downloaded from SICK App Pool (<http://apppool.cloud.sick.com/>).

License activation instructions will be attached to the license ticket email that is provided after purchase of a license.

##### Trial mode

The Deep Learning functionality in Intelligent Inspection is possible to use in a trial mode for two hours per reboot when a trial network is uploaded to the device.

For further use, a Deep Learning license is required. Use dStudio (<https://dstudio.cloud.sick.com/>) to create the trial network.

##### Production mode

For full deep learning functionality, an activated deep learning classification license and a purchased network is required. The license handling procedure is available directly from Intelligent Inspection. The network is downloaded via dStudio.

##### Activation of Deep Learning license

1. Open the **System** tab and select **Licensing**.
2. Follow the **LicenseManager on AppPool** link to download the License Manager sensor app.
3. Install SICK LicenseManager to the device with SICK AppManager.
4. Update the **Licensing** window and follow the **Navigate to LicenseManager** link.
5. Follow the instructions provided in the license ticket email to activate the license.

To install the SensorApp on a device, the SICK AppManager software must be installed on the PC, see "[Installing or updating the SensorApp on a device](#)", page 16.

### 5.2 Tool box - System

#### 5.2.1 Interfaces tools

The **Interfaces** category contains tools that communicate with external devices. Tools in the **Communication** category can use the **Interfaces** tools for communication and data transmission.

##### 5.2.1.1 Fieldbus tool

The **Fieldbus** tool is a static (non-removable) tool that contains the available fieldbus modes for the device.

### Settings

Setting	Description
Mode	<ul style="list-style-type: none"> <li>Select <b>EtherNet/IP</b> to enable EtherNet/IP.</li> <li>Select <b>PROFINET</b> to enable PROFINET.</li> <li>Select <b>Off</b> to inactivate all fieldbus options.</li> </ul>
PROFINET station name	The device is identified on the PROFINET network by its station name. This option is only available when PROFINET is selected.



#### NOTE

Click **Apply and reboot** to restart the device and apply the updated settings.

For more information, see the [EtherNet/IP tool](#) or [Profinet tool](#) help sections.

### 5.2.1.2 Command Channel tool



The **Command Channel** tool is used to control the camera programmatically from an external source. The **Command Channel** can be run as a **TCP/IP Client**, **TCP/IP Server**, or **Fieldbus**.

The **Fieldbus** version of the **Command Channel** does not support text commands.

### Settings

Setting	Description
Interface	List of possible interfaces to select.

### TCP/IP Client or server commands

Sending a command:

- Add the command delimiter bytes `stx` (0x02) and `etx` (0x03) to mark the beginning and end of a command.
- Use single spacing between a command and an argument, and between arguments.
- Use quoted text for string arguments and unquoted text for all other argument types.

Command	Argument	Return	Description
get job		job_id (number)	Get the id of the active job.
set job	job_id	OK or Error message if job id is not found or provided.	Select active job by id.
trigger		OK	Trigger a new image. The External trigger must be set to <b>Command Channel</b> in the active job.
echo	message (string)	message (string)	Return the argument, e.g. for testing connectivity.

### TCP/IP Client or server examples

#### Getting a job

Use the following syntax to get the ID of the currently running job:

```
<stx>get job<etx>
```

#### Selecting a job

Use the following syntax to select job 3:

```
<stx>set job 3<etx>
```

### Triggering

Use the following syntax to trigger a new image:

```
<stx>trigger<etx>
```

### Testing connectivity

Use the following syntax to test the connectivity:

```
<stx>echo "Test message"<etx>
```

### Fieldbus

The two supported Fieldbuses are **Profinet** and **Ethernet/IP**.

See "[Fieldbus tool](#)", page 28 for information on how to enable **Profinet** or **Ethernet/IP** on the device.

### Fieldbus commands

The current version of the **Command Channel Fieldbus** has pre-set positioning and data type assignments of the incoming data. The available commands are **Trigger** and **Change Job**.

Table 5: Command Control bits

Bit	Name	Description
0	Trigger	Trigger image.
1	Change Job	Change job.
2	[Reserved]	Set to 0 (zero).

Table 6: Command Data field

Position	Type	Name	Description
0	SINT	Job ID	The <b>Job ID</b> for change job.
1-127	SINT	[Reserved]	Set to 0 (zero).

When setting a new job, the **Job ID Command Data** field must be set before the **Change Job** bit is set in the **Command Control** bits.

A response is sent for each received command. Here the positioning and data type assignment is also pre-set.

Table 7: Response Control bits

Bit	Name	Description
0	[Reserved]	
1	Command OK	Is set to 1 if the last command sent was OK.
2	Error	Is set to 1 if any type of error occurred during the last command.

Table 8: Result Data field

Position	Type	Name	Description
0	SINT	Job ID	The currently selected <b>Job ID</b> .
1	SINT	Error Code	If bit 2 is set in the result control bit, the error code is set here.
2-127		[Reserved]	Analysis result data.

Since the first two SINTs of the result data field contains response data, it means that they cannot be used for **Tool Analysis Results**. The dropdown for those positions will be disabled.

### Fieldbus examples

Command Control bits			Command Data	
Bit 2-15	Bit 1	Bit 0	Position 0	Position 1-127
[Reserved]	Change job	Trigger image	Job ID	[Reserved]

Response Control bits			Response Data		
Bit 2	Bit 1	Bit 0	Position 0	Position 1	Position 2-127
Com. Error	Com. OK	[Reserved]	Job ID	Error code	Analysis result data

#### Example 1:

Change to job 2 from job 4, where job 2 exists. Start by clearing the control bits and setting the data. Afterward, set the change job bit.

Command control bits			Command data		Response control bits			Response data		
0	0	0	0x02	-	-	-	-	0x04	-	-
0	1	0	0x02	-	0	1	-	0x02	-	-

#### Example 2:

Change to job 2 from job 4, where job 2 does not exist. The setup is the same as in example 1, but this response will contain an error code.

Command control bits			Command data		Response control bits			Response data		
0	0	0	0x02	-	-	-	-	0x04	-	-
0	1	0	0x02	-	1	0	-	0x04	0x38	-

#### Example 3:

Trigger an image when **Run** mode is active and the device is configured to be triggered via the **Command Channel**. Start by clearing the control bits. Afterward, set the trigger image control bit.

Command control bits			Command data		Response control bits			Response data		
0	0	0	0x02	-	-	-	-	-	-	-
0	0	1	0x02	-	0	1	-	-	-	-

#### Example 4:

Trigger an image when the device is not configured to be triggered via the **Command Channel**. The setup is the same as in example 3, but this response will contain an error code.

Command control bits			Command data		Response control bits			Response data		
0	0	0	0x02	-	-	-	-	-	-	-
0	0	1	0x02	-	1	0	-	-	0x3E	-

### Error codes

Code	Description
0x38	No job with provided id exists.
0x3D	External trigger is not set to <b>Command Channel</b> .

Code	Description
0x3E	In <b>Configure</b> mode but <b>Run triggered</b> not selected.

5.2.1.3 I/O Configuration tool



The **I/O Configuration** tool lets the user select the usage for each available digital I/O port.



**NOTE**

All options are not available for all ports.

**Settings**

Setting	Description
I/O	The port number of the digital I/O.
Usage	Select how to use the port: <ul style="list-style-type: none"> <li>• <b>IN/Image Trigger:</b> Use the port as input for external triggering. This option is only available for I/O 1.</li> <li>• <b>IN/Job selection:</b> Use the port as input for the <b>Job Selection I/O</b> tool.</li> <li>• <b>OUT/Digital output:</b> Use the port as output for the <b>Digital Output</b> tool.</li> <li>• <b>OUT/External Light:</b> Use the port as output for external lighting. This option is only available for I/O 4 and I/O 6. When this option is selected, further settings for the external lighting appear in the <b>Acquisition</b> settings.</li> </ul>

5.2.1.4 Job Selection I/O tool



The **Job Selection I/O** tool enables job selection via digital input signals. The tool operates by linking a job to a binary configuration of digital input signals. To select the job, the digital input signals must be correctly set to HIGH and LOW according to the configuration.



**NOTE**

An **I/O Configuration** tool instance must be added before the **Job Selection I/O** tool can be used. The ports that are set as **IN/ Job Selection** in the **I/O Configuration** tool are available in the **Job Selection I/O** tool.



**NOTE**

To select a job, all corresponding input signals, must be set to their correct values within 1 ms.

**Settings**

Setting	Description
Value	Index of the current row.
Job	The job that is linked to the configuration of input signals on the current row.



Setting	Description
Digital input (IN1, IN2, ...)	Each column represents an available digital input port. Each row represents a binary configuration of digital input signals, where "1" corresponds to signal level HIGH and "0" corresponds to signal level LOW. To select a job, all input signal levels on the same row must be set according to the given configuration.

### 5.2.1.5 TCP Client tool



The **TCP Client** tool sets up an interface for sending data to an external server, using a TCP protocol.

#### Settings

Setting	Description
Server IP address	The external server's IP address.
Port	The port number to connect to on the external server.

The **Connection Status** indicator displays the real-time status of the connection between the **TCP Client** tool and the external server:

- Green indicator: The connection is successfully set up.
- Red indicator: There is no connection to the server.

### 5.2.1.6 TCP Server tool



The **TCP Server** tool provides a server that external TCP clients can connect to. Data can then be sent from the server to the connected clients using a TCP protocol.

#### Settings

Setting	Description
Port	The port that the clients can connect to.
Max number of clients	The maximum number of clients allowed to connect.

The **Number of clients connected** indicator shows how many clients that are currently connected to the server.

## 5.2.2 Calibration tools

The **Calibration** category contains tools for calibration of image data. When a calibration is applied to the image data, values and positions can be expressed as millimeter values in a world coordinate system.

### 5.2.2.1 Camera Pose Estimation tool



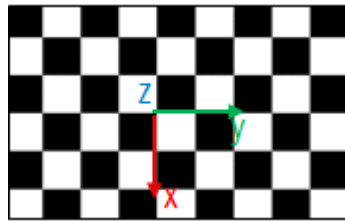
The **Camera Pose Estimation** tool estimates a calibration model for a camera setup. When the calibration model is applied, values and coordinates can be reported as millimeter values in a world coordinate system.

#### Calibration targets

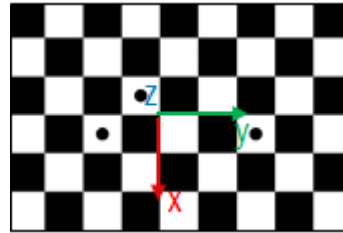
The **Camera Pose Estimation** tool requires a printed calibration target to estimate a calibration model. The following target types are supported:

- **Plain:** A checkboard target that contains only squares. This target type calibrates the image so that the applied calibration rotates the original image as little as possible (maximum about 45°). When the calibration is complete, the origin is located between the four squares closest to the middle of the image, according to the figure below.
- **Three dot:** A checkboard target that includes three black dots. The dots are easy to detect, which makes the target suitable for cases with low camera resolution. All three dots must be visible in the camera's field of view during the calibration. When the calibration is complete, the origin is located in the lower right corner of the square containing the middle dot, according to the figure below.

The calibration targets are available in the SICK Support Portal, [supportportal.sick.com](https://supportportal.sick.com).



Origin for Plain calibration target



Origin for Three dot calibration target

**Settings**

Setting	Description
Tile size	The length of the sides of the squares on the printed calibration target.
Target type	The type of calibration target to use for the pose estimation. See the target descriptions above for details.
Estimate pose	Estimate a calibration model based on the image currently displayed in the image viewer. All available image sources (live images, reference image or playback images) can be used for estimating a calibration model. If using live images, position the calibration target in the measurement plane in front of the camera and adjust the <b>Acquisition</b> settings to get a good image. If the pose estimation is successful, a calibration model is created and the mean error for the calibration is displayed in the GUI. If the pose estimation fails, an error message is displayed and no calibration model is created. Once a calibration model is created, use the <b>Image correction</b> options in the <b>Acquisition</b> settings to apply the calibration model to the image data.

**5.3 Tool box - Jobs**

**5.3.1 Analysis tools**

The **Analysis** category contains tools for image processing and image analysis.

Add a tool to the tool tree by either click a tool, or drag and drop a tool from the tool box (to the left of the tool tree) to the **Analysis** category. Click a tool in the tool tree to display its tool pane, which contains tool settings and results.

If the object rotation and position varies between the acquired images, it is recommended to link each **Analysis** tool to an **Object Locator** tool. To link a tool to the **Object Locator** either first select the **Object locator** and then click a tool in the tool box, or drag and drop a tool onto an added **Object locator** tool. Linked tools appear as indented items below the **Object Locator** tool in the tool tree.

### 5.3.1.1 Angle tool



The **Angle** tool measures the angle, 0 to 180°, between two lines. The smallest angle between the lines in the chosen direction is measured, starting from the reference line.

#### Settings

Setting	Description
Reference line	The reference line from which the angle is calculated.
Secondary line	The line that has an angle in relation to the reference line.
Select angle direction	Direction: <ul style="list-style-type: none"> <li>• <b>Clockwise</b> measures the angle from the reference line to the secondary line in a clockwise direction.</li> <li>• <b>Counter clockwise</b> measures the angle from the reference line to the secondary line in a counter clockwise direction.</li> </ul>

#### Results

Result	Description	Variable name
Angle (deg)	The angle between the lines in degrees. The angle is between 0 and 180 degrees. Set which result is <b>Expected</b> and the <b>Tolerance</b> for the decision to pass.	Angle
Intersection point	The point, which is located where the two lines intersect.	Point
Pass decision	A valid angle measurement gives a <b>Pass</b> result.	Pass

#### Wrap-around effect

When validating that two lines are almost parallel there is a wrap-around effect to consider. Setting the **Expected** value to 0, but allowing a positive and negative **Tolerance**, will accept a result above 0° and below 180° as a valid angle measurement.

#### Example:

If the **Expected** value is 0 and the **Tolerance** is set to  $\pm 1$ , both 0-1° and 179-180° will be accepted as valid angle measurements.

### 5.3.1.2 Blob Counter tool



The **Blob Counter** tool counts blobs within its region of interest. A blob is defined as a cluster of connected pixels within a specified intensity and area range.



#### NOTE

If the object position varies between the acquired images, this tool must be linked to an **Object Locator** tool. Tools which are linked to an **Object Locator** tool are repositioned according to the position of the located object. Drag and drop a created tool onto an added **Object Locator** tool to link them.

### Settings

Setting	Description
Intensity	Only search for pixels with an intensity value within the specified intensity range.
Area	Only include blobs with an area within the specified area range.

Advanced setting	Description
Circularity	A circularity measure that is 100 for ideal circles and smaller for other shapes. The measure is robust to high-frequency noise like jagged edges along the circle perimeter, so even noisy circles get a measure close to 100. The measure is significantly lower if the overall appearance is rather an ellipse, square or other non-circular shapes.
Compactness	The compactness measure of the blob ( $4 * \text{PI} * \text{Area} / \text{Perimeter}^2$ ). This is close to 100 for circles and smaller for less compact blobs.
Convexity	The convexity measure of the blob (blob area divided by area of convex hull). This is 100 for convex blobs and smaller the more non-convex the blob is.
Number of holes allowed	Allow holes inside the blob.

### Regions

This tool operates within its region of interest (ROI), which is set in the **Regions** section in the tool pane. For more information about how to set the ROI, see ["Setting the region of interest for a tool"](#), page 24.

### Results

Result	Description	Variable name
Number of blobs	The number of found blobs.	NumBlobs
Pass decision	Total result, based on the set threshold values for <b>Number of blobs</b> .	Pass

#### 5.3.1.3 Circle Fitter tool



The **Circle Fitter** tool searches for an edge of a circle in the image data and fits a circle to that edge.

The search direction for the **Circle Fitter** tool is from the inner circle to the outer circle of the search region.



#### NOTE

If the object position varies between the acquired images, this tool must be linked to an **Object Locator** tool. Tools which are linked to an **Object Locator** tool are repositioned according to the position of the located object. Drag and drop a created tool onto an added **Object Locator** tool to link them.

### Settings

Setting	Description
Inner and outer diameter	The inner and outer diameter controls the diameters of the search region.
Polarity	The transition of the edge in the search direction: from dark to bright, from bright to dark, or any.

Setting	Description
Edge strength	The threshold value for detecting an edge. A high value means that a higher contrast is required between the bright and dark side of an edge.
Advanced setting	Description
Edge selection	If multiple edges are located, the <b>Edge selection</b> setting determines whether to select the strongest, first or last edge found within the region of interest, with regard to the search direction.
Outlier margin	<b>Outlier margin</b> sets a margin outside of the found circle. The probes that lie within this margin are set as inliers, i.e. accepted and contributes to the circle fit, and the probes outside of the margin are discarded. In effect, a higher value increases the probability of locating an edge, but the located edge may be noisy or not close enough to fit the edge of a perfect circle. A low <b>Outlier margin</b> value ignores noisy edges and edges that are not close enough to a perfect circle.
Edge fuzziness	Increasing <b>Edge fuzziness</b> can improve the accuracy for very blurred edges, where there is no sharp transition from dark to bright (or vice versa).
Number of probes	The <b>Number of probes</b> parameter sets how many probes that are sent to detect an edge. A larger value gives higher accuracy but might increase calculation time, whereas a lower value gives lower accuracy but increases speed.

### Results

Result	Description	Variable name
Diameter	The diameter of the fitted circle. Set which result is <b>Expected</b> and the <b>Tolerance</b> for the decision to pass.	Diameter
Average error	The average distance, in pixels, between the fitted edge and the identified image edge points. A noisy or wave-shaped edge gives a large error.	MeanError
Edge detection	A high value means that the located edge extends over a large part of the region of interest.	EdgeDetection
Center point	The center point of the fitted circle.	Point
Pass decision	The total result, based on the set threshold values for <b>Diameter</b> , <b>Average error</b> and <b>Edge detection</b> .	Pass

#### 5.3.1.4 Deep Learning Classification tool



The **Deep Learning Classification** tool is used for classification of acquired images. The use of the **Deep Learning Classification** tool requires that a trained neural network is uploaded prior to starting the classification. The resulting class can be communicated with the **Send string** tool.

The **Deep Learning Classification** tool enables the usage of trained neural networks from dStudio. For more information about how to get your own network, visit <https://dstudio.cloud.sick.com/>.

## Settings

Setting	Description
Upload network	Upload a trained neural network to use for the classification. The neural network must be trained by and downloaded as a .json file from the dStudio software.
Uploaded network filename	Read-only field that displays the filename of the currently uploaded neural network.
Region reference	<p>Reference a specific region produced by a <b>Region</b> tool. If a region is referenced, the image classification is only done on the content within this region.</p> <p><b>Notes:</b></p> <ul style="list-style-type: none"> <li>Only positive rectangular regions can be used for the image classification. If the referenced <b>Region</b> tool contains more than one region, the first positive rectangular region in the list is used. If the <b>Region</b> tool does not contain any positive rectangular regions, an error message appears.</li> <li>If the position and rotation of the object of interest vary between the acquired images, link the connected <b>Region</b> tool to an <b>Object Locator</b> tool. See the <b>Object Locator</b> tool help for more information.</li> </ul>

## Output activation depending on Deep Learning Classification Class name

In order to activate an output depending on the resulting **Deep Learning Classification** class name, **Expression** tools are needed. See the **Expression** tool help for examples.

## Results

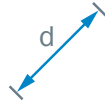
Result	Description	Variable name
Confidence	The neural network's estimation of the probability that the classification of the object in the image is correct.	Confidence
Class Index	The index of the class to which the current image belongs, according to the classification. If no network is uploaded, <b>Class Index</b> is set to -1.	ClassIndex
Class	The name of the class to which the current image belongs, according to the classification. If no network is uploaded, <b>Class</b> is set to <b>No class</b> .	Class
Network Loaded	Whether a neural network was available during the classification of the current image.	NetworkLoaded
Pass decision	<p>The total result, based on the following settings:</p> <ul style="list-style-type: none"> <li>The set threshold value for <b>Confidence</b>.</li> <li>The uploaded network: If no valid network is uploaded, the <b>Pass decision</b> is set to Fail.</li> <li>The referenced region: If an invalid or non-existing region is referenced, the <b>Pass decision</b> is set to Fail.</li> </ul>	Pass

## Visualization

When the classification for an image is done, the class name and the confidence are displayed on top of the image in the image viewer.

- If a region is referenced, the class name and the confidence are displayed inside the region.
- The class name is displayed in the upper left corner of the image or region.
- The confidence is illustrated as a bar in the right part of the image or region. The higher the confidence, the higher the bar.

### 5.3.1.5 Distance tool



The **Distance** tool measures the distance between two features. Each feature must be either a point or a line.

#### Settings

Setting	Description
Feature A	The first referenced feature (point or line) for the distance measurement.
Feature B	The second referenced feature (point or line) for the distance measurement.
Measurement type	<p><b>The type of measurement:</b></p> <ul style="list-style-type: none"> <li>• <b>Point To Point</b> measures the distance between two points. For line features, the point is projected onto the center of the line.</li> <li>• <b>Right Angle</b> measures the orthogonal distance between a point feature and a line feature.</li> </ul> <p><b>Right angle</b> measurements require that at least one of the referenced features is a line. If both features are lines, the center point of Feature B is used as point feature.</p>

#### Results

Result	Description	Variable name
Distance	The distance between the referenced features. If the <b>Image Correction</b> mode is set to <b>Full calibration</b> , the distance is expressed as a millimeter value. Otherwise, the distance is expressed as a pixel value. Set which result is <b>Expected</b> and the <b>Tolerance</b> for the decision to pass.	Distance
Pass decision	A valid distance measurement gives a <b>Pass</b> result.	Pass

### 5.3.1.6 Edge Pixel Counter tool



The **Edge Pixel Counter** tool counts all pixels which are located on edges within the tool's region of interest.



#### NOTE

If the object position varies between the acquired images, this tool must be linked to an **Object Locator** tool. Tools which are linked to an **Object Locator** tool are repositioned according to the position of the located object. Drag and drop a created tool onto an added **Object Locator** tool to link them. If the object position varies between the acquired images, it is recommended to link this tool to an **Object Locator** tool. See the **Object Locator** tool help for more information.

### Settings

Setting	Description
Edge strength	Threshold value for detecting an edge. A high edge strength means that a high contrast is required between an edge and the background.

### Regions

This tool operates within its region of interest (ROI), which is set in the **Regions** section in the tool pane. For more information about how to set the ROI, see "[Setting the region of interest for a tool](#)", page 24.

### Results

Result	Description	Variable name
Edge pixels	The number of found edge pixels in relation to the total number of pixels within the region of interest.	Coverage
Number of pixels	The number of found edge pixels within the tool's region of interest.	NumPixels
Pass decision	Total result, based on the set threshold values for Edge pixels.	Pass

#### 5.3.1.7 Ellipse Fitter tool



The **Ellipse Fitter** tool searches for an edge of an ellipse in the image data and fits an ellipse to that edge.

The search direction for the **Ellipse Fitter** tool is from the inner circle to the outer circle of the search region.



#### NOTE

If the object position varies between the acquired images, this tool must be linked to an **Object Locator** tool. Tools which are linked to an **Object Locator** tool are repositioned according to the position of the located object. Drag and drop a created tool onto an added **Object Locator** tool to link them.

### Settings

Setting	Description
Inner and outer diameter	The inner and outer diameter controls the diameters of the search region.
Polarity	The transition of the edge in the search direction: from dark to bright, from bright to dark, or any.
Edge strength	The threshold value for detecting an edge. A high value means that a higher contrast is required between the bright and dark side of an edge.

Advanced setting	Description
Edge selection	If multiple edges are located, the <b>Edge selection</b> setting determines whether to select the strongest, first or last edge found within the region of interest, with regard to the search direction.



Advanced setting	Description
Outlier margin	<b>Outlier margin</b> sets a margin outside of the found ellipse. The probes that lie within this margin are set as inliers, i.e. accepted and contributes to the circle fit, and the probes outside of the margin are discarded. In effect, a higher value increases the probability of locating an edge, but the located edge may be noisy or not close enough to fit the edge of a perfect circle. A low <b>Outlier margin</b> value ignores noisy edges and edges that are not close enough to a perfect ellipse.
Edge fuzziness	Increasing <b>Edge fuzziness</b> can improve the accuracy for very blurred edges, where there is no sharp transition from dark to bright (or vice versa).
Number of probes	The <b>Number of probes</b> parameter sets how many probes that are sent to detect an edge. A larger value gives higher accuracy but might increase calculation time, whereas a lower value gives lower accuracy but increases speed.

### Results

Result	Description	Variable name
Largest diameter	The largest diameter of the fitted ellipse. Set which result is <b>Expected</b> and the <b>Tolerance</b> for the decision to pass.	DiameterMax
Smallest diameter	The smallest diameter of the fitted ellipse. Set which result is <b>Expected</b> and the <b>Tolerance</b> for the decision to pass.	DiameterMin
Average error	The average distance, in pixels, between the fitted edge and the identified image edge points. A noisy or wave-shaped edge gives a large error.	MeanError
Edge detection	A high value means that the located edge extends over a large part of the region of interest.	EdgeDetection
Center point	The center point of the fitted ellipse.	Point
Pass decision	The total result, based on the set threshold values for <b>Largest diameter</b> , <b>Smallest diameter</b> , <b>Average error</b> and <b>Edge detection</b> .	Pass

#### 5.3.1.8 Fixed Point tool



The **Fixed Point** tool creates a reference point in the image, based on coordinates set by the user. The reference point defined by a **Fixed Point** tool can be used by other tools such as the **Distance** tool.



#### NOTE

If the object position varies between the acquired images, this tool must be linked to an **Object Locator** tool. Tools which are linked to an **Object Locator** tool are repositioned according to the position of the located object. Drag and drop a created tool onto an added **Object Locator** tool to link them.

### Results

Result	Description	Variable name
Point	The point result shows the point coordinates (x, y).	Point

Result	Description	Variable name
Pass decision	A Pass result means that the reference point position is valid.	Pass

5.3.1.9 Line Fitter tool



The **Line Fitter** tool searches for a straight edge in the image data and fits a line to that edge.

The search direction for the **Line Fitter** tool is defined by blue arrows, displayed in the image viewer. The **Line Fitter** tool searches for edges that are perpendicular to the arrows. Rotate the region of interest to change the search direction.



**NOTE**

If the object position varies between the acquired images, this tool must be linked to an **Object Locator** tool. Tools which are linked to an **Object Locator** tool are repositioned according to the position of the located object. Drag and drop a created tool onto an added **Object Locator** tool to link them.

**Settings**

Setting	Description
Polarity	The transition of the edge in the search direction: from dark to bright, from bright to dark, or any.
Edge strength	The threshold value for detecting an edge. A high value means that a higher contrast is required between the bright and dark side of an edge.

Advanced setting	Description
Edge selection	If multiple edges are located, the <b>Edge selection</b> setting determines whether to select the strongest, first or last edge found within the region of interest, with regard to the search direction.
Outlier margin	This parameter was previously named <b>Edge quality</b> where the low setting was set to 30, medium to 10 and high to 3. <b>Outlier margin</b> sets a margin outside of the found line. The probes that lie within this margin are set as inliers, i.e. accepted and contributes to the line fit, and the probes outside of the margin are discarded. In effect, a higher value increases the probability of locating an edge, but the located edge may be noisy or not perfectly straight. A low <b>Outlier margin</b> value ignores noisy edges and edges that are not straight enough.
Edge fuzziness	Increasing <b>Edge fuzziness</b> can improve the accuracy for very blurred edges, where there is no sharp transition from dark to bright (or vice versa).
Number of probes	The <b>Number of probes</b> parameter sets how many probes that are sent to detect an edge. A larger value gives higher accuracy but might increase calculation time, whereas a lower value gives lower accuracy but increases speed.

**Regions**

This tool operates within its region of interest (ROI), which is set in the **Regions** section in the tool pane. For more information about how to set the ROI, see "[Setting the region of interest for a tool](#)", page 24.

## Results

Result	Description	Variable name
Average error	The average distance, in pixels, between the fitted edge and the identified image edge points. A noisy or wave-shaped edge gives a large error.	MeanError
Edge detection	A high value means that the located edge extends over a large part of the region of interest.	EdgeDetection
Pass decision	The total result, based on the set threshold values for <b>Edge detection</b> and <b>Average error</b> .	Pass

### 5.3.1.10 Object Locator tool



The **Object Locator** tool uses edge matching to first locate an object in a reference image, then find the position of similar objects in other images. Use the **Object Locator** tool when the position or rotation of the object varies.

#### Reference image

The **Object Locator** tool requires a reference image for teach-in of a reference object and for setting the region of interest. Teach-in is done automatically when a reference image is added or updated. For each new image, the **Object Locator** tool produces a transform that describes how the located object's position and rotation varies relative to the reference image.

- Click **Update Reference Image** to add or update the reference image. The teach-in of the reference object is automatically done on the updated image.
- Click **View Reference Image** to display the current reference image and set the ROI for the tool.

#### Linking other tools to the Object Locator

Select the **Object Locator** tool in the tool tree. Click or Drag and drop a tool instance onto an **Object Locator** tool instance to create a parent-child relationship. For each new image, the region of interest for each child tool is repositioned according to the transform produced by the parent **Object Locator** tool. Tools that are linked as children appear as indented items below the **Object Locator** tool instance in the tool tree.

#### Settings

Setting	Description
Edge strength	Threshold value for locating an edge. A high value means that a high contrast is required between an edge and the background. An optimal edge strength value includes the edges of the reference object while excluding clutter edges in the background.
Background clutter	Make the <b>Object Locator</b> tool more robust to background noise. Set this option to reflect the expected background clutter level, LOW, MEDIUM, or HIGH. Set this option to LOW if the background is clean.
Rotation (±)	The maximum allowed object rotation in relation to the reference object. Decrease the allowed rotation to increase the speed and robustness of the analysis.
Scaling	Search for objects which are scaled in relation to the reference object. Scaling is suitable if the distance between the object and the sensor varies. De-select this option to increase the speed and robustness of the analysis.

Setting	Description
Search region	Defining a smaller search region increases speed as only a subset of positions are evaluated in the search. It also increased robustness as false matches with edges outside the search region are discarded. The object itself can extend outside the search region, it is the center of the object that needs to be within the search region.

### Regions

This tool operates within its region of interest (ROI), which is set in the **Regions** section in the tool pane. For more information about how to set the ROI, see "[Setting the region of interest for a tool](#)", page 24.

To get the best possible robustness, make the **Object Locator** ROI as large part of the image as possible. Only include features that are stable and unchanged between the acquired images.

### Results

Result	Description	Variable name
Match score	The percentage of matching between the taught reference object and the current object.	MatchScore
Angle	The angle of the current object compared to the reference object.	Angle
Scale	The scale of the current object in relation to its size in the reference image.	Scale
Translation X	The X-translation of the current object, compared to the reference object.	TranslationX
Translation Y	The Y-translation of the current object, compared to the reference object.	TranslationY
Pass decision	The total result, based on the set threshold values for <b>Match score</b> and <b>Angle</b> .	Pass

#### 5.3.1.11 Pixel Counter tool



The **Pixel Counter** tool counts the pixels in a specified intensity range within the tool's region of interest.



#### NOTE

If the object position varies between the acquired images, this tool must be linked to an **Object Locator** tool. Tools which are linked to an **Object Locator** tool are repositioned according to the position of the located object. Drag and drop a created tool onto an added **Object Locator** tool to link them. If the object position varies between the acquired images, it is recommended to link this tool to an **Object Locator** tool. See the **Object Locator** tool help for more information.

### Settings

Setting	Description
Intensity	Only include pixels that have an intensity value within the specified range.

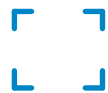
## Regions

This tool operates within its region of interest (ROI), which is set in the **Regions** section in the tool pane. For more information about how to set the ROI, see "[Setting the region of interest for a tool](#)", page 24.

## Results

Result	Description	Variable name
Coverage	The percentage of pixels within the specified <b>Intensity</b> range, in relation to the total number of pixels in the tool's region of interest.	Coverage
Number of pixels	The number of pixels within the specified <b>Intensity</b> range in the tool's region of interest.	NumPixels
Pass decision	Total result, based on the set threshold values for <b>Coverage</b> .	Pass

### 5.3.1.12 Region tool



The **Region** tool defines a region of interest within the image area. The defined region of interest can be referenced by the **Image Collection** tool and **Deep Learning Classification** tool for deep learning applications where only a specific part of each acquired image is relevant for the image classification.

## Settings

Use the **Regions** list to set the region of interest (ROI) for the **Region** tool. Each region in the list is defined as positive or negative. The total ROI is defined as the union of all the positive regions subtracted by the union of all the negative regions. To change the size and position of a region, click and drag its handles in the image viewer.

## Results

Result	Description	Variable name
Pass decision	A <b>Pass</b> result means that the set ROI is valid. A <b>Fail</b> result means that the set ROI is invalid, or that the connected <b>Object Locator</b> tool is invalid or did not find a match.	Pass

## 5.3.2 Results tools

The **Results** category contains settings and tools for result processing and output handling.

Click or Drag and drop tools from the tool box (to the left of the tool tree) to the **Results** category to add them to the tool tree. Click a tool in the tool tree to display its tool pane, which contains tool settings and results.

### 5.3.2.1 Expression tool



The **Expression** tool is used for creating an expression, based on mathematical and logical operations. The expression is evaluated and the result value is updated for each new image. The data type of the result value is evaluated each time the expression is changed.

The **Expression** tool result can be used by other tools:

- If the expression returns a boolean value, the **Digital Output** tool can use the result value for setting the signal levels of the digital outputs. A true value corresponds to signal level HIGH, and a false value corresponds to signal level LOW.
- The **Send String** tool can send the result value as a string to external devices.

### Settings

Setting	Description
Expression	<p>Create an expression by inserting any combination of the following elements:</p> <ul style="list-style-type: none"> <li>• Mathematical operators</li> <li>• Logical operators</li> <li>• Mathematical functions</li> <li>• Constants</li> <li>• General variables related to the image acquisition and the tool output</li> </ul> <p>See the "References" section for a list of available elements.</p>

The **Add** list contains the available results for the current job. See the tool help pages for descriptions of the tool results and corresponding variable names.

### Results

Result	Description
Value	<p>The result value, based on the expression created in the <b>Settings</b> section. The result value is updated for each new image.</p> <p>The result value may be a boolean or real number. The data type is evaluated each time the expression is changed.</p>

### Examples

#### Insert a tool result in an expression

Use the following syntax to insert a tool result in an expression:

```
result("<tool name>", "<result name>")
```

The name of each tool instance is displayed in the tool tree. Use a colon operator between the tool name and the number. For example, "PixelCounter1" is referred to as "PixelCounter:1".

#### Create an expression that is true if the Blob Counter tool finds more than two blobs

Expression:

```
result("BlobCounter:0", "NumBlobs") >= 2
```

Result value/Result type:

true/boolean

#### Check that the average coverage of two Pixel Counter tools is greater than 50%

Expression:

```
((result("PixelCounter:0", "Coverage") + result("PixelCounter:1", "Coverage"))/2) > 50.0
```

Result value/Result type:

false/boolean

#### Get the maximum value from two PixelCounter tools

Expression:

```
max(result("PixelCounter:0", "Coverage"), result("PixelCounter:1",
"Coverage"))
```

Result value/Result type:

0.78/number

#### Check if the number of found blobs is even (dividable by two)

Expression:

```
fmod(result("BlobCounter:0", "NumBlobs"), 2) == 0
```

Result value/Result type:

true/boolean

#### Get the x-coordinate value from a Point

Expression:

```
getX(result("FixedPoint:0", "Point"))
```

Result value/Result type:

250.3/number

#### Output activation depending on Deep Learning Classification class name or index

To activate an output depending on the resulting **Deep Learning Classification** class name or index, **Expression** tools are needed. When the **Expression** tool is created it will be visible and usable in the dropdown list under **Results** in the **Digital Output** tool.

One **Expression** tool needs to be created for each class name. It is also possible to evaluate multiple classes in one expression hence activate the same output with several classes.

The expression below evaluates if the class name result from the **Deep Learning Classification** tool is "Up" or not:

```
result("DeepLearningClassification:0", "Class")=="Up"
```

The expression below evaluates if the class name result from the **Deep Learning Classification** tool is "Up" or "Down":

```
(result("DeepLearningClassification:0", "Class")=="Up") or
(result("DeepLearningClassification:0", "Class")=="Down")
```

When the expression below is used as **Result** for the **Digital Output** tool, a digital output signal is activated for each image that has class index 1.

Expression:

```
result("DeepLearningClassification:0", "ClassIndex")=="1"
```

Result value/Result type:

true/boolean

#### Reference

The **Expression** tool supports a set of operators and functions for result handling. See the tables below for details.

Table 9: Mathematical operators

Operator	Result type	Description
^	NUM	Exponentiation
/	NUM	Division
*	NUM	Multiplication

Operator	Result type	Description
+	NUM	Addition
-	NUM	Subtraction

Table 10: Logical operators

Operator	Result type	Description
>	BOOL	Larger than
>=	BOOL	Larger than or equal to
<	BOOL	Smaller than
<=	BOOL	Smaller than or equal to
==	BOOL	Equal to
!=	BOOL	Not equal to
and	BOOL	Logical and
or	BOOL	Logical or
not	BOOL	Logical not of a boolean x

Table 11: Mathematical functions

Function	Result type	Description
abs (x)	NUM	Returns the absolute value of x
acos (x)	NUM	Returns the arccosine of x in radians.
asin (x)	NUM	Returns the arcsine of x in radians.
atan (x)	NUM	Returns the arctangent of x in radians.
atan2 (y, x)	NUM	Returns the arctangent of y/x (in radians), but uses the signs of both parameters to find the quadrant of the result.
ceil (x)	NUM	Rounds x up to the nearest integer.
cos (x)	NUM	Returns the cosine of x in radians.
cosh (x)	NUM	Returns the hyperbolic cosine of x in radians.
deg (x)	NUM	Converts radians to degrees.
exp (x)	NUM	Returns e to the power of x ( $e^x$ ).
floor (x)	NUM	Rounds x down to the nearest integer.
fmod (x, y)	NUM	Returns x modulo y.
getX (a)	NUM	Returns the x-coordinate value of a.
getY (a)	NUM	Returns the y-coordinate value of a.
log (x)	NUM	Returns the natural logarithm of x.
log10 (x)	NUM	Returns the logarithm of x (base 10).
max (a, b)	NUM	Returns the maximum value of a and b.
min (a, b)	NUM	Returns the minimum value of a and b.
pow (x, y)	NUM	Returns x to the power of y ( $x^y$ ).
rad (x)	NUM	Converts degrees to radians.
sin (x)	NUM	Returns the sine of x in radians.
sinh (x)	NUM	Returns the hyperbolic sine of x in radians.
sqrt (x)	NUM	Returns the square root of x.
tan (x)	NUM	Returns the tangent of x in radians.



Function	Result type	Description
$\tanh(x)$	NUM	Returns the hyperbolic tangent of x in radians.

Table 12: Mathematical constants

Constant	Result type	Description
pi	NUM	Returns the value of pi.
true	BOOL	
false	BOOL	

Table 13: General variables

Variable	Result type	Description
ImageNumber	NUM	Returns the image number for the currently acquired image.
OverallResult	BOOL	Returns the overall result, based on the tool results for the applied Analysis tools.

### 5.3.2.2 Result String tool

- “ ” The **Result String** tool is used for creating a text string, based on the available tool results. The created string can be used by the communication tools that support sending strings to external devices.

#### Settings

Setting	Description
String Formatter	Create an output string by inserting any combination of the following options into the <b>String Formatter</b> : <ul style="list-style-type: none"> <li>Tool result: Select an option from the list and click <b>Add</b>. The result is inserted at the end of the current string.</li> <li>Static text: Write the text directly in the String Formatter.</li> <li>Line break: Type <code>\n</code>.</li> </ul> The resulting output string is displayed as the <b>Output string</b> in the <b>Results</b> section.
Number of decimals	Select the number of decimals to display in the output string for results of number type.
Boolean representation	Select how to format boolean values in the output string.

The **Add** list contains the available results for the current job. See the tool help pages for descriptions of the tool results and corresponding variable names.

#### Result

Result	Description
Output string	The output string, based on the text string created in the <b>String Formatter</b> in the <b>Settings</b> section. The <b>Output string</b> is updated for each new image.

#### Output format

When creating the output string, the included tool results are converted to string format according to the table below:

Tool result type	Format	Example
string	The string value.	"Hello"

Tool result type	Format	Example
int	Value converted to string.	"234"
bool	Value converted to string.	"true"
float	Value converted to string, with the number of decimals according to the <b>Number of Decimals</b> setting.	"245.56"
Point	"x,y" with the number of decimals according to the <b>Number of Decimals</b> setting.	"16.45,43.98"
Shape_LineSegment	"x1,y1,x2,y2", where the values correspond to the x- and y-coordinates of the endpoints on the line segment. Number of decimals according to the <b>Number of Decimals</b> setting.	"16.76,201.83,89.02,45.09"

### Examples

Examples of formatted strings and the corresponding output strings are shown below.

#### Format a test string

String Formatter:

```
Hello World
```

Corresponding output string:

```
Hello World
```

#### Format a test string with a line break

String Formatter:

```
Hello \nWorld
```

Corresponding output string:

```
Hello
```

```
World
```

#### Format a string which includes the image number

String Formatter:

```
Image number: \n\ImageNumber()
```

Corresponding output string:

```
Image number:
```

```
83
```

#### Format a string which includes the number of blobs from the BlobCounter0 tool

String Formatter:

```
Number of blobs: \n\result("BlobCounter:0", "NumBlobs")
```

Corresponding output string:

```
Number of blobs:
```

```
4.00
```

#### Format a string which includes the result and the coverage for the PixelCounter0 tool

String Formatter:

```
{\result("PixelCounter:0", "Pass");\result("PixelCounter:0", "Coverage")}
```

Corresponding output string:

```
{false;82.12}
```

#### Format a string which includes a result that does not exist

String Formatter:

```
\result("BlobCounter:0", "InvalidResultName")
```

Corresponding output string:

```
{Error: Tool BlobCounter:0 has no result named InvalidResultName}
```

#### Format a string which includes a tool that does not exist

String Formatter:

```
\result("InvalidTool:0", "Result")
```

Corresponding output string:

```
{Error: Tool InvalidTool:0 is not found}
```

### 5.3.3 Communication tools

The **Communication** category contains tools for sending results to external devices.

Click or Drag and drop tools from the tool box (to the left of the tool tree) to the **Communication** category to add them to the tool tree. Click a tool in the tool tree to display its tool pane, which contains tool settings.

#### 5.3.3.1 Digital Output tool



The **Digital Output** tool sends tool results to the device's digital outputs.

When a **Digital Output** tool has been added to the tool tree, click it to view a list of available ports and edit the associated settings.

To configure additional ports as outputs, use the **I/O Configuration** tool on the **System** page.



#### NOTE

The digital outputs are only active in **Run** mode.



#### NOTE

An **I/O Configuration** tool instance must be added before the **Digital Output** tool can be used. The ports that are set as **OUT/Digital Output** by the **I/O Configuration** tool are available in the **Digital Output** tool.

#### Settings

The following settings are available for each digital output port:

Setting	Description
Enabled	Activate the port for output signals.

Setting	Description
Result	Select a result which will give output signal HIGH. The <b>Result</b> list contains the following options: <ul style="list-style-type: none"> <li>• <b>All Passed</b>: A <b>Pass</b> result for all <b>Analysis</b> tool instances gives output signal HIGH.</li> <li>• All <b>Expression</b> tool instances where the output is a boolean value: A <b>True</b> result for the selected tool instance gives output signal HIGH.</li> <li>• All <b>Analysis</b> tool instances: A <b>Pass</b> result for the selected tool instance gives output signal HIGH.</li> </ul>
Deactivate after	Deactivate the output signal after a defined time duration (pulse length). If the <b>Deactivate after</b> checkbox is not selected, the output signal will remain HIGH until a new result is available.

The **State** indicator displays the current status based on the **Result**. For example: If **Result** is set to **All Passed** and all tools **Pass** decision are true, the **State** indicator turns green.

### Output activation depending on Deep Learning Classification class name

In order to activate an output depending on the resulting **Deep Learning Classification** class name, **Expression** tools are needed. See the **Expression** tool help for examples.

#### 5.3.3.2 EtherNet/IP tool



The **EtherNet/IP** tool sends a byte stream assembly to a listening PLC using the EtherNet/IP™ standard, see [www.odva.org](http://www.odva.org). The assembly type-structure is predefined but the content of each position is editable.

The **EtherNet/IP** tool requires that EtherNet/IP is enabled. To enable EtherNet/IP:

1. Go to **Configure** mode.
2. Click **System** in the upper left part of the user interface.
3. In the **Fieldbus** section, select **EtherNet/IP**.
4. Click **Apply and reboot** to restart the device and apply the updated settings. If **Apply and Reboot** is inactive, it means that EtherNet/IP is already enabled.

### Settings

The **Settings** section displays the assembly configuration to send to the PLC. The order and length of the assembly cannot be changed by the user. The assembly configuration consists of the following data types:

Number of positions	Data type	Size	Range
12	SINT	1 byte	[-128, 127]
12	INT	2 bytes	[-32768, 32767]
11	DINT	4 bytes	[-2 <sup>31</sup> , 2 <sup>31</sup> -1]
12	REAL	4 bytes	Represented as IEEE 754 binary32 format

For each position in the assembly, select one of the following list options:

- Select **Empty** to set the value to zero (default option).
- Select a tool result. The results list includes all available results that are numbers or booleans.

If a float number is inserted into an integer position, the number is rounded down before sending it to the PLC. Boolean values are represented as integers, where 1 = true, 0 = false.

An EDS file for the InspectorP6xx is available from the "Fieldbus kit for InspectorP6XX" page in the SICK Support Portal, [supportportal.sick.com](https://supportportal.sick.com).

**NOTICE**

When inserting tool results into the assembly, make sure that the results are assigned the correct data type. If a result value is outside the available range for the assigned data type, no data is sent to the PLC.

**NOTICE**

When running the **Command Channel** via a **Fieldbus**, the first two assignable slots will be occupied by the **Job ID** and the **ErrorCode** from **Command Channel** responses. The dropdowns for these slots will be disabled.

**NOTE**

For Rockwell PLCs with Logix software: When copying data from an input assembly to a created UDT, copy the data from the third byte where the SINT array starts. According to the Logix alignment rule, arrays begin and end on 32-bit word boundaries. The InspectorPxx assembly has two reserved bytes first in the assembly. If copying from the first byte, the two first SINTs are used as padding.

### 5.3.3.3 Image Collection



The **Image Collection** tool is used to save acquired images to an FTP server or an SD card (if it is supported by the device). Saving images to an FTP server takes longer time. The saved images can be used by the dStudio software for training a Deep Learning network. The tool should be used during the collection phase. The tool should not be used default when going live since it will reduce performance.

The **Image Collection** tool makes it possible to append information such as image number and result variables to the filename of each image, to facilitate the labeling that is required for the training of the network.

**Settings**

Setting	Description
<b>Collection Mode</b>	Select the target medium to which to save the acquired images. Different devices support different collection modes. The mode <b>Disk</b> is only available when running on SICK AppEngine. <b>SD</b> is not available when running on SICK AppEngine.
<b>FTP Server IP Address</b>	Enter the IP address of the FTP server. The plugin assumes that you are using port 21. This option is only applicable if <b>Collection Mode</b> is set to <b>FTP</b> .
<b>FTP Username</b>	Enter the username to use for authentication towards the FTP server. This option is only applicable if <b>Collection Mode</b> is set to <b>FTP</b> .
<b>FTP Password</b>	Enter the password for authentication towards the FTP server. This option is only applicable if <b>Collection Mode</b> is set to <b>FTP</b> .

Setting	Description
Disk File Path	<p>This option is only visible when running on SICK AppEngine, and is the path where the images are saved.</p> <p>By default, <b>Disk File Path</b> is left empty. The default path, SICK AppEngine's public folder, is used. This folder is found by opening File Explorer and searching for %AppData% in the address bar, and press Enter.</p> <ul style="list-style-type: none"> <li>• This will navigate you to <code>../AppData/Roaming</code>.</li> <li>• Go one step back to <code>../AppData</code> and navigate into <code>../AppData/Local/SICK/SICK AppEngine/app-data/public</code>.</li> </ul> <p>The folder can also be found in AppManager in the tab "AppData". If a path is specified, the images will be saved at the specified location. A new folder called <code>nova</code> is created at the current file path if it does not exist, and should not be included in the file path.</p> <p>Examples of what a file path can look like:  <code>/C:/</code>, <code>C:/</code> and <code>C:</code>  Entering <code>C:/</code> in <b>Disk File Path</b> will save the images at <code>C:/nova</code>. This option is only applicable if <b>Collection Mode</b> is set to <b>Disk</b>.</p>
Sort into job folder	<p>Sort each saved image into a sub-directory on the target medium, based on which job that was active when the image was saved. When a job is active and the first image is saved, the corresponding sub-directory is created.</p>
Append instance to filename	<p>Append the name of the <b>Image Collection</b> tool instance to the filename of each acquired image. This option is recommended when more than one <b>Image Collection</b> tool instance is used, to avoid that images with identical filenames are overwritten.</p>
Append power-on count to filename	<p>Append the number of device resets to the filename of each saved image. The number of device resets is the total count since the device was produced.</p>
Append image number to filename	<p>Append the image number to the filename of each saved image. The image number is 1 for the first acquired image and increases by 1 for each image acquisition. The image number resets after each device reboot.</p>
Append string result to filename	<p>Append a string result, produced by a referenced tool, to the filename of each saved image.</p> <p>Examples:</p> <ul style="list-style-type: none"> <li>• Use a <b>Result String</b> tool instance to parse the image analysis output and then reference the tool instance to append the result string to the filename of the image.</li> <li>• Use a <b>Result String</b> tool instance to add free text in order to pre-classify the image.</li> </ul>
Save Image during Configure	<p>Save the acquired images in <b>Configure</b> mode, to allow the user to test the settings before entering <b>Run</b> mode. When running on SICK AppEngine this setting is activated by default since <b>Run</b> mode is not available when running on an emulator. For other devices, default is still to not save during <b>Configure</b>. Selecting this checkbox will only save images when in <b>Configure</b> mode.</p> <p><b>Save Image during Configure</b> does only affect <b>Configure</b> mode. If an <b>Image Collection</b> tool is added to a configuration, images will always be saved in <b>Run</b> mode. To stop saving images in <b>Run</b> mode, the <b>Image Collection</b> tool needs to be removed from the configuration.</p>

Setting	Description
Image downsample factor	The downsample factor for the saved images, compared to the acquired images. The downsample factor is applied both vertically and horizontally. For example, a downsample factor of 2 will resize a 1000 x 1000 px image into a 500 x 500 px image. Downsampling is recommended to save disk space and to decrease the processing time for images with high resolution.
Region reference	Crop each acquired image. The outer boundaries of the cropping area are defined by a referenced <b>Region</b> tool. Cropping is recommended for images that have a lot of variance and noise that is not useful for image classification.  Notes: <ul style="list-style-type: none"> <li>• Only positive rectangular regions can be used for cropping. If the referenced <b>Region</b> tool contains more than one region, the first positive rectangular region in the list is used. If the <b>Region</b> tool does not contain any positive rectangular regions, an error message appears.</li> <li>• If the referenced region is empty or invalid, no cropping is applied to the image.</li> <li>• If the position and rotation of the object of interest vary between the acquired images, link the connected <b>Region</b> tool to an <b>Object Locator</b> tool. See the <b>Object Locator</b> tool help for more information.</li> </ul>
Save condition	From the dropdown menu: <ul style="list-style-type: none"> <li>• Select <b>Always</b> to save the image, regardless of tool result.</li> <li>• Select a boolean tool result to save the image only if that result is true.</li> </ul> <p>Tool results can be combined as expressions. See the <b>Expression</b> tool help for more information.</p>

## Results

Result	Description	Variable name
Filename	The filename to be assigned to the currently displayed image when it is saved.	Filename
Image Information	The image resolution and estimated file size for the acquired image. The <b>Image Information</b> result helps the user estimate the number of images that can be stored on the target medium. The file size estimation is updated if the parameters related to the image resolution are changed.	ImageSize

### 5.3.3.4 Profinet tool



The **PROFINET** tool sends a 128-byte stream to a listening PLC using the PROFINET standard. The type-structure of the stream is pre-defined but the content of each position is editable.

The **PROFINET** tool requires that PROFINET is enabled on the device. To enable PROFINET:

1. Go to **Configure** mode.
2. Set the **System/Jobs** switch to **System**.
3. In the Systems tool tree, click **Fieldbus**.
4. In the **Mode** list, select **PROFINET**.
5. Click **Apply and reboot** to restart the device and apply the updated settings.

If **PROFINET** is selected and **Apply and Reboot** is inactive, it means that **PROFINET** is already enabled on the device.

**Settings**

The **Settings** section displays the configuration to send to the PLC. The configuration consists of the following data types:

Number of positions	Data type	Size	Range
12	SINT	1 byte	[-128, 127]
12	INT	2 bytes	[-32768, 32767]
11	DINT	4 bytes	$[-2^{31}, 2^{31}-1]$
12	REAL	4 bytes	

All data types are according to the IEC EN 61131-3 standard.

For each position in the configuration, select one of the following list options:

- Select **Empty** to set the value to zero (default option).
- Select a tool result. The results list includes all available results that are numbers or booleans.

If a float number is inserted into an integer position, the number is rounded down before sending it to the PLC. Boolean values are represented as integers, where 1 = true, 0 = false.



**NOTICE**

When inserting tool results into the configuration, make sure that the results are assigned the correct data type. If a result value is outside the available range for the assigned data type, no data is sent to the PLC.



**NOTICE**

When running the **Command Channel** via a **Fieldbus**, the first two assignable slots will be occupied by the **Job ID** and the **ErrorCode** from **Command Channel** responses. The dropdowns for these slots will be disabled.

5.3.3.5 Send String tool



The **Send String** tool sends text results from tools to an external device. When the system is in **Run** mode, a text string is sent to the external device for each new image.

**Settings**

Setting	Description
Interface	The ID of the interface tool that connects to the external device. All <b>TCP Client</b> and <b>TCP Server</b> tool instances in the <b>System</b> tool tree can be used.
Result	The tool instance that creates the text string to send as output.

5.4 Standard plug-in tools

The following standard plug-in tools are available for download. For information about installation process, see [see "Installing tools", page 18](#).



## 5.4.1 Analysis tools

### 5.4.1.1 Bead tool



The **Bead** tool verifies completeness, position and width tolerance of string-formed features, for example, glue beads. The reference position of the bead is configured with a polyline, with points placed along the center line of the reference bead.



#### NOTE

If the object position varies between the acquired images, this tool must be linked to an **Object Locator** tool. Tools which are linked to an **Object Locator** tool are repositioned according to the position of the located object. Drag and drop a created tool onto an added **Object Locator** tool to link them.

#### Settings

Setting	Description
Number of points	The number of points in the reference polyline.
Threshold	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. A high value means that higher contrast is required between the bright and dark sides of an edge.
Bead intensity	The intensity of the bead string. Set this value to <b>Bright</b> if the bead is brighter than the background, and <b>Dark</b> if the bead is darker than the background.
Width search range (px)	The range for how much the bead width (in pixels) is allowed to vary.
Position search range +/- (px)	Defines how much the position of the bead is allowed to differ from the reference polyline.
Distance between probes	The distance (in pixels) between the probes along the polyline. A short probe distance will provide a more precise trace of the bead string, but also increase the runtime.

#### Results

Result	Description	Variable name
Mean width	The mean width of the bead.	MeanWidth
Total number of too wide probes	The number of probe points where the bead is wider than the Width search range.	TooWide
Total number of too narrow probes	The number of probe points where the bead is narrower than the Width search range.	TooNarrow
Max number of too wide probes in sequence	The number of consecutive probe pairs that are wider than the Width search range.	TooWideInSequence
Max number of too narrow probes in sequence	The number of consecutive probe pairs that are narrower than the Width search range. This tolerance is useful for detecting gaps in the bead.	TooNarrowInSequence
Position tolerance	The maximum number of pixels the bead is moved in any direction from the position of the reference bead center line.	MaxPositionDeviation
Tool result	Total result, based on the set threshold values for all the other tool results.	Pass

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